Pre-Service Teachers' Intentions to Implement STEM Activities

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Abstract
Teachers' intention to adopt and implement curriculum reform is an important matter for success in achieving standards for education. Science-Technology-Engineering-Mathematics practices advocated in the current curriculum. In this research pre-service math and science teachers' intentions to implement STEM activities are investigated through the general framework of Theory of Reasoned Action. The questionnaires are formed by the researchers with the interviews and literature related to the theory. 260 pre-service math and science teachers from a state university in Turkey engaged in the research. The reliability and validity indexes of the questionnaires had evidence for the usability of the instruments. According to the results of the study, pre-service math and science teachers' attitudes towards STEM activities, perceived behavioral control and subjective norms had significant contribution to their intentions to practice STEM in their classrooms. Behavioral beliefs including perceived behavioral expectancy and perceived behavioral values were effective for explaining pre-service teachers' attitudes toward STEM. Subjective norms were significantly predicted by descriptive norms while injunctive norms did not significantly contribute to their formation. Perceived behavioral control is shaped by perceived difficulties rather than perceived behavioral convenience for STEM. Overall, the theory is effective and suitable in explaining pre-service teachers' STEM intentions and pre-service teachers had high intention scores for implementing STEM in their classrooms. Further research may concentrate on improving in-service and pre-service teachers' perceptions via effective implementations related to STEM both for their professional development and their students' development.
Keywords: Attitude, Behavioral Control, Intention, Norm, STEM

Introduction

In this century in many countries, school science curriculum is designed for two main objectives: scientific literacy for all people and providing pre-professional knowledge and skills for science areas. The students who are scientifically literate, can investigate, make effective decisions, find solutions to problems, study cooperatively, communicate effectively and are self-confident. According to current reform document (Ministry of National Education [MoNE], 2018); in science courses, active participation of students to solve scientific problems based on science and engineering practices is adopted as main strategy from an interdisciplinary perspective. According to an interdisciplinary perspective, Science Technology Engineering and Mathematics is defined as a student-centered learning approach that students construct alternative solutions to problems including planning, designing and producing processes (MoNE, 2018). In this learning process, teachers give guidance to students rather than dictating their own ideas. The teacher encourages students to express themselves in a democratic classroom atmosphere and promote scientific reasoning process.

On the other side, the results of research studies on STEM implementations in classrooms suggest evidence for improved critical thinking skills (Hacıoğlu & Gülhan, 2021), understanding and use of science process skills and science concepts and scientific knowledge (Robinson, Dailey, Hudges & Cotabish, 2014), and increased science and mathematics achievement (Hansen &Gonzalez, 2014). Although educational reforms and research studies emphasize the importance and effectiveness of implementing STEM approach, teachers' fail to use these strategies in their classroom. Success of any reform in education is mainly depending on teachers' understanding and practices of the strategies emphasized in the curriculum.

There is a gap between educational reform and teachers' interpretation and practices of these methods in their classroom. The issue of bridging the gap between reform and practice is not a new one. Clark and Yinger (1979) stated the importance of teachers' cognitive processes, thinking and behavior in their classroom practices. Therefore, understanding and explaining teacher behavior as means of implementing educational reforms in their classrooms emerges as an important research issue in education. In line with this idea, the main aim of this article is to investigate pre-service elementary math and science teachers' intentions to implement STEM in their classrooms.

Literature Review

The common result arising from the research studies is teachers' knowledge, values, attitudes and beliefs have a relation with teachers' instructional practices in various ways. Teacher beliefs are one of the most mentioned cognitive constructs in the instructional process. Therefore, literature related to teacher beliefs is synthesized, initially. The research studies about the Reasoned Action Approach in educational area are synthesized then.

Teacher Beliefs

The role of beliefs in teachers' instructional implementations has been emphasized by researchers for a long time (Clark & Yinger, 1979; Pajares, 1992; Levitt, 2001). Teachers' beliefs have a critical relationship with their reform-based practices (Bryan, 2012). Teachers have beliefs about learning, beliefs about teaching process, nature of science and knowledge, beliefs about context.

A group of research studies investigated pre-service teachers' beliefs through method courses, teaching practices and authentic learning experiences and those researchers tried to explain the inconsistencies between practices and beliefs of pre-service teachers in classroom context (Boz & Uzuntiryaki, 2006; Yıldız-Feyzioğlu, 2012; Mansour, 2013). In class studies that includes real classroom experiences of in-service teachers and pre-service indicate the importance of external factors as a facilitator or a barrier to motivate teachers for authentic instructional practices in addition to their general beliefs about teaching andlearning process (Crawford, 2007; Lotter, Harwood & Bonner, 2007; Kang, 2008).

In their study, Li, Kam and Zhang (2019) investigated limitations experienced by junior physical education teachers in a pliying STEM education in their classroom, specifically. The authors emphasized the role of physical education teachers' understanding of nature of STEM, subjective norms, their attitudes, and perceived behavior control variables in implementing STEM education in classrooms. Physical education teachers who have positive subjective norms, attitudes, and perceived behavior controls are found to be more inclined to use STEM in lessons.

Another factor namely teachers' behavioral intention and Technological Pedagogical Content Knowledge (TPACK) is asserted to be related to perceived variables for STEM practices. Cheung and Tse (2021) investigated in-service science teachers' pedagogical,technological and content knowledge, subjective norms,attitude and behavioral intentions and perceived behavioral control towards integrated STEM education. They pointed out that college science instructors' technological knowledge and attitude have significant effect on teachers' behavioral intention, while perceived behavioral control and subjective norms have little impact.

The research implies the importance of teachers' beliefs in their instructional decisions. However, it is not possible to make consistent explanations on teachers' instructional behavior when we just take into account general beliefs. This situation implies the relations of some other factors with teacher behavior as emphasized by various authors. We need more comprehensive and unified framework to explain teachers' instructional behaviors.

The Reasoned Action Approach

We used the reasoned action approach to explain pre-service teachers' intention to implement STEM activities in their classrooms (Fishbein & Ajzen, 2010). This approach is a general framework which consists of Theory of Reasoned Action and Theory of Planned Behavior. This framework asserts that particular social behavior can be represented by perceived behavioral control, perceived norms and attitudes toward behavior. Beliefs about target behavior have an important role in guiding behavior. Specifically normative beliefs,behavioral beliefs and control beliefs are distinguished. Behavioral beliefs serve as an informational base for negative or positive outcomes of a target behavior. Attitudes toward behavior are shaped through these behavioral beliefs. Opinions of other important peoples in relation to the certain behavior -when taken as a referent- are expressed as normative beliefs and these normative beliefs are assessed as a base for perceived norms. Environmental and personal factors that are thought to be effective in performing or impeding a certain action formed control beliefs. Control beliefs are the bases for perceived behavioral control. Perceived norm,attitudes and perceived behavioral control contribute to the formation of behavioral intentions. Behavioral intentions are best single predictor of behavior. Environmental factors and actual control on the behavior are also important. However, when it is not possible to understand actual control on the behavior, perceived behavior control can be used to understand the behavior (Fishbein & Ajzen, 2010). Various background factors such as sociocultural factors, attitudes, mood and past experiences may have role in shaping beliefs.

The Reasoned Action Approach is used for understanding different types of human social behavior including health related behavior, environmental behavior, political behavior, organizational behavior and discriminatory behavior. In educational area, the approach is used for understanding teacher behavior and intentions including implementation of science-technology-society relationships (Lumpe, Haney & Czerniak, 1998), thematic units (Czerniak, Lumpe, & Haney, 1999), evolutionary theory (Sultan-Kılıç, Soran & Graf, 2011), outdoor learning activities in science courses (Karademir, 2013),teaching STEM intention (Lin & Williams, 2015), implementing Next Generation Science Standards (Pierce, 2018) and energy saving behavior intention (Yuzuak & Erten, 2018). In these studies the results yielded different weights for explanatory constructs, and supported the validity of approach in explaining teacher intentions.

The studies from various domains indicate the explanatory power of The Reasoned Action Approach. Indeed, when it comes to explain teachers' instructional behaviors this approach provides a unified framework to understand the target behavior, at least teachers' readiness to practice the behavior. Since, the approach takes the beliefs as a reference point to explain the intentions to perform the specific behavior, as means of an instructional behavior; it also has a power to explain the inconsistencies within the current research about teachers' beliefs and practices.

Hypothesized Model of Research

The hypothesized relationships among the factors explaining pre-service teachers' intention to practice STEM activities in their classrooms are given in the Figure 1.

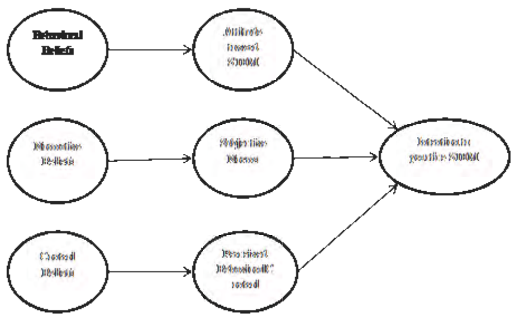

Figure 1 Hypothesized Relations among Variables Explaining Pre-Service Teachers' Intentions to Practice STEM Activities (Adapted from Fishbein & Ajzen, 2010)

According to the model, it is proposed that pre-service teacher' intentions to practice STEM activities can be represented in term of their attitudes toward STEM activities, perceived behavioral control and subjective norms. There are significant relationships among pre-service teachers' normative beliefs,control beliefs and behavioral beliefs about STEM activities. The relationships among their intentions to practice STEM activities and their beliefs namely normative,behavioral and control are mediated by their attitudes towards STEM activities, perceived behavioral controland subjective norms.

Significance of Study

Understanding pre-service teachers' intentions to implement STEM activities in their classrooms mainly provides us an insight about effective practice of the curriculum reform. It is not possible reach the objectives indicated in the curriculum unless teachers are not intended to practice the methods and tools emphasized in curriculum. Therefore, this study purposes to support the knowledge about the practice of future teachers from the view of both curriculum developers and researchers. The results of the study may be helpful for designing interventions to change and improve teachers' STEM practices.

Research Questions

The study aims to investigate two main research questions:

1. To what extend pre-service math and science teachers intend to implement STEM activities in their classrooms?
2. What are the relationships among the factors explaining pre-service math and science teachers' intentions to implement STEM activities in their classrooms?

Method

Research Design

Present research study aims to investigate the relationships among variables; therefore it is a correlational research (Fraenkel & Wallen, 2009). More elaborately, since it aims to explain teachers' intentions in terms of a variety of factors by collecting data during a single time period it is a cross-sectional, explanatory research (Johnson, 2001). In the present study, structural equation model analysis was used to test the likelihood of a causal connection among attitude toward STEM activities, behavioral beliefs (expectancy and value), perceived behavioral control, control beliefs (difficulties and convenience), subjective norms and normative beliefs (descriptive and injunctive) and intention to practice STEM activities of pre-service math and science teachers.

Sample

A total of 260 pre-service math and science teachers in a state university of Turkey participated in the research. A convenient sampling method is used to collect data from 284 pre-service teachers. After controlling of forms, incomplete or incorrect forms were excluded, and a remaining 260 valid form have been used for the research. Characteristics of sample are given in Table 1 below:

Table 1 Sample of the Study

		Frequency (f)	Percentages (%)
Department	Science	171	65.77
	Math	89	34.23
Grade Level	Freshman	38	14.62
	Sophomore	60	23.08
	Junior	67	25.77
	Senior	95	36.54
Gender	Female	193	74.23
	Male	67	25.77

Data Collection Tools

A STEM activities implementation scale including a variety of subscales is developed by the researchers in the light of the Reasoned Action Approach. The instrumentation process is designed through following procedure. The factors explaining intentions to act on the specific behavior are adapted to explain pre-service teachers' intentions to implement STEM activities in their classrooms. Semi-structured interviews are conducted with pre-service teachers to understand their STEM practices, beliefs of teaching, learning, context and obstacles for STEM activities. The interviews are assessed through the conceptual framework of the theory. The categories arising from the interviews are examined if they fit into conceptual structure of the Reasoned Action Approach. After producing the items relating to each factor of the explanatory framework, the questionnaire is assessed for construct validity through expert opinions. Reliability and validity analysis are held for constructs of the questionnaire by statistical procedures. Theoretically, the factors explaining teachers' intentions to implement STEM activities are given in the Table 2. The questionnaire aims to grasp each of these factors as constructs.

Table 2 The Classification of Factors which Aim to Explain Teachers' Intentions to Practice STEM Activities

Construct	Definition	Example Item
Intention to implement STEM activity	The subjective probability of implementing STEM activity	I plan to implement STEM activity in my courses.
Behavioral beliefs about implementing STEM activity	The beliefs regarding the probable outcomes of implementing STEM activity	The students learn concepts better when I implement STEM activity in my courses.
Normative beliefs	The beliefs about ideas of important people on STEM activity	The people who I appreciate their ideas, expect me to implement STEM activity in my course.
Control beliefs	The beliefs about constrains and easiness of STEMactivity	The students have enough prior knowledge for STEM activity.
Attitude toward practice STEM activity	The expression of favor or disfavor STEM activity	STEM activity practices are valuable-invaluable.
Subjective norms	Indication of social pressure to practice STEM activity	The important people for my career have expectancy on me to practice STEM activity.
Perceived behavioral control	Perceived ease or difficulty of STEM activity practice under control of teacher	It will be easy for me to practice STEM activity in my science classes if I want to do it.

Procedures

The main body of research is based on the understanding of the explanatory power of model of pre-service teachers' intentions to practice STEM activities. Therefore, in first phase of the study literature was reviewed for the relationships among variables explaining the intentions. The basic model about explaining the intentions was modified through the literature. The instruments were developed in line with this process. After the instrumentation, the researchers collected data for two or three monthsdue to Covid-19 pandemics.

Structural equation modeling was used to understand the relationships among the factors explaining pre-service teachers' intentions to implement STEM activities. Also, statistical procedures including exploratory factors analysis and calculation of reliability coefficients were used for validation of questionnaire for the study.

Reliability and Validity of the Questionnaire

Table 3 Factor Loadings of Scale According to Exploratory Factor Analysis (CFA)

Factor 1	Component											Component									
	1	2	3	4	5	6	7	8	9	10		1	2	3	4	5	6	7	8	9	10
a1					.72						d20		.75								
a2					.77						d21		.79								
a3					.75						d22		.59								
a4					.78						d23		.56								

a5					.74						d24		.69								
a6					.70						d25		.67								
a7					.73						d26		.67								
Factor 2											d27		.69								
b1										.45	d28		.73								
b2										.42	**Factor 5**										
b3										.52	e1									.53	
b4										.30	e2									.47	
b5										.45	e3									.63	
b6										.31	e4									.76	
b7										.40	e5									.76	
b8										.45	**Factor 6**										
Factor 3											f1			.74							
c1	.70										f2			.73							
c2	.68										f3			.46							
c3	.59										f4			.77							
c4	.65										f5			.74							
c5	.72										f6			.31							
c6	.71										f7			.68							
c7	.71										f8			.66							
c8	.68										f9			.75							
c9	.71										f10			.71							
c10	.77										f11			.67							
c11	.75										f12			.59							
c12	.67										f13			.74							
c13	.73										f14			.62							
c14	.75										**Factor 7**										
c15	.75										g1				.74						
c16	.61										g2				.77						
c17	.74										g3				.74						
c18	.76										g4				.79						
c19	.79										g5				.78						
c20	.77										g6				.74						
c21	.75										g7				.71						
c22	.63										g8				.73						
c23	.69										g9				.72						
c24	.72										g10				.75						
c25	.69										g11				.69						

c26	.76										g12				.70						
c27	.73										g13				.65						
c28	.72										g14				.75						
Factor 4											**Factor 8**										
d1		.69									h1								.68		
d2		.69									h2								.61		
d3		.65									h3								.73		
d4		.67									h4								.74		
d5		.76									h5								.69		
d6		.77									**Factor 9**										
d7		.76									i1						.71				
d8		.75									i2						.77				
d9		.74									i3						.73				
d10		.69									i4						.61				
d11		.72									i5						.45				
d12		.76									i6						.65				
d13		.73									**Factor 10**										
d14		.77									j1							.80			
d15		.65									j2							.85			
d16		.65									j3							.76			
d17		.77									j4							.72			
d18		.79									j5							.36			
d19		.72									j6							.73			

The construct validity of STEM Intention Questionnaire was analyzed by using Exploratory Factor Analysis (EFA). The Kaiser-Meyer-Olkin test is measuring of sampling adequacy for STEM Intention Questionnaire was .935, and Barlett's Test of Sphericity was found to be statistically significant at $\chi2(7260) = 37329.024$, $p < .000$. STEM Intention Questionnaire was suitable for EFA. All items could remain in the EFA. For the 121 items, the data analysis revealed a 10-factor solution and accounted for 69.90% of the sample variance. Cronbach's α values for intention to practice stem, attitude toward stem, behavioral beliefs (expectancy), behavioral beliefs (value), perceived behavioral control, control beliefs (difficulties), control beliefs (convenience), subjective norms, normative beliefs (descriptive) and normative beliefs (injunctive) were .96, .90, .98, .98, .82, .91, .98, .94, .91 and .85, respectively (Table 3).

Table 4 Factor Loadings of Scale According to Confirmatory Factor Analysis (CFA)

	t	**Path coefficients**		**t**	**Path coefficients**		**t**	**Path coefficients**
Factor 1:α = .958			Factor4: α = .980			Factor7:α = .973		
a1	17.4	.86	d1	14.32	.76	g1	15.06	.78
a2	19.43	.92	d2	13.63	.73	g2	15.85	.81
a3	19.25	.92	d3	12.26	.67	g3	15.57	.80

a4	18.69	.90	d4	12.33	.68	g4	17.39	.86
a5	17.16	.86	d5	16.69	.84	g5	18.24	.89
a6	16.11	.82	d6	17.45	.86	g6 (deleted)		
a7	16.78	.84	d7	17.34	.86	g7	17.25	.86
Factor 2:α = .942			d8	15.67	.81	g8	17.26	.86
b1	16.80	.85	d9	16.66	.84	g9	17.64	.87
b2	17.83	.88	d10	14.40	.76	g10	17.99	.88
b3	17.46	.87	d11	15.59	.80	g11	17.10	.85
b4	12.21	.68	d12	15.38	.79	g12	16.75	.84
b5	16.08	.82	d13	14.73	.77	g13	17.03	.85
b6	15.01	.79	d14	15.14	.79	g14	17.40	.86
b7 (deleted)			d15	14.53	.76	Factor 8:α = .937		
b8	16.22	.83	d16	13.31	.72	h1	15.45	.80
Factor 3:α = .982			d17	17.02	.85	h2	15.05	.79
c1	14.55	.76	d18	17.91	.88	h3	19.46	.93
c2	14.62	.77	d19	15.16	.80	h4	18.66	.90
c3	12.12	.67	d20	16.50	.83	h5	18.16	.89
c4	13.90	.74	d21	17.21	.86	Factor 9: α= .909		
c5	16.46	.83	d22	11.71	.65			
c6	16.44	.83	d23	11.77	.65	ı1	16.98	.86
c7	16.69	.84	d24	14.75	.77	ı2	17.50	.87
c8	14.90	.78	d25	14.41	.76	ı3	16.51	.84
c9	15.13	.79	d26	13.99	.75	ı4	13.58	.74
c10	16.12	.82	d27	14.88	.78	ı5	11.07	.63
c11	17.28	.86	d28	15.59	.80	ı6	15.36	.80
c12	14.88	.78	Factor5: α = .823			Factor10:α=.852		
c13	16.21	.82	e1	10.18	.60	j1	12.75	.72
c14	16.94	.85	e2	9.42	.56	j2	16.35	.85
c15	15.45	.80	e3	10.68	.62	j3	14.58	.79
c16	13.46	.72	e4	15.39	.81	j4	12.42	.70
c17	16.78	.84	e5	17.20	.87	j5	6.39	.40
c18	17.59	.87	Factor6: α = .915			j6	12.55	.71
c19	17.23	.86	f1	13.72	.74			
c20	17.99	.88	f2	14.44	.77			
c21	16.76	.84	f3	13.99	.75			
c22	13.69	.73	f4	16.27	.83			
c23	14.03	.75	f5	13.50	.73			
c24	15.16	.79	f6 (deleted)					
c25	14.84	.78	f7	13.02	.71			

c26	16.43	.83	f8	11.71	.66			
c27	14.82	.77	f9	15.48	.68			
c28	15.25	.79	f10	13.89	.73			
			f11	11.33	.59			
			f12	10.26	.64			
			f13	13.42	.75			
			f14	12.17	.80			

Since STEM Intention Questionnaire was a new instrument, Confirmatory Factor Analysis (CFA) wasused to control whether the model build through EFA show coherence with the model constructed in CFA. This is the first reason for CFA as represented by Schumacker and Lomax (2012). In this study, the CFA analysis for STEM Intention Questionnaire indicated that three items (b7, f6 and g6) had a low regression weight, and so it was deleted to enhanced the model fit. The last model ensured satisfying goodness of fit indices for CFA model (Table 5); and STEM Intention Questionnaire was validated with 118 items and 10 factors as showed in Table 4.

Table 5 Fit Indices Results from Confirmatory Factor Analysis (CFA)

Fit indices	Value	Criterion
NFI	.95	Excellent
NNFI	.97	Excellent
IFI	.97	Excellent
RFI	.95	Excellent
CFI	.97	Excellent
GFI	.51	Good
AGFI	.50	Good
RMR	.089	Good
RMSEA	.067	Good
$\chi 2$/df	2.17	Excellent

Results

In this study, the effects of attitude toward STEM, behavioral beliefs (expectancy and value), perceived behavioral control, control beliefs (difficulties and convenience), subjective norms and normative beliefs (descriptive and injunctive) on intention to practice STEM activities of pre-service math and science teachers were investigated. For this purpose, first of all, descriptive statics and correlation values of the variables in research are included. The obtained values are given in Table 6.

Table 6 Descriptive Statics and Correlation Values for Variables in the Model

Factors	1	2	3	4	5	6	7	8	9	10
1	1	.697**	.613**	.490**	.460**	.454**	.476**	.519**	.292**	.135*
2		1	.770**	.635**	.344**	.315**	.586**	.523**	.339**	.142*
3			1	.731**	.361**	.340**	.638**	.551**	.347**	.167**
4				1	.304**	.246**	.679**	.503**	.346**	.230**
5					1	.779**	.250**	.363**	.481**	.280**
6						1	.299**	.452**	.556**	.307**
7							1	.562**	.407**	.294**
8								1	.533**	.280**
9									1	.454**
10										1
$\bar{X}$	39.77	43.46	174.71	183.21	24.87	58.55	82.56	28.79	30.65	35.12
SD	8.31	6.47	23.20	19.09	5.35	14.71	11.75	5.78	7.86	6.50
N	260	260	260	260	260	260	260	260	260	260

**"Correlation is significant at the 0.01 level (2-tailed)".

*"Correlation is significant at the 0.05 level (2-tailed)".

Büyüköztürk (2006) stated that the relationship between 0-0.29 is low, the relationship between 0.30-0.69 is medium, and the relationship between 0.70-1.00 is high. When Table 6 is examined, a low correlation was found between normative belifes (injunctive) scores and scores of other factors except for control beliefs (difficulties) and normative beliefs (descriptive), and a low correlation was found between control beliefs (difficulties) and perceived behavioral control, control beliefs (convenience) and perceived behavioral control, intention to practice STEM and normative beliefs (descriptive). Also, a moderate and positive relationship was found between other variables. The average scores obtained from the scale were found as 39.77 for intention to practice stem, 43.46 for attitude toward stem, 174.71 for behavioral beliefs (expectancy), 183.21 for behavioral beliefs (value), 24.87 for perceived behavioral control, 58.55 for control beliefs (difficulties), 82.56 for control beliefs (convenience), 28.79 for subjective norms, 30.65 for normative beliefs (descriptive) and 35.12 for normative beliefs (injunctive).

Research Model

In this research, firstly, the model presented in Figure 2 was tested, and it was concluded that normative beliefs (injunctive) did not directly affect subjective norms and control beliefs (convenience) did not directly affect perceived behavioral control. In the measurement model, other variables affected each other in accordance with the TPB model. Detailed path coefficients and t values of measurement model was given in the appendix 1 and 2.

Table 7 Fit Indices of Research Model

Fit indices	Value	Criterion
NFI	.95	Excellent
NNFI	.97	Excellent
IFI	.97	Excellent
RFI	.95	Excellent
CFI	.97	Excellent
GFI	.51	Acceptable
AGFI	.50	Acceptable
RMR	.087	Good
RMSEA	.068	Good
$\chi 2/df$	2.18	Excellent

As seen as Table 7, the fit values for model (χ^2/sd=2.18; RMSEA=0.068; NFI=0.95; IFI=0.97; CFI=0.97; GFI=.51) was acceptable. Thus, all the indicators suggested an overall fit for structural model explaining intention to practice STEM activities.

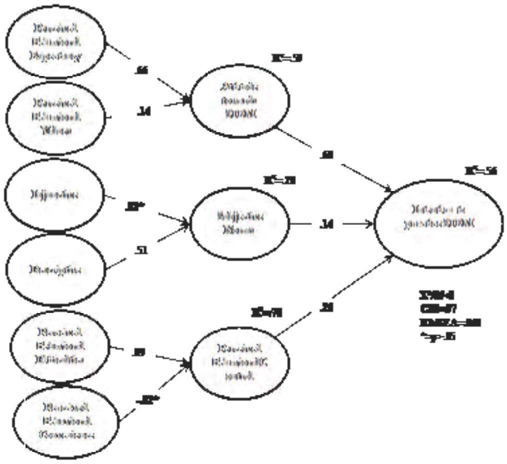

Figure 2 Research model

In the research model, perceived behavioral beliefs (expectancy and values related to STEM activities) accounted for 59% of the variance in pre-service science and math teachers' attitude towards STEM (Figure2). More specifically, results demonstrated that perceived behavioral expectancy (β= .66) was positively and significantly associated with pre-service math and science teachers' attitude towards STEM. Also, perceived behavioral value(β= .14) was positively and significantly associated with pre-service math and science teachers' attitude towards STEM. These results pointed out that pre-service math and science teachers' behavioral beliefs regarding STEM practices including their values and expectancy were antecedents for their attitude towards STEM.

In the research model, injunctive and descriptive normative beliefs accounted for 28% of variance in pre-service science and math teachers' subjective norms (Figure 2). More specifically, results demonstrated that injunctive normative beliefs (β= .03) did not significantly associate with pre-service math and science teachers' subjective norms. Besides, descriptive normative beliefs (β= .51) significantly and positively associated with pre-service science and math teachers' subjective norms. These results represented that pre-service science and math teachers' subjective norm towards STEM was predicted by their descriptive normative beliefs towards STEM.

In the research model, perceived behavioral beliefs including perceived difficulties and convenience accounted for 78% of the variance in pre-service science and math teachers' perceived behavioral control (Figure 2). More specifically, results demonstrated that perceived behavioral difficulties (β= .89) were positively and significantly associated with pre-service science and math teachers' perceived behavioral control while perceived behavioral convenience (β= - .02) did not significantly associate with pre-service science and math teachers' perceived behavioral control towards STEM. These findings implied that perceived difficulties regarding implementing STEM activities were explaining pre-service science and maths teachers' perceived behavioral control towards implementing STEM activies.

Regarding the relationship of intention to practice STEM with attitude towards STEM, subjective norms, perceived behavioural control, results showed that attitude towards STEM (β= .60), subjective norms, (β= .14) and perceived behavioural control (β= .26) was associated with intetion to practice STEM (R2= .56). Therefore, pre-service math and science teachers who have favorable attitude toward STEM, high level of subjective norms and perceived behavioural control, inclined to practice STEM. Moreover, pre-service math and science teachers who show positive attitude to integrate STEM acitivities in their classroom, also believe that they may overcome difficulties of integrating STEM activities in their classroom. In addition, candidate teachers expressing the expectations of persons, institutions or organizations, are also likely to integrate STEM activities in their classroom.

Table 8 Indirect Effects

Path	Total Indirect	p	Supported (p<0.05)
PBE →INT	.40	0.000	Supported
PBV → INT	.087	0.025	Supported
NBI →INT	.004	0.668	Not Supported
NBD →INT	.073	0.007	Supported
PBD →INT	.23	0.000	Supported
PBC →INT	-.005	0.66	Not Supported

As seen as Table 8, total indirect effects of perceived behavioral expectancy and values, injunctive and descriptive normative beliefs, perceived behavioral difficulties and convenience on the intetion to practice STEM activities were given. Results showed that perceived behavioral expectancy (β= .40), perceived beahvioral values (β= .087), injunctive normative beliefs (β= .004), descriptive normative beliefs (β= .073), perceived behavioral difficulties (β= .23) and perceived behavioral convenience (β= -.005) was associated with intetion to practice STEM (R2= .38). Therefore, pre-service math and science teachers have high level of perceived behavioral expectancy and values, descriptive normative beliefs, perceived behavioral difficulties inclined to practice STEM activities.

Discussion and Conclusion

Pre-service math and science teachers' intentions to practice STEM activities were positively and significantly related to their subjective norms, attitudes, and perceived behavioral control towards STEM activities. As another important finding, perceived behavioral expectancy and perceived beahvioral value toward STEM activities significantly and positively associated with pre-service science and math teachers' attitude towards STEM activities. Although injunctive normative beliefs toward STEM activities did not significantly and positively associate with pre-service science and math teachers' subjective norms toward STEM activities, descriptive normative beliefs toward STEM activities significantly and positively associated with their subjective norms toward STEM activities. Even though perceived behavioral convenience toward STEM activities negatively and did not significantly associate with pre-service science and math teachers' perceived behavioral control towards STEM activities, perceived behavioral difficulties toward STEM activities significantly and positively associate with their perceived behavioral control toward STEM activities. In conclusion, pre-service math and science teachers have favorable attitude toward STEM activities, high level of subjective norms and perceived behavioural control toward STEM activities inclined to practice STEM.

There are similar results with the results of this research in literature. Lin and Williams (2015) researched on pre-service science teachers' behavioral intention toward STEM education. As a consequence, favorable subjective norms and perceived behavioral control were associated with positive intention to teach STEM in terms of direct and positive effects. Higher knowledge and more favorable attitude were indirectly associated with favorable subjective norms and perceived behavioral control, which lead to more powerful STEM teaching intention. Similarly, Li, Kam and Zhang (2019) found that subjective norms, attitudes, and perceived behavior control significantly explained physical education teachers' behavioral intentions to STEM, which was coherent with the theory of planned behavior. Cheung and Tse (2021) carried out a study about in-service science teachers' technological pedagogical content knowledge (TPACK) and their behavioral intention towards STEM education. Science teachers' technological knowledge and attitude have favorable impact on teachers' behavioral intention, while perceived behavioral control and subjective norms have little effect.These findings of current study and studies in literature confirmed the usability of TPB in understanding pre-service mathand science teachers' intentions to implement STEM activities in their classrooms. Besides, the results supplied first-hand direct evidence for policymakers to promote STEM activities in science and math teacher education.

One of the important findings of the study is total indirect effects of perceived behavioral expectancy and values, descriptive normative beliefs, perceived behavioral difficulties on the intetion to practice STEM activities. However, pre-service math and science teachers' injunctive normative beliefs and perceived behavioral convenience did not significantly influence on their intention to implement STEM activities in their classroom. Cheung and Tse (2021) found that attitude has a positive influence on behavioral intention, while other variables do not have any important effects. Lin and Williams (2015) concluded that if we want to increase the applicability of STEM programs by pre-service teachers, the focus on rising the value of STEM teaching (values), improving pre-service teachers' proficiency in overcoming difficulties about STEM teaching (perceived behavioral control) and school administration and principals promote for practice STEM teaching (subjective norms), were essential. Çetin and Kahyaoğlu (2018) found that even though pre-service teachers have a favorable attitude toward STEM education and 21st century skills, they do not feel completely sufficient to apply STEM education and they feel inadequate especially to use STEM education application tools (Arduino, Fischer). In the present study, pre-service teachers' perceived behavioral expectancy and values, perceived behavioral difficulties in STEM activities were associated with intentions to practice STEM activities through positive attitudes toward STEM activities and perceived behavioral control. Hacıömeroğlu (2018) concluded that pre-service teachers have a favorable attitude towards STEM teaching and have a positive intention on the integration of STEM teaching. In addition, although they are aware of the obstacles and difficulties they will encounter towards STEM teaching integration, they will show positive behavior towards the implementation of STEM teaching. In conclusion, if subjective norms, attitudes, and perceived behavioral control towards implementation of STEM activities may be improved, pre-service math and science teachers' intention to practice STEM activities in their schoolroom may have enhanced. The integration of STEM activities in pre-service teachers' classroom helps their middle school students develop their STEM-related skills in the future.

Although the pre-service education of math and science teachers favorably affects their subjective norms,attitudes and perceived behavioral control towards STEM activities, they cannot completely reduce their perceived behavioral difficulties and anxiety towards STEM activities. Consequently, it is significant to carry out research to resolve their perceived behavioral difficulties and anxieties about STEM activities.

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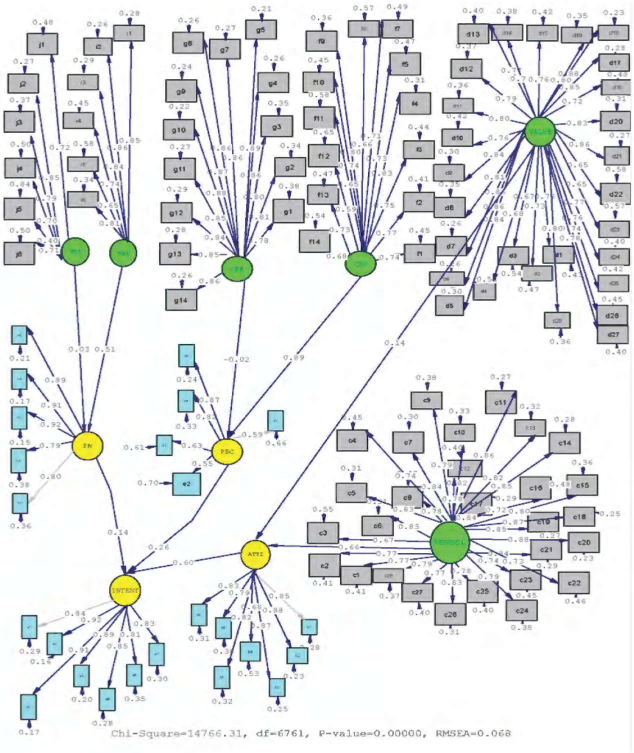
Appendix 1 Path Coefficients of Measurement Model



Appendix 2 T Values of Measurement Model