

Predicting Pre-service teachers' intention to implement education for sustainable development: A fuzzy-set qualitative comparative analysis

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Abstract

Implementation of Education for Sustainable Development is a complex social phenomenon. This research aims to suggest ways to strengthen the implementation of ESD, identifying the factors affecting pre-service teachers' intention of implementing ESD. To this end, the author focused on revealing the different combinations of conditions predicting Korean pre-service teachers' intention to implementing education for sustainable development (ESD). The research method is the fuzzy sets qualitative comparative analysis (fsQCA) using the set-theoretic relations, starting from the premise that social phenomena have causal complexity characteristics. An analysis of 245 valid questionnaires from Korean pre-service teachers resulted in three main findings. The author suggested that teacher education institutions need to include content related to ESD in the teacher education curriculum so that pre-service teachers can cultivate positive attitudes toward ESD and improve their self-efficacy in student engagement and instruction in the context of ESD.

Keywords Education for sustainable development; ESD; Fuzzy-set Qualitative Comparative Analysis(fsQCA), Necessary Condition; Self-responsibility; self-efficacy; Theory of planned behavior

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1. Introduction

Teachers play a critical role in implementing education for sustainable development (ESD). Becoming a teacher is a continuing process from pre-service experience to the end of a professional career. From this perspective, implementing ESD can be formed from the pre-teacher period. Therefore, as a part of exploring strategies for implementing ESD, it is very important to identify the factors affecting pre-service teachers' intention of implementing ESD. In the Theory of Planned Behavior (TPB), frequently used to elucidate human behaviors, the intention is emphasized as a direct antecedent of the behavior. Therefore, the investigation of pre-service teachers' intention to implement ESD would be the first step to predict whether teachers would implement ESD.

Despite TPB's contribution to explaining behavior, some researchers have argued that attitude, subjective norms, and perceived behavioral control (PBC) are insufficient for predicting the expected behavioral intentions. Therefore, they have merged additional indicators to TPB for predicting behavioral intentions (Hasbullah, Mahajar & Ithnin, 2014; Gao, Wang, Li & Li, 2017; Fan et al., 2012).

For example, Aziz et al., (2021) added environmental ethics and emotional intelligence to the TPB to explain university employees' pro-environmental behavior (PEB). Also, Chen and Tung (2014) extended the TPB model with perceived moral obligation and environmental concern to formulate behavioral intention. Similarly, Botetzagias and colleagues (2015) also incorporated moral norms into the extended TPB model to predict the recycling intention. These researches imply that personal injunctive norms, or moral norms, play an essential role in the intention of behaviors with a moral or ethical component such as environmental behavior. Furthermore, prior researches strongly suggest that environmental ethics, moral obligation, and environmental concern, as well as TPB's three determinants, can be just as significant predictors for certain behavior intention. Therefore, this author combined pre-service teachers' responsibility to implement ESD as a teacher, personal injunctive norms, and TPB's three predictors to predict their intention to implement ESD. In this regard, the fuzzy set research method was used in this study.

Therefore, this author tried to merge pre-service teachers' self-responsibility to implementing ESD, personal injunctive norms, to TPB's three predictors, focusing on their intentions to implement ESD. For this purpose, the author used the fuzzy set research method, unlike the popular research methods in TPB fields, which is regression analysis or structural equation modeling (SEM). In these methodologies, the effect of the independent variable on the dependent variable was analyzed while controlled the level of the rest of the independent variables was controlled, but, the independent variables are not independent of one another in reality. Therefore, despite the significant applicability of these methodologies, they have a limit.

Furthermore, several conditions can be deemed necessary but insufficient for causation to be determined in SEM (Beran & Violato, 2010) because social phenomena are characterized by causal complexity, defined as conjunctural causation, equifinality, and causal asymmetry (Kapsali, 2012). Pre-service teachers' intentions to implement ESD also is a complex social phenomenon. Hence, pre-service teachers' intention to implement ESD rarely has any single factor, and whose factors interact in multiple ways and rarely work in isolation from each other. Due to such causal complexity of intention of implementing ESD, there is a need to use methodological approaches to reveal its antecedents' complex interactions. One alternative method to assess complex causality is fuzzy sets qualitative comparative analysis (fsQCA) using set theory (Ragin, 2006; Ragin, 2008; Schneider & Wagemann, 2012; Schneider & Eggert, 2014).

Purpose of study

To explain the causal complexity of intention of implementing ESD, this study focused on identifying the factors affecting pre-service teachers' intention of implementing ESD, using the set-theoretic analytical approach fuzzy-set qualitative comparative analysis (fsQCA). Hence, this study aims to reveal sufficient combinations of the four variables to predict pre-service teachers' intention of implementing ESD and offer a deeper insight into the TPB. Along with noting the combination of the four variables, this is, to my knowledge, the first attempt in the literature to identify the necessary factors of TPB for achieving desired behavioral intentions among pre-service teachers.

2.Literature Review

The Theory of Planned Behavior (TPB), one of the most influential conceptual frameworks explaining human behavior, suggests that intention is determined by attitude, subjective norm, and perceived behavioral control (Ajzen, 1991). In this theory, behavioral intention, defined as one's willingness to perform a specific behavior, is the main predictor of actual behavior. Attitude, subjective norm, and perceived behavior control (PBC) are key predictors of behavioral intention and act jointly to determine behavioral intention (Ajzen, 1991).

Attitude is defined as one's positive/negative evaluation of specific behavior. The subjective norm is the perceived social pressure that encourages one to engage in a particular behavior. Ajzen (1991) pointed out that when predicting an individual's behavior, the specific behavior will be related to the reference group, and social pressure and compliance motivation are the functions of the subjective norm.

Ajzen (1991) suggested that perceived behavior control can account for considerable variance in behavioral intention and actions. When people believe they have more resources such as time, money, and skills, their perceptions of control are high, increasing their behavioral intentions. Perceived behavioral control can be referred to as a difficulty perceived by the individual while performing a specific behavior. It predicted intention above and beyond attitude toward the behavior and subjective norms. Additionally, some meta-analyses indicated a direct influence of perceived behavioral control on behavior (McEachan et al., 2011).

Despite the fact TBP has significant applicability, recent research has attempted to extend (Conner and Armitage, 1998) and dissect (Rhodes & Courneya, 2003) the TPB. Above all, regarding extending TPB, some researchers have argued that TPB indicators are insufficient for predicting the expected behavioral intentions and need to be extended to support conceptual models for predicting behavioral intentions (Park & Smith, 2007). Aziz et al., (2021) added environmental ethics and emotional intelligence to the TPB to explain university employees' pro-environmental behavior (PEB). Chen and Tung (2014) extended the TPB model with perceived moral obligation and environmental concern to formulate behavioral intention. Similarly, Verma and Chandra (2018) merge moral reflectiveness and consciousness into the TPB to the proposed structural model. Botetzagias et al., (2015) integrated moral norms into the extended TPB model to predict behavioral intention. Chen (2016) proposed the extended TPB model, including moral obligation to explain people's energy savings and carbon reduction behavioral intentions to mitigate climate change, which increases explanatory power. Also, one's moral obligation plays a significant role in predicting one's intentions and even may weaken or eliminate the impact of one's perceived behavioral control.

Meanwhile, Wang and colleagues proposed the extended theory of planned behavior (TPB) model, integrating TPB with the theory of environmental regulation. Regarding the dissection of TPB's three indicators, a recent study has focused on the value of splitting attitude, subjective norms, and PBC into two components. First of all, attitudes are replaced with affective and instrumental ones. The semantic differential measures of attitude used in TPB studies often have focused more on instrumental or cognitive (e.g., desirable–undesirable, valuable–worthless) compared to experiential or affective (e.g., pleasant–unpleasant, interesting–dull) aspects of attitudes (Ajzen & Drive, 1992). However, the affective measures of attitudes were more closely linked to intentions and behavior (Lawton, Conner & McEachan, 2009)

Another indicator, subjective norms are elaborated with injunctive norms, which refer to social approval of the act, and descriptive social norms, which mean perceptions of what others do and refer to the popularity of a specific action (White et al., 2009; Cialdini, Kallgren & Reno, 1991). Past research shows some evidence that these two types of perceived norms operate differently and have differential effects on various drinking-related intentions and behaviors (Park, Klein & Smith, 2009)

Therefore, social influence does not simply reflect perceived pressure from significant others but also reflects perceptions that other people engage in the behavior themselves (descriptive norms) and through the construction of internalized moral principles (personal norms). These results support the argument that social factors are essential within the theory of planned behavior and support the inclusion of additional sources of social influence into the TPB

(Park & Smith, 2007; Park, Klein & Smith, 2009). Park and Smith (2007) also note that injunctive norms can also be perceived at a personal as well as a societal level, defining them as "individuals' beliefs regarding approval or disapproval of the behavior in question," either by valued others or societal members.

As one of the personal norms, self-responsibility means not only having the ability to respond, decide, and choose but further to participate in an engaged, most practical possible fashion in taking responsibility for ones' entire life. This character trait of self-responsibility is synonymous with self-accountability (Lawton, Conner & McEachan, 2009). In addition, the author adds a personal injunctive norm, the pre-service teachers' self-responsibility, to TBP in this study. Finally, though PBC can be considered as a unitary latent variable, nonetheless, it can be spitted into separable components, self-efficacy (e.g., ease/difficulty, confidence) and controllability (e.g., personal control over behavior) (Ajzen, 2002).

3.Methods and Materials

Data Collecting

The data was collected from June 1st, 2018, to September 15th, 2018. The convenience sampling method was preferred. All missing data were deleted, and 245 cases were qualified for analysis. Among 245 valid samples, 79% were female and 21% male. Freshman, sophomore, and junior had a distribution of 19%, 28%, and 40%, respectively, while senior accounted for a relatively small percentage at 12%. The more detailed demographic information of pre-service teachers is displayed in Table 1.

Table 1. Teacher Demographics

Characteristics		Respondents	
Gender	Male	51	20.8
	Female	194	79.2
Year	Freshman	47	19.2
	Sophomore	69	28.2
	Junior	99	40.4
	Senior	30	12.2
Major	English	30	12.2
	Social Studies	193	78.8
	Physics	1	0.4
	Special Education	10	4.1
	Mathematics	11	4.5

1.1.1. Variables and Measurement Instrument

An outcome variable often referred to as the dependent variable, is an intention to implement ESD (IT). Causal variables, which are often referred to as the independent variables, are pre-service teachers' attitudes toward ESD (AT), social norm (SN), pre-service teachers' self-efficacy in the ESD (TSE), and pre-service teachers' responsibility to implement ESD. Each scale was based on previous studies, but a few adaptations were applied to match this study. All of them applied a four-point Likert scale with a range of 1 to 4: 1-Strongly Disagree, 2-Disagree, 3-Agree and 4-Strongly Agree. The Likert scale is noncomparative and only measures a single trait. To establish the reliability and validity of the scales, the author used exploratory factor analysis, confirmatory factor analysis (CFA), and Cronbach's alpha test of internal consistency. First of all, exploratory factor analysis followed by the principal axis factoring technique using a varimax rotation with an eigenvalue greater than 1 was performed for each of the variables included in this study. Then,

items with communality less than 0.40 were removed, and items with a loading less than 0.40 on component were deducted. EFA for Pre-service teachers' self-efficacy in ESD (PTSE) led to a solution comprising two factors, as shown in Table 2. As shown in Table 1, Kaiser-Meyer-Olkin (KMO) show that the sampling is adequate for factor analysis (its value ranged from 0.8 to 0.9 indicates data are likely to factor analysis well, (Hutcheson & Sofroniou, 1999) . Also, Bartlett's Test of Sphericity indicates that this data is likely suitable for factor analysis. Pre-service teachers' self-efficacy in ESD was assessed with seven items to cover the two factors (self-efficacy in instruction related to ESD and self-efficacy in student engagement in ESD). However, these were reproduced through exploratory factor analysis, which accounted for 70.36% of the variance.

Table 2. :Factors loadings from Principal Axis Factoring technique with Varimax rotation

	Pre-service teachers' self-efficacy in student engagement in ESD (PTSS)	Pre-service teachers' self-efficacy in instruction in ESD (PTSI)
I am convinced that I can motivate even students who show low interest in learning when I implement ESD.	0.84	0.16
I am confident that I can be responsive to the learning needs of students in ESD class.	0.81	0.23
I am confident that I can stimulate my students to participate in ESD-related activities.	0.77	0.31
I am confident that I can effectively implement instructional strategies suitable for ESD.	0.07	0.89
I am confident that I can accurately evaluate student activities related to ESD, using a variety of assessment strategies.	0.33	0.76
I am confident that I have the content knowledge to implement ESD.	0.30	0.69
I am confident that I can integrate content related to ESD into the subject matter.	0.58	0.63
Eigenvalue	2.50	2.42
Percentage of variance explained	35.75	34.61

KMO coefficient 0.86 Bartlett's test of sphericity 0.000

EFAs for intention (IT), attitude toward ESD (AT), and social norm (SN) each extracted a single factor. IT, AT, and SN accounted for 58.07%, 67.670%, and 75.43% of the variance. Although the percentage of variance explained for IT is less than 60%, it can be considered that the criterion of cumulative variance is met because a solution that accounts for 56.6 percent of the total variance can be considered to be satisfactory (Peterson, 2000).

Confirmatory factor analysis was also conducted to assess the construct validity of items. The construct validity was tested by composite reliability (CR) and the average variance extracted (AVE) indices. The construct validity was tested by composite reliability (CR) and the average variance extracted (AVE) indices. When generally CR is more than 0.7, and AVE is more than 0.5, they are considered acceptable. But, even though AVE is less than 0.5, only if CR is higher than 0.6, then the construct's convergent validity can be considered still adequate (Hair et al., 2010). Also, Cronbach's alpha was measured to test internal consistency. Cronbach's alpha coefficient of 0.70 and above is considered to be good. Table 3 presents variables, measurement items, AVE, CR, and Cronbach's α .

Table 3 : Variables and Measurement

Variables	Items	AVE	CR	Cronbach'α
IT	I am willing to implement ESD in my classroom.	0.65	0.85	0.82
	I plan to implement ESD in my classroom.			
	I am willing to do my best to implement ESD even if school support is insufficient.			
PTSS	I am confident that I can motivate even students who show low interest in learning when implementing ESD.	0.59	0.81	0.82
	I am confident that I can be responsive to the learning needs of students in ESD class.			
	I am confident that I can stimulate my students to participate in ESD-related activities.			
PTSI	I am confident that I can effectively implement instructional strategies suitable for ESD.	0.55	0.83	0.82
	I am confident that I can accurately evaluate student activities related to ESD, using various assessment strategies.			
	I am confident that I have the content knowledge to implement ESD.			
AT	I am confident that I can integrate content related to ESD into the subject matter.	0.58	0.83	0.82
	Implementing ESD in my classroom is beneficial			
	Implementing ESD in my classroom is controversial*			
SN	Implementing ESD in my classroom is an unrealistic approach*	0.67	0.89	0.89
	Implementing ESD in my classroom is useful.			
	Some instructors recommend that I implement ESD			
RE	It is expected of me that I implement ESD.	0.43	0.75	0.75
	I feel under social pressure to implement ESD.			
	People who are important to me want me to implement ESD.			
RE	I have a belief that teachers have to teach students to connect their lives with sustainable development.	0.43	0.75	0.75
	I believe that teachers should design ESD to develop the competencies necessary for the future society.			
	I have a belief that teachers should develop the competencies to implement ESD.			
RE	I have a belief that teachers have to integrate ESD into their subjects or implement it as cross-curricular.	0.43	0.75	0.75
	I have a belief that teachers have to integrate ESD into their subjects or implement it as cross-curricular.			

*Note: * indicate reverse coding. The questionnaire consisted of how strongly you agreed or disagreed with the following statements, and all variables were estimated on a 4-point scale. IT: intention to implement ESD, AT: Attitude toward ESD, PTSS: Pre-service teachers' self-efficacy in student engagement in ESD, PTSI: Pre-service teachers' self-efficacy in ESD instruction, SN: Social pressure on ESD, RE: Responsibility for implementing ESD as a teacher.*

The convergent validity for each variable was met for the criteria to be considered acceptable. Also, all constructs exhibited Cronbach's α reliability coefficient values greater than 0.70. Thus, the internal consistency of each construct indicates high internal consistency reliability.

Analysis Method and Analysis Tools

This research method is fsQCA based on the premise that social phenomena have causal complexity characteristics. fsQCA uses the set-theoretic relations such as necessary condition and sufficient condition. fsQCA evaluates causal necessity and causal sufficiency through consistency, which measures the proportion of members of the subset that are members of the superset, and coverage, which gauges a configuration's empirical relevance (Ragin, 2006; Ragin, 2008; Schneider & Eggert, 2014; Schneider & Wagemann, 2012) fsQCA uses the probabilistic concept of quasi-sufficiency, based on specific benchmarks: almost always sufficient (significantly passing a standard of 0.8), usually sufficient (significantly passing a standard of 0.65), or sufficient more often than not (significantly passing a standard of 0.50) in causing the outcome. Descriptive analyses, EFA, and reliability analyses were conducted using SPSS version 25.0 for Windows. CFA was carried out using the AMOS 26.0, and convergent validity analysis was performed using the construct calculator. The fsQCA software version 2.5 for Windows was used for fsQCA.

Results

Distribution to teachers' response

Table 4: Descriptive Statistics and Qualitative Anchors

Variable	Mean	SD	Median	Min.	Max	Qualitative anchors		
						full membership	cross-over	full non-membership
IT	8.97	1.77	9	3	12	0.8	0.66	0.2
AT	13.25	1.95	13	8	16	0.8	0.62	0.2
SN	7.76	3.07	8	4	16	0.8	0.33	0.2
PTSS	8.11	1.95	9	3	12	0.8	0.66	0.2
PTSI	9.11	2.64	9	4	16	0.8	0.42	0.2
RE	12.92	1.67	13	8	16	0.8	0.62	0.2

Note. IT: intention to implement ESD, AT: Attitude toward ESD, SN: Social pressure on ESD, PTSS: Pre-service teachers' self-efficacy in student engagement in ESD, PTSI: Pre-service teachers' self-efficacy in instruction in ESD, RE: Responsibility for implementing ESD as a teacher.

A descriptive analysis was carried out to examine the distribution of teachers' responses. A fuzzy-set scale's degree of membership ranges from a score of 0 (full exclusion) to 1 (full inclusion). All conditions must be transformed into calibrated sets using three qualitative anchors. Three anchors must be included the threshold for full membership (fuzzy score =0.95), the cross-over point (fuzzy score = 0.5), and the threshold for full non-membership (fuzzy score = 0.05) (Ragin, 2008 ; Ajzen, 1991). These three anchors need to be based on theoretical and substantive knowledge of the cases. Since there are no explicit external standards for calibration, the threshold values were determined using the sample's existing distribution. All indicators were normalized using the min-max normalization method. The threshold for full membership (fuzzy score =0.95) was set at 0.8, and the threshold for full non-membership (fuzzy score = 0.05) was set at 0.2. The cross-over point was set at median. For example, membership in the set of intention to implement ESD (IT), coding membership as fully out of the set if a pre-service teacher showed causal values of 0.2 or below and fully in the set if a pre-service teacher showed causal values of 0.8 or higher. The cross-over point was set at 0.67, which corresponds to the median value of 9. Table 4 summarizes the descriptive statistics and three anchors for each of the variables.

Analysis of Necessary Conditions

As the first step to necessary condition analysis, five causal conditions' positive and negative forms were included in the necessary analysis. Table 3 includes analyzing the necessary conditions of AT, SN, PTSS, PTSI, and RE for pre-service teachers' intention to implement ESD. For necessary conditions analysis, consistency of more than 0.90 is recommended (Schneider & Wagemann, 2012) and the acceptable level of consistency for the test of necessary condition was set at 0.90. Since consistency for conditions ranged from 0.45 to 0.88, none of the variables is necessary condition for pre-service teachers' intention to implement ESD.

Table 5: Necessary conditions for intention to implement ESD

Variable	High Level		Low Level	
	Consistency	Coverage	Consistency	Coverage
	0.80	0.79	0.60	0.46
~AT	0.45	0.59	0.72	0.74
SN	0.52	0.73	0.50	0.54
~SN	0.67	0.64	0.75	0.55
PTSS	0.68	0.88	0.55	0.54
~PTSS	0.64	0.65	0.88	0.68
PTSI	0.63	0.75	0.60	0.55
~PTSI	0.62	0.66	0.73	0.61
RE	0.78	0.85	0.58	0.49
~RE	0.53	0.62	0.82	0.74

Note. ~ indicate logical negation and is interpreted as the absence of factors, AT: Attitude toward ESD, SN: Social pressure on ESD, PTSS: Pre-service teachers' self-efficacy in student engagement in ESD, PTSI: Pre-service teachers' self-efficacy in instruction in ESD, RE: Responsibility for implementing ESD as a teacher.

Analysis of sufficient conditions

To identify the configurations leading to pre-service teachers' intention to implement ESD, truth table analysis was performed, an aggregated form of the raw data, and has as many rows as possible combinations of values on the causal conditions. The configurations leading to high intention to implement ESD can differ from those leading to low intention due to the asymmetry causality. Regarding this characteristic, researchers recommend that fuzzy-set analysis of the negation of the outcome be conducted separately from the outcome analysis (Ragin, 2006; Ragin, 2008; Schneider & Eggert, 2014; Schneider & Wagemann, 2012). Therefore, in this study, fsQCA leading to high intention to implement ESD was carried out separately from fsQCA leading to low intention to implement ESD separately.

Table 5 shows the distribution of cases across combinations of causal conditions for them. The number of logically possible configurations is $32(2^5)$. Greckhamer and his colleagues recommend that a minimum typically higher (3+) threshold should be used when the total N (number of cases) is large, and a threshold be chosen to retain at least 80% of the cases (Greckhamer, Vilmos & Fiss, 2013). Therefore, the frequency threshold was set at 3, which accounted for 94%, as presented in the number column in Table 5. In order to select a consistency threshold to differentiate causal combinations that were subsets of the outcome from those that were not, both raw consistency and PRI (proportional reduction in inconsistency) consistency have to be considered together so that we can avoid simultaneous subset relations of configurations in both the outcome presence and its absence. A reasonably well-established raw consistency threshold for sufficiency analysis is 0.80 and PRI consistency values less than 0.5 indicate significant inconsistency (Ragin, 2006). Considering both raw consistency and PRI consistency, raw consistency threshold was set

at 0.9 while PRI consistency threshold was set at 0.5. '1' was assigned for configurations that meet both the raw consistency threshold and the PRI consistency threshold, and '0' was assigned for configurations that did not meet either of the two consistency thresholds.

Table 6: Truth table showing causal conditions of intention to implement ESD

AT	SN	PTSS	PTST	RE	N(%)	High Level		Low Level	
						raw consist.	PRI consist.	raw consist.	PRI consist.
0	1	1	1	0	20(11%)	0.85	0.48	0.85	0.48
1	0	0	0	1	18(22%)	0.92	0.79	0.70	0.17
1	1	1	1	1	17(31%)	0.98	0.95	0.62	0.05
0	0	0	0	0	16(41%)	0.71	0.19	0.91	0.76
1	0	0	0	0	11(47%)	0.87	0.46	0.88	0.52
1	0	1	0	1	8(52%)	0.99	0.96	0.66	0.04
1	0	0	1	1	7(56%)	0.96	0.88	0.75	0.12
1	1	1	0	1	6(59%)	0.99	0.96	0.67	0.04
1	1	0	1	1	6(63%)	0.96	0.85	0.76	0.11
1	0	1	1	1	6(66%)	0.99	0.96	0.66	0.02
1	1	1	1	0	6(69%)	0.95	0.76	0.83	0.24
0	1	1	1	1	6(73%)	0.92	0.67	0.83	0.33
0	0	0	0	1	6(76%)	0.86	0.44	0.89	0.56
0	1	0	1	0	6(80%)	0.81	0.32	0.90	0.65
0	0	1	1	0	5(83%)	0.91	0.58	0.87	0.42
0	0	1	1	1	4(85%)	0.96	0.84	0.80	0.16
1	0	1	1	0	3(87%)	0.97	0.85	0.85	0.15
0	1	0	1	1	3(89%)	0.91	0.53	0.89	0.47
0	0	1	0	1	3(90%)	0.95	0.74	0.85	0.26
0	1	0	0	0	3(92%)	0.81	0.32	0.91	0.66
0	0	1	0	0	3(94%)	0.91	0.51	0.91	0.49
1	0	1	0	0	2(95%)	0.95	0.69	0.89	0.31
0	0	0	1	0	2(96%)	0.88	0.41	0.91	0.59
1	1	0	0	1	1(97%)	0.97	0.90	0.75	0.10
1	1	0	0	0	1(97%)	0.94	0.63	0.90	0.37
1	0	0	1	0	1(98%)	0.95	0.69	0.88	0.31
0	1	0	0	1	1(98%)	0.95	0.69	0.88	0.31
0	0	0	1	1	1(99%)	0.95	0.72	0.87	0.28
0	1	1	0	0	1(100%)	0.90	0.44	0.92	0.56
1	1	1	0	0	0				
1	1	0	1	0	0				
0	1	1	0	1	0				

Note. bold font indicates configurations that are sufficient for the outcomes of pre-service teachers' intention to implement ESD

AT: Attitude toward ESD, SN: Social pressure on ESD, PTSS: Pre-service teachers' self-efficacy in student engagement in ESD, PTSI: Pre-service teachers' self-efficacy in instruction in ESD, RE: Self-responsibility for implementing ESD as a teacher.

After the truth table was constructed, a standard analysis was performed, producing the complex, intermediate, and parsimonious solutions. Although three solution formulas differ in their degree of complexity, they are logically true because they do not contradict the available empirical information in the truth table (Ragin, 2008). Schneider and Wagemann (2012) suggest providing at least two solution formulas. One is based on simplifying assumptions on the logical remainders, which is parsimonious solutions. Another one without any such simplifying assumption always leads to more complex solutions. In this research, both intermediate and parsimonious solutions related to pre-services teachers' intention to implement ESD were summarized in table 7.

Table 7 :Main Configurations for pre-service teachers' intention to implement ESD

	High Level				Low Level	
	HI1	HI2	HI3	HI4	LI1	LI2
AT	●		●	●		
SN		●				●
PTSS		●	●			
PTSI			●	●		
RE	●	●		●		
Consistency	0.91	0.90	0.96	0.97	0.89	0.89
Raw coverage	0.52	0.34	0.45	0.53	0.43	0.33
Unique coverage	0.11	0.03	0.02	0.03	0.24	0.14
Overall solution consistency		0.86			0.88	
Overall solution coverage		0.77			0.57	

Note. Black circles represent the presence of a condition, and circles with × indicate its absence. Large circles represent core conditions; small ones represent peripheral conditions. Blank spaces represent "don't care", which means a corresponding condition is not considered in a configuration. AT: Attitude toward ESD, SN: Social pressure on ESD, PTSS: Pre-service teachers' self-efficacy in student engagement in ESD, PTSI: Pre-service teachers' self-efficacy in ESD instruction, RE: Self-responsibility for implementing ESD as a teacher.

In Table 7, each column represents a configuration of causal conditions with their corresponding raw coverage, unique coverage, and solution consistency. Each configuration represents the alternative paths for the outcome. These are consecutively numbered HI1, HI2, HI3, and HI4. Noticeably, the existence of multiple sufficient configurations indicates equifinality. The numbers at the bottom of the table represent the coverage and consistency of the solution as a whole.

Table 7 shows the results of a fsQCA for the high intention to implement ESD and a fsQCA for its low level together. When the consistency of the configuration is generally above 0.8, and the coverage scores more than 0.3, it is considered adequate (Ragin, 2006). As shown in Table 7, all configurations satisfied the consistency of the configuration above 0.8, and the coverage scores more than 0.3. Considering the coverage, the findings indicate an overall consistency of 0.86 and an overall solution coverage of 0.77, which suggests that four configurations can explain 77% of the empirical evidence, and the overall consistency of the four conditions is appropriate.

Table 7 shows the presence of both core conditions and peripheral conditions, where the core condition indicates a stronger causal relationship with the outcome. In contrast, peripheral conditions indicate a weaker causal

relationship with the outcome.

HI1($AT \cap \sim SN \cap RE$) provides a path for leading pre-service teachers' high intention to implement ESD by combining the positive attitude toward ESD and high self-responsibility, despite the low perceived social pressure on ESD. HI2 ($SN \cap PTSS \cap RE$) reflects the combination with the lowest coverage. However, the strong self-responsibility combined with high self-efficacy in student engagement and high perceived social pressure is still sufficient for the intention to implement ESD. Meanwhile, HI3 ($AT \cap PTSS \cap PTSI$) indicates that positive attitudes in conjunction with high self-efficacy in student engagement and high self-efficacy in instruction lead to pre-service teachers' high intention to implement ESD.

HI4 ($AT \cap PTSI \cap RE$) reflects the combination with the highest coverage, which means that it can be seen as the best path in representing pre-service teachers' high intention to implement ESD. HI4 substitute self-responsibility for self-efficacy in student engagement, compared with HI3.

In Table 7, the final two configurations (LI1, LI2) show paths leading to pre-service teachers' low intention to implement ESD. The two configurations can explain 57% of the empirical evidence, and the two conditions' overall consistency is appropriate. A negative attitude toward ESD and absence of responsibility are common core conditions for two configurations.

More specifically, LI1($\sim AT \cap \sim SN \cap \sim PTSS \cap \sim RE$) indicates that a negative attitude toward ESD and a low perceived social pressure combined with low self-efficacy in student engagement and absence of responsibility is sufficient for pre-service teachers' low intention to implement ESD. LI2 ($\sim AT \cap SN \cap \sim PTSI \cap \sim RE$) indicates that although pre-service teachers perceived social pressure, a negative attitude toward ESD combined with low self-efficacy in instruction and absence of responsibility is sufficient for low intention to implement ESD.

4. Discussion

This research aims to suggest ways to strengthen their intention to implement ESD, identifying the factors affecting pre-service teachers' intention of implementing ESD (Fornell & Larcker, 1981; Verma & Chandra, 2018). To this end, the author focused on revealing the different combinations of conditions predicting Korean pre-service teachers' intention to implementing education for sustainable development (ESD).

The most important finding from the study is that this research identified different paths for pre-service teachers to be willing to try to implement ESD. More specifically, four distinct paths were extracted clearly to explain the high level of intention to implement ESD; meanwhile, two distinct paths were extracted to explain the low intention of implementing ESD. These findings confirmed that the intention to implement ESD has characteristics of conjunctural causation, equifinality, and causal asymmetry (Tschannen-Moran & Woolfolk, 2001; Sagdıç & Şahin, 2016).

Notably, it confirmed that pre-service teachers would plan to implement ESD only when a variable is combined with other variables, and neither variable is sufficient. To the best of my knowledge, this research is the first empirical study to model pre-service teachers' intention to implement ESD using fsQCA, which provides a deeper insight into the ESD implementation among teachers.

5. Conclusion

Research findings support that while it is true that the TPB's three determinants of intention are strong predictors of intention to implement ESD, self-responsibility, individual norm, can be just as significant predictors for it. This finding is the other originality of this study because, to date, there is little research merging pre-service teachers' self-responsibility within the TPB in the context of ESD. Research findings imply a need to include ESD in the teacher education curriculum so that pre-service teachers can cultivate positive attitudes toward ESD and self-responsibility of implementing ESD and improve their self-efficacy in student engagement and self-efficacy in instruction in the context

of ESD. The inclusion of ESD in the teacher education curriculum has significant meanings because teacher education can strengthen the positive attitude toward ESD, self-responsibility, and pre-service teachers' self-efficacy in ESD and act as social pressure.

Although this study makes some noteworthy contributions to the existing literature, limitations must be considered. First of all, in large-N fsQCA studies, stratified-sampling was recommended for the sample to represent the population's diversity of cases better. Nevertheless, there is a limit in securing the population's diversity of cases because this study chose non-probability convenience sampling as the sampling method. Furthermore, therefore, the results of this study might not be generalized to the whole of Korean secondary pre-service teachers.

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