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Determinants of pro-environmental behavior among excessive smartphone usage children and moderate smartphone usage children in Taiwan

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Abstract:

Background: Although there are evidences linking the relationships between smartphone usage with health, stress, and academic performance; however, there is still inadequate knowledge about the influence on pro-environmental behaviors. This study seeks to bridge this gap by adapting the theory of attribution framework to examine the effects of personal norms, social norms, perceived behavioral control on pro-environmental behavior of smartphone usage in children.

Methods: A total of 225 children aged between 11 to 12 from eight selected public primary schools at the Hsinchu Science and Industrial Park in Taiwan were surveyed. Two distinct groups (excessive versus moderate usage) were purposefully selected for comparison, and of which 96 (42.7%) participants were regarded as excessive smartphone users while the remaining 129 (57.3%) were moderate smartphone users.

Results: Findings revealed significant differences between excessive smartphone usage children and moderate smartphone usage children in personal norms ($p < 0.001$), social norms ($p = 0.002$), perceived behavioral control ($p = 0.001$), and pro-environmental behavior ($p = 0.001$), where moderate smartphone usage children's responses were considerably higher than those of excessive smartphone usage children. Path analysis suggested that the two smartphone usage groups had different pro-environmental behavior paths. For excessive smartphone usage children, findings showed that social norms ($\beta = 0.428$, $t = 4.096^{***}$, $p < 0.001$) had a direct predictive impact on pro-environmental behavior. In contrast, while there was no direct path established between personal norms and pro-environmental behavior ($\beta = 0.177$, $t = 1.580$, $p > 0.05$), as well as social norms and pro-environmental behavior for moderate smartphone usage children ($\beta = 0.181$, $t = 1.924$, $p > 0.05$), but such a relationship could be developed through the mediating effect of perceived behavioral control ($\beta = 0.497$, $t = 4.471^{***}$, $p < 0.001$).

Conclusions: In conclusion, findings suggested that excessive smartphone usage children lack positive perceived behavioral control, and their pro-environmental behavior could only be predicted through explicit social norms. Whereas, pro-environmental behavior of moderate smartphone usage children were implicitly influenced by personal norms through perceived behavioral control.

Keywords: pro-environmental behavior; perceived behavioral control; personal norms; social norms; smartphone usage; children

Background

Nowadays, smartphones are becoming increasingly popular that have brought many changes to our day-to-day lives, particularly with the ease of access to a vast variety of mobile applications for the purpose of internet

browsing, gaming, social networking, communication, and so on. This phenomenon has seen the number of smartphone users grow steadily from 2.5 billion in 2016 to 2.9 billion in 2018, and is expected to reach 3.8 billion by 2021 globally [1]. The growth is stimulated by the many benefits (e.g. entertainment, banking, socializing, and gaming) offer by smartphones, and this has been attested by past studies [2, 3, 4]. Although there are numerous advantages of using smartphones, but several side effects have also arisen due to the excessive smartphone usage. Particularly, the widespread use of smartphones is regarded as a factor influencing pro-environmental behavior, leading to disconnect people from the natural environment which has become substantial worldwide psychological and behavioral issues [5, 6]. While it remains controversial whether smartphone usage cause disconnectedness between people and natural environment [7, 8], studies have found that adults who spent extended amount of time on smartphone in a day are more likely to exhibit a stronger negative pro-environmental behavior [8, 9]. Such extensive smartphone usage behavior is not only limited to adults, but also evident in children who are increasingly smartphone users nowadays. The smartphone technology has changed a child's growth and development, and there are evidences to support a close correlation between health, behavior and smartphone use [6, 10].

Studies show that children have abandoned physical outdoor activities and their curiosity about the natural environment, which may have direct health and behavioral benefits, and instead spending their time and energy on smartphones [11, 12]. Other studies have also investigated several different aspects of smartphone usage, such as factors influencing smartphone usage [13, 14], impact of smartphone usage on social relationships [15], the effects of smartphone usage on academic performance [16], and relationship between smartphone usage and stress [17, 18]. However, there are very few studies attempted to combine the two fields of smartphone usage and environmental behaviors together, and explore their relationship. Therefore, the key focus of this study is to fill this gap by investigating specifically the impact of smartphone usage on children's pro-environmental behaviors. This is particularly important because experiences gained through interactions with the environment during the early human development phase can have a considerable influence on a person's perception of the environment [19].

Conceptual framework and hypotheses

In the present study, we used Attribution Theory to explain the causes of children's pro-environmental behavior. Attribution theory posits that a behavior can be influenced by situations that arise from internal and/or external attributions [20, 21]. Internal attributions refer to causes of behavior related to some internal characteristic, and

the two key elements involve are: (1) perceived behavioral control, and (2) personal norms. Perceived behavioral control is related to an individual's perceived ease or difficulty of performing personal capabilities to control external challenges [22]. Whereas personal norms refer to an individual's perceived moral obligations when taking an action; it is a kind of environmental self-awareness and self-discipline, which is believed to be associated with the generation of pro-environmental behavior [23, 24, 25]. On the other hand, external attributions are causes of behavior result from some situations or events outside a person's control. Social norms is a key component of external attributions that goes beyond attitudes that shape people's behaviors, and can be further classified as (1) subjective norms, and (2) descriptive norms [26, 27, 28]. Figure 1 below shows the proposed research framework for this study.

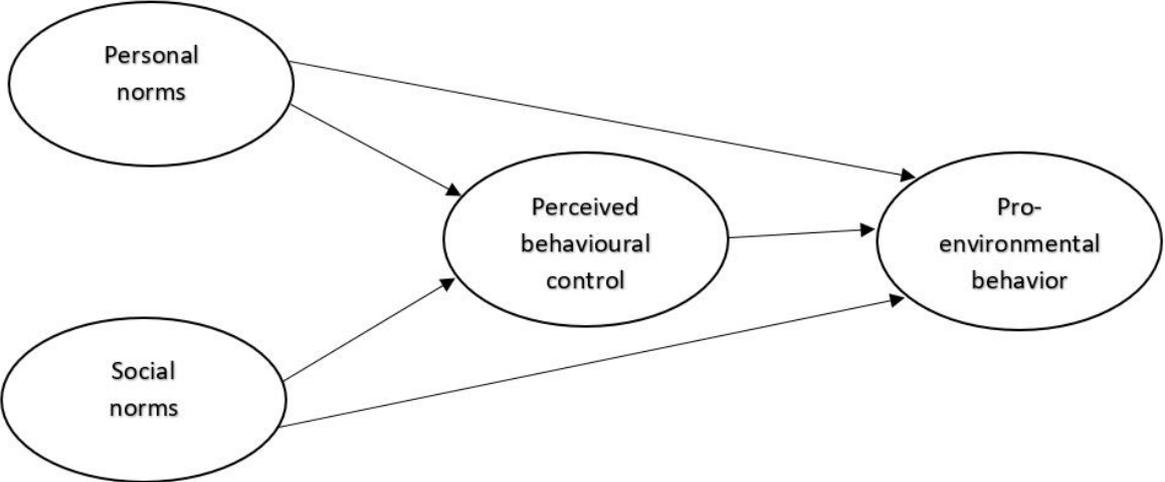


Figure 1. Proposed research framework

This study has adapted the Attribution Theory to investigate the pro-environmental behavior of children in Taiwan, whereby the ownership of smartphones in children aged between 10 to 12 has grown significantly from 38.7% in 2013 to 82.7% in 2019 [29]. This alarming trend has elicited considerable related discussions (e.g. counter measurements for smartphone usage, responsibilities of the government and parents, social impact, cyber bullying), and is an increasingly concerning social phenomenon in Taiwan that requires further understanding of the situation [30]. Specifically, this research will seek to examine how internal attributions (perceived behavioral control, personal norms) and external attributions (social norms) have a direct/indirect association with children's pro-environmental behavior. Thus, this study proposed the following research hypotheses, which are supported by the relevant prior studies:

Hypothesis 1 (H1). Personal norms influence the pro-environmental behavior of long hours of smartphone used children [31, 32, 33].

Hypothesis 2 (H2). Social norms influence the pro-environmental behavior of long hours of smartphone used children [26, 34].

Hypothesis 3 (H3). Personal norms influence the perceived behavioral control of long hours of smartphone used children [24, 31].

Hypothesis 4 (H4). Social norms influence the perceived behavioral control of long hours of smartphone used children [23, 34].

Hypothesis 5 (H5). Perceived behavioral control influences the pro-environmental behavior of long hours of smartphone used children [35, 36, 37].

Hypothesis 6 (H6). Personal norms influence the pro-environmental behavior of non-long hours of smartphone used children [31, 32, 33].

Hypothesis 7 (H7). Social norms influence the pro-environmental behavior of non-long hours of smartphone used children [26, 34].

Hypothesis 8 (H8). Personal norms influence the perceived behavioral control of non-long hours of smartphone used children [24, 26].

Hypothesis 9 (H9). Social norms influence the perceived behavioral control of non-long hours of smartphone used children [23, 34].

Hypothesis 10 (H10). Perceived behavioral control influences the pro-environmental behavior of non-long hours of smartphone used children [35, 36, 37].

Methods

Research area

This study was carried out in Hsinchu City, Taiwan, one of the major technological and industrial cities in Asia. Specifically, the research was undertaken at the elementary schools around the Hsinchu Science Park, which

was founded in 1980 with a development area of 653 hectares at the Hsinchu Park that resembles the Silicon Valley in the United States [38]. In 2017, there were 520 companies in Hsinchu Science Park with a total of 150,000 employees that generated an overall revenue exceeding NT\$1 trillion [38]. There were several elementary schools situated in the Hsinchu Science Park area that cater to the needs of many families working there.

Participants and procedure

A probability cluster sampling method was adopted in this study with the selection of eight public elementary schools around the Hsinchu Science and Industrial Park located at Hsinchu City, Taiwan. A total of 16 classes (one each from grades five and six, age between 11 to 12) were randomly selected from eight elementary schools. Prior to conducting this research study, written information (e.g. purpose and objectives of the study) about the survey and consent forms were sent to children, parents, school principals and class teachers to brief them about the research and obtain their agreement to participate in the study. At the same time, their rights to withdraw from the study at any time were also conveyed to them. Upon receiving the completed consent forms, the questionnaire survey was then conducted in the classroom setting at the respective schools. Participants had approximately 15 minutes in class to complete the questionnaire survey and the class teacher would collate them when completed. A total of 260 questionnaires were distributed and were all returned. However, 35 were considered invalid due to their incomplete responses. Therefore, statistical analysis was performed using the remaining 225 questionnaires.

Measures

This study was based on a substantial body of literature demonstrating the cognitive and psychological influence on pro-environmental behavior research [24, 35, 36]. Therefore, this study specifically sought to measure three key dimensions: (1) perceived behavioral control, (2) personal norms, and (3) social norms that were considered influential to pro-environmental behavior [24, 26, 39]. This research adopted the self-administered questionnaire survey method, which comprised of background and psychological variables developed according to the three key dimensions identified earlier.

Background variables

In the background variables, personal data were gathered about participants' gender, grade level, and smartphone usage. Gender and grade level were measured through nominal variables (i.e. Gender – Male or Female; Grade level – Grade 5 or Grade 6), whereas smartphone usage was measured by the question “How many hours per day do you usually spend on smartphone during a typical day?” with five possible multiple-

choice responses (i.e. none, less than 1 hour, between 1 to 2 hours, between 2 to 3 hours, between 3 to 4 hours, between 4 to 5 hours, more than 5 hours). While there is no one single agreed definition for excessive smartphone usage, but it can be broadly defined as the extended use of smartphone by individuals that interferes their daily lives [40]. Studies have shown that there were about 50% of children used smartphones for more than 2 hours per day [11], and approximately 70% of children's daily screen time exceeded the American Academy of Pediatrics recommendations (i.e. more than two hours per day) [41, 42]. Thus, for the purpose of this study, excessive smartphone usage is considered to be more than two hours per day. In this research study, two groups of children (i.e. excessive smartphone usage group - more than two hours per day of smartphone usage, and moderate smartphone usage group - less than 2 hours of smartphone usage per day) were purposefully selected for comparison.

Psychological variables

The psychological variables in the questionnaire survey were mainly compiled and adapted from previously conducted pro-environmental behavior research studies, specifically related to perceived behavioral control, social norms and personal norms dimensions [25, 31, 43]. The questionnaire survey was pre-tested by three experts and 50 children in grades five and six, to determine the appropriateness and understanding of the questions. Consequently, some minor changes were made to the questionnaire and subsequently used in the conduct of the actual survey. These minor changes mainly involved simplifying the wordings to include more colloquial and explicit terms for the children to understand in their local context, but retained the original meaning of the items adapted from the earlier mentioned studies. A five-point Likert scale (i.e., 1 = "Strongly disagree" to 5 = "Strongly agree") was applied for the measurement in this study. The Cronbach's α values of the respective dimensions were: perceived behavioral control (0.686), personal norm (0.766), social norm (0.886), and pro-environmental behavior (0.846), which demonstrated internal reliability since their values were greater than the 0.6 requirement. In addition, the Kaiser–Meyer–Olkin value was recorded at 0.885 (which was greater than the required value of 0.8), and the Spherical Bartlett test value was recorded at 2496.758, with $p < 0.001$. Factor analyses were subsequently conducted in PLS and the factor loading of each question in the key dimensions had exceeded the value of 0.4 [44]. Therefore, the measured psychological variable scales were considered reliable.

Statistical analysis

The Statistical Package for Social Sciences (version 22) software program was used to carry out the analysis. Frequency analysis was used to determine the total number of occurrences, the mean and standard deviation (SD) scores for the demographic questions and items in the key dimensions, i.e., perceived behavioral control, personal norms, social norms, and pro-environmental behavior. Pearson's correlation coefficient was used to measure the intensity and direction of the relationship between the key dimensions. Whereas the multiple regression analysis was used to predict the influence of perceived behavioral control, personal norms, social norms on pro-environmental behavior. The SmartPLS 2.0 statistical software was utilized in this study to carry out the path analysis, which were used to predict the magnitude and significance of the causal relationships between perceived behavioral control, personal norms, social norms, and pro-environmental behavior.

Results

Descriptive statistics

Overall results showed that both males (48.9%, $n=110$) and females (51.1%, $n=115$) were relatively well represented in this study. Among them, 47.6% ($n=107$) were in grade five and the remaining 52.4% ($n=118$) were in grade six. Of the two control groups investigated, the excessive smartphone usage group accounted for 42.7% ($n=96$), whereas the moderate smartphone usage group was 57.3% ($n=129$). Findings revealed significant differences between males and females in their perceived behavioral control ($df = 223$, two-tailed, $t = 2.126 > 1.96$, $p = 0.035$). Similarly, significant differences were also identified between grade five and grade six children in terms of their personal norms ($df = 223$, two-tailed, $t = 2.095 > 1.96$, $p = 0.037$) and perceived behavioral control ($df = 223$, two-tailed, $t = 2.498 > 1.96$, $p = 0.013$). There were also significant differences between excessive smartphone usage group children and moderate smartphone usage group children in personal norms ($df = 223$, two-tailed, $t = 4.693 > 1.96$, $p < 0.001$), social norms ($df = 223$, two-tailed, $t = 3.205 > 1.96$, $p = 0.002$), perceived behavioral control ($df = 223$, two-tailed, $t = 3.465 > 1.96$, $p = 0.001$), and pro-environmental behavior ($df = 223$, two-tailed, $t = 3.520 > 1.96$, $p = 0.001$). Table 1 presents a brief summary of the demographic findings and their association with personal norms, social norms, perceived behavioral control, and pro-environmental behavior.

1
2

Table 1. Descriptive statistics related to the demographic questions for personal norms, social norms, perceived behavioral control, and pro-environmental behavior

Variables	Frequency	Percent (%)	Personal norms				Social norms				Perceived behavioral control				Pro-environmental behavior			
			Mean	SD	<i>t</i>	<i>p</i>	Mean	SD	<i>t</i>	<i>p</i>	Mean	SD	<i>t</i>	<i>p</i>	Mean	SD	<i>t</i>	<i>p</i>
Gender																		
Female	115	51.1	3.76	0.791	1.665	0.097	3.60	0.78	1.161	0.247	3.73	0.78	2.126	0.035	3.43	0.96	1.768	0.078
Male	110	48.9	3.59	0.777			3.48	0.78			3.50	0.84			3.21	0.91		
Grade level																		
Grade 6	118	52.4	3.58	0.76	-2.095	0.037	3.51	0.75	-0.655	0.513	3.49	0.81	-2.498	0.013	3.25	0.88	-1.101	0.272
Grade 5	107	47.6	3.80	0.81			3.58	0.82			3.76	0.80			3.39	1.00		
Smartphone usage																		
Excessive	96	42.7	3.41	0.71	-4.693	0.000	3.43	0.68	-3.205	0.002	3.40	0.80	-3.465	0.001	3.07	0.90	-3.520	0.001
Moderate	129	57.3	3.89	0.78			3.75	0.74			3.78	0.80			3.50	0.93		

As shown in Table 2, the mean score for the overall perceived behavioral control was 3.62. Among the four perceived behavioral control related items, “I can save water resources” had the highest mean score (3.92), and this was followed by “I can observe environmental cleanliness” (3.80), “I take the initiative to go outdoors” (3.38), and “I have involvement in and disseminate information beneficial to the environment” (3.37). The results indicated an internal consistency reliability measurement with the Cronbach’s α value of 0.686 for perceived behavioral control related items.

Table 2. Descriptive statistics for perceived behavioral control related items

Perceived behavioral control	Mean	SD
PBC1. I take the initiative to go outdoors.	3.38	1.16
PBC2. I have involvement in and disseminate information beneficial to the environment.	3.37	1.05
PBC3. I can save water resources.	3.92	1.07
PBC4. I can observe environmental cleanliness.	3.80	0.96
Overall perceived behavioral control	3.62	0.82

Findings for the overall personal norms revealed a mean score of 3.68. There were three personal norms related items, namely “For self-discipline, I carry my own water cup when I go out” (3.79), “For self-discipline, I carry my own cutlery when I go out” (3.70), and “I must not arbitrarily abandon pets or plant garden plants in the wild” (3.45). Results of the personal norms related items are outlined in Table 3 below. There was a consistent reliable measurement for the personal norms related items with the Cronbach’s α value of 0.766.

Table 3. Descriptive statistics for personal norms related items

Personal norms	Mean	SD
PN1. For self-discipline, I carry my own cutlery when I go out.	3.70	1.08
PN2. For self-discipline, I carry my own water cup when I go out.	3.79	1.06
PN3. I must not arbitrarily abandon pets or plant garden plants in the wild.	3.45	1.08
Overall personal norms	3.68	0.79

Results (see Table 4) indicated that the mean score for the overall social norms was 3.61. There were six social norms related items whereby “People I know do not litter arbitrarily”, and “People I know go outdoors instead of staying indoors with air conditioning” had the highest (3.78) and lowest (3.22) mean score respectively. Other items also include: “People I know are well aware of how to save water” (3.77), “People I know expect me to go outdoors and use less air conditioning” (3.68), “People I know want me to carry a water cup and cutlery when I go out” (3.63), and “People I know carry their own cutlery when they go out” (3.59). The Cronbach's α value of 0.886 suggested internal consistency for the social norms related items.

Table 4. Descriptive statistics for social norms related items

Social norms	Mean	SD
SN1. People I know want me to carry a water cup and cutlery when I go out.	3.63	1.05
SN2. People I know want me to go outdoors instead of staying indoors with air conditioning.	3.68	0.13

SN3. People I know carry their own cutlery when they go out.	3.59	1.06
SN4. People I know are well aware of how to save water.	3.77	1.01
SN5. People I know do not litter arbitrarily.	3.78	1.01
SN6. People I know go outdoors instead of staying indoors with air conditioning.	3.22	1.22
Overall social norms	3.61	0.79

In terms of the overall pro-environmental behavior, findings revealed a mean score of 3.32. There were five items related to pro-environmental behavior, and of which “I go outdoors in my free time, rather than watching TV and sitting in front of the computer” received the highest mean score (3.62). This was followed by “I participate in conducting surveys on animal and plant-related activities in the vicinity of the community” (3.52), “I persuade others to sort waste” (3.34), “I visit the park and volunteer” (3.14), and “I participate in environmental activities conducted outdoors” (2.97). Results of the pro-environmental behavior related items are outlined in Table 5 below. The internal consistency reliability for the pro-environmental behaviors related items was measured, with the Cronbach's α value of 0.846.

Table 5. Descriptive statistics for pro-environmental behavior related items

Pro-environmental behavior	Mean	SD
PEB1. I persuade others to sort waste.	3.34	1.211
PEB2. I go into nature in my free time instead of using smartphone.	3.62	1.174
PEB3. I participate in environmental activities conducted outdoors.	2.97	1.185
PEB4. I participate in conducting surveys on animal and plant-related activities in the vicinity of the community.	3.52	1.203
PEB5. I visit the park and volunteer.	3.14	1.200
Overall pro-environmental behavior	3.32	0.940

Correlation analysis

As shown in Table 6, the correlation analysis results indicated that personal norms and perceived behavioral control were highly correlated with a value of 0.723 ($p < 0.01$). The correlation coefficient of the remaining relationships indicated a moderate correlation; social norms and perceived behavioral control ($r = 0.520$, $p < 0.01$); perceived behavioral control and pro-environmental behavior ($r = 0.598$, $p < 0.01$); personal norms and pro-environmental behavior ($r = 0.536$, $p < 0.01$); social norms and pro-environmental behavior ($r = 0.522$, $p < 0.01$). Hence, personal norms, social norms, perceived behavioral control, and pro-environmental behavior were considered to be correlated.

Table 6. Pearson's correlation matrix (Mean)

	Personal norms	Social norms	Perceived behavioral control	Pro-environmental behavior
Personal norms	1.000			
Social norms	0.559	1.000		

Perceived behavioral control	0.723	0.520	1.000	
Pro-environmental behavior	0.536	0.522	0.598	1.000

All correlations are significant, $p < 0.01$ (two-tailed test).

Regression and path analysis

Results of the partial least squares regression analysis indicated different paths influencing pro-environmental behavior for both excessive smartphone usage, and moderate smartphone usage children. In the excessive smartphone usage group (as shown in Table 7), all of the convergent validity, i.e. average variance extracted (AVE) values were above 0.50, and likewise the composite reliability (CR) values were at least 0.70. Therefore, the model statistically supported the convergent validity and reliability for the measurement model between the latent variables and their respective dimensions [45, 46]. The Cronbach's α values for social norms (0.8280), and pro-environmental behaviors (0.8173) were above 0.7, and thus achieved a high level of internal consistency. While the Cronbach's α values for personal norms (0.5604), and perceived behavioral control (0.6976) were below the value of 0.7, but they were higher than the acceptable value of 0.5, which indicated that the survey items had demonstrated an acceptable level of internal consistency. The explanatory power (R^2) of the dimensions affected were perceived behavioral control (0.2865), and pro-environmental behavior (0.2964).

Table 7. Partial least square regression analysis of personal norms, social norms, and perceived behavioral control that predict pro-environmental behavior of excessive smartphone usage children ($n = 96$)

	AVE	CR	R^2	Cronbach's α
Personal norms	0.5297	0.7660		0.5604
Social norms	0.5363	0.8736		0.8280
Perceived behavioral control	0.5219	0.8130	0.2865	0.6976
Pro-environmental behavior	0.5782	0.8711	0.2964	0.8173

Figure 1 displayed the path analysis about the relationship between personal norms, social norms, perceived behavioral control, and pro-environmental behavior of excessive smartphone usage children. The bootstrapping method was used to obtain the t value of the path in order to examine the significant level. According to the path analysis, personal norms ($\beta = -0.044$, $t = 0.395$, $p > 0.05$) had no direct influence on pro-environmental behavior for excessive smartphone usage children, whereas social norms ($\beta = 0.428$, $t = 4.096^{***}$, $p < 0.001$) had a direct predictive impact. Therefore, H1 was not supported as there was no evidence of a direct influence of personal norms on pro-environmental behavior for excessive smartphone usage children. However, H2 was supported, whereby social norms had shown a direct positive influence on pro-environmental behavior for excessive smartphone usage children. Although personal norms ($\beta = 0.304$, $t = 2.721^{**}$, $p < 0.01$), and social

norms ($\beta = 0.333, t = 2.779^{**}, p < 0.01$) had a significant impact on perceived behavioral control, but there were no evidences suggesting a relationship existed between perceived behavioral control ($\beta = 0.220, t = 1.823, p > 0.05$) and pro-environmental behavior for excessive smartphone usage children. Hence, H3 and H4 were supported since both personal norms and social norms had a positive influence on perceived behavioral control for excessive smartphone usage children. Conversely, H5 was not supported because perceived behavioral control had no direct effect on pro-environmental behavior for excessive smartphone usage children.

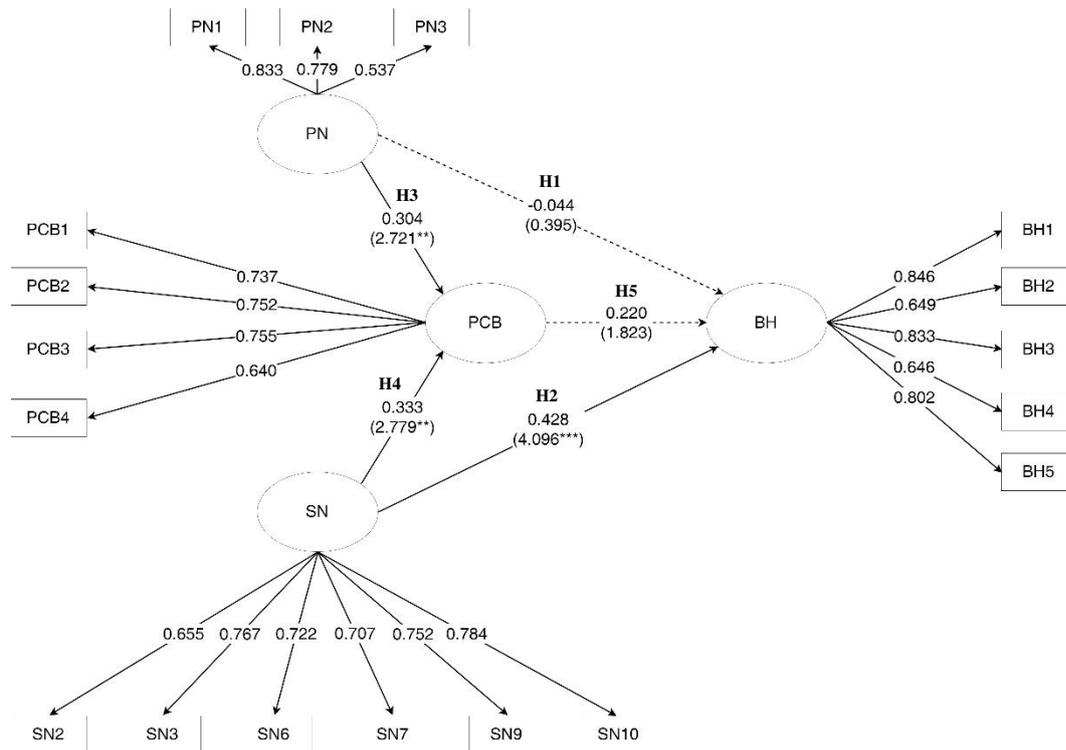


Figure 1. Path diagram on personal norms (PN), social norms (SN), perceived behavioral control (PBC), and pro-environmental behavior (PEB) of excessive smartphone usage children

For the moderate smartphone usage children group (as shown in Table 8), all of the convergent validity, i.e. average variance extracted (AVE) values had exceeded 0.50, and similarly the composite reliability (CR) values were above 0.70. Thus, the model statistically supported the convergent validity and reliability for the measurement model between the latent variables and their respective dimensions (Hair et al., 2014; 2016; Henseler, 2017). The Cronbach's α values for personal norms (0.7309), social norms (0.8794), perceived behavioral control (0.7989), and pro-environmental behaviors (0.8618) were greater than 0.7, and therefore indicated a high level of internal consistency. The explanatory power (R^2) on the affected dimensions; perceived behavioral control, and pro-environmental behavior were recorded as 0.5697 and 0.5684 respectively.

Table 8. Partial least square regression analysis of personal norms, social norms, and perceived behavioral control that predict pro-environmental behavior of moderate smartphone usage children ($n = 129$)

	AVE	CR	R²	Cronbach's α
Personal norms	0.6549	0.8496		0.7309
Social norms	0.6270	0.9093		0.8794
Perceived behavioral control	0.6240	0.8688	0.5697	0.7989
Pro-environmental behavior	0.6441	0.9004	0.5684	0.8618

The path analysis (as shown in Figure 2) displayed the relationship between personal norms, social norms, perceived behavioral control, and pro-environmental behavior of moderate smartphone usage children. In order to determine the level of significance, the bootstrapping method was used to obtain the t value of the path. Analysis results revealed that personal norms and social norms did not have a direct path relationship to pro-environmental behavior for moderate smartphone usage children, but instead displayed an influence on perceived behavioral control. Therefore, H6 and H7 were not supported since there was no evidence of personal norms and social norms having direct influence on pro-environmental behavior for moderate smartphone usage children. Accordingly, personal norms had a greater impact on perceived behavioral control ($\beta = 0.664$, $t = 10.357^{***}$, $p < 0.001$) than social norms ($\beta = 0.153$, $t = 2.160^*$, $p < 0.05$), thus H8 and H9 were supported which confirmed the influence of personal norms and social norms on perceived behavioral control for moderate smartphone usage children. Although there was no direct path established between personal norms and pro-environmental behavior, and social norms and pro-environmental behavior, but such a relationship could be developed through the mediating effect of perceived behavioral control ($\beta = 0.497$, $t = 4.471^{***}$, $p < 0.001$). The P -values of the paths from personal norms to pro-environmental behavior, and social norms to pro-environmental behavior were greater than the significance levels ($\alpha = 0.05$). Therefore, H10 was supported, whereby perceived behavioral control had a positive influence on pro-environmental behavior for moderate smartphone usage children.

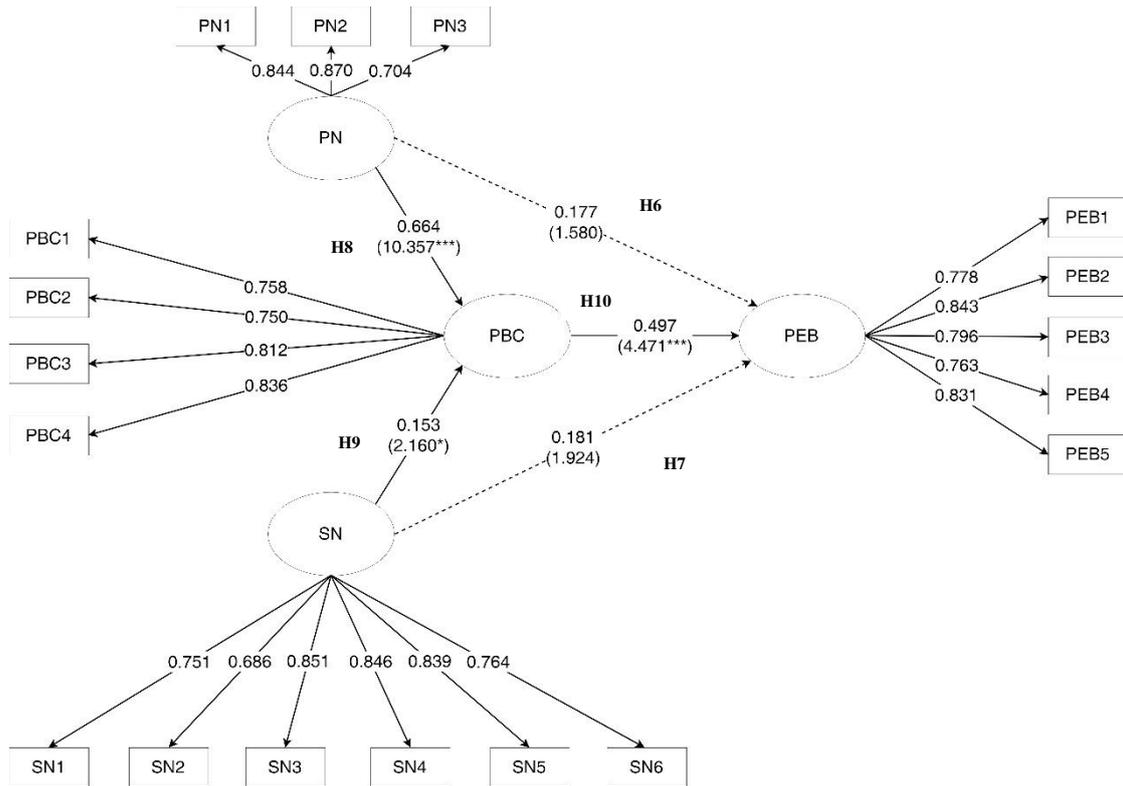


Figure 2. Path diagram on personal norms (PN), social norms (SN), perceived behavioral control (PBC), and pro-environmental behavior (PEB) of moderate smartphone usage children

Discussion

This study adopted the Social Attribution Theory to explore the impact of personal norms, social norms, and perceived behavioral control on pro-environmental behaviors by two groups of children in Taiwan based on their daily smartphone usage (i.e. excessive versus moderate). The extant literature suggested that there were inadequate studies conducted to understand the relationship between smartphone usage and environmental behaviors, which this study sought to fill the gap by investigating personal norms, social norms, and perceived behavioral control to determine their specific path and level of influence on pro-environmental behaviors. The overall results indicated that moderate smartphone usage children had shown a greater level of pro-environmental behaviors than those children who were excessive smartphone users, and this finding was supported by previous studies [8, 9]. The results also revealed support and accepted six (i.e. H2, H3, H4, H8, H9 and H10) of the 10 hypotheses, indicating significant direct positive relationship.

Excessive smartphone usage children group

Results suggested that the causal relationship between personal norms and pro-environmental behaviors for excessive smartphone usage children was relatively weak, and as such H1 was rejected. This outcome indicated that the personal beliefs of the excessive smartphone usage children had minimal influence on their pro-

environmental behaviors. The absence of this relationship could be explained through a possible lack of one's desire to conform to pro-environmental behaviors and/or a lack of environmental self-awareness and self-discipline that could contribute to exhibiting pro-environmental behaviors.

Findings revealed the support for H2 since social norm was a major predictive variable of pro-environmental behaviors for excessive smartphone usage children. This implied that excessive smartphone usage children were more likely to display and engage in pro-environmental behavior when they felt under pressure to conform to the expectation and requirement of normative social influence. This could be explained by the cultural context whereby Confucianism, which is an East Asian ethical and philosophical system that emphasizes on social values, has strong culture roots in countries such as China, Korea, Japan, Singapore and Taiwan (which is the key focus of this study). This strong emphasis on social values formed the basis for a sense of belonging to the group, which could explain the results emphasizing a greater influence of social norms for excessive smartphone usage children on their pro-environmental behavior. Hence, pro-environmental behavior was only predicted through social norms, whereby excessive smartphone usage children followed the rules that regulate their life from explicit standards for proper behaviors.

Analysis results also indicated that while both personal norms and social norms had a significant impact on perceived behavioral control (i.e. H3 and H4) on the excessive smartphone usage children, but a relationship between perceived behavioral control and pro-environmental behaviors was not established (i.e. H5). The rejection of this hypothesis (H5) could be due to a lack of individual's beliefs about their personal capabilities to overcome challenges that impeded their exhibition of pro-environmental behaviors. Hence, pro-environmental behaviors were only predicted through social norms, whereby excessive smartphone usage children followed the rules that regulate their life from explicit standards for proper behaviors.

Moderate smartphone usage children group

For the moderate smartphone usage children group, findings rejected H6 and H7 since there were no evidences supporting the direct influence of personal norms on pro-environmental behaviors, and social norms on pro-environmental behaviors. This suggested that the pro-environmental behaviors of the moderate smartphone usage children would neither directly affected solely by their perceived moral obligations towards environment, nor when pressured to conform because of external social influences.

On the other hand, there were evidences in the moderate smartphone usage children group that indicated a direct influence from personal norms to perceived behavioral control, and social norms to perceived behavioral control, hence H8 and H9 were supported. Although personal norms would have provided moderate smartphone usage

children the perceived moral obligations to undertake pro-environmental behaviors, but it did not appear to have a direct impact, instead an indirect influence on pro-environmental behaviors was only achieved through perceived behavioral control. An explanation to this could be that the perceived moral obligations to the environment itself was not strong enough for moderate smartphone usage children to undertake pro-environmental behaviors, but through self-resilience from perceived behavioral control, pro-environmental behaviors were attained. Therefore, personal norms could only affect pro-environmental behaviors through the mediating variable of perceived behavioral control [24, 31]. Findings also suggested that perceived behavioral control was a major predictive variable affecting pro-environmental behaviors (i.e. H10) for moderate smartphone usage children. This result aligned with other studies [e.g. 36, 47] that found perceived behavioral control having a significant role to play in determining pro-environmental behaviors.

Differences between two groups

There were two key differences in the findings between excessive and moderate smartphone usage children investigated in this study. Firstly, results indicated that social norms were considered the key influencing factor for excessive smartphone usage children's pro-environmental behavior. Social norm had a very strong direct positive association with behavioral intention for excessive smartphone users [48], and behavioral intention was the most direct predictor of behavior [49]. Thus, social requirements and social expectation were more likely to predict pro-environmental behaviors of excessive smartphone usage children than moderate smartphone usage children. This suggested that excessive smartphone usage children might rely on the role of socializing agents in the development of self-regulation, such as parents, teachers, and peers, and therefore were unable to develop their own thoughts, feelings, and actions towards the exhibition of pro-environmental behavior [50]. As such, their norms could not be internalized due to a lack of self-regulation, resulting in their "following the instructions of the teachers and other adults or acting based on observed actions of the peers" behavior. Therefore, their demonstrated pro-environmental behavior was likely to be coercive and conditional under physical and emotional duress that were not necessarily the intended actual behavior of their own. This supported previous studies [51, 52] conducted about predictors of self-regulation on smartphone usage.

Secondly, the research results revealed that personal norms of moderate smartphone usage children had a greater predictive power on their perceived behavioral control, which subsequently affected pro-environmental behaviors. This indicated that moderate smartphone usage children had internalized their personal norms, and with the perceived ease of their capabilities, to perform pro-environmental behaviors. Hence, the personal norms of the moderate smartphone usage children could have an indirect positive impact on their pro-environmental

behaviors via perceived behavioral control. The findings align with previous studies [e.g. 25, 31, 33] conducted on the effects of personal norms on environmental behaviors.

Implications, limitations and future research

There are two key implications from the findings in this study. Firstly, pro-environmental behavior of excessive smartphone usage children was predominantly affected by social norms only. Therefore, it is recommended that environmental education programs (formal and informal) at schools need to be targeting independent of knowledge so that children can better understand the relationship between their behavior and the environment. This helps toward attaining a more sustainable pro-environmental behavior of becoming a socially responsible citizen and not just conforming because of the social norm pressure. Next, the increasing concern of excessive smartphone usage by children has also prompted the need to explore different ways to minimize such a harmful behavior. Through the promotion of more outdoor activities and retaining more outdoor activity venues and spaces (such as parks), children are then provided with more choices other than engaging with their smartphones (e.g. gaming, internet surfing), therefore reducing the potential of smartphone overuse.

There are several limitations in this research study. First, the sample was selected within the context of the primary schools located near the Hsinchu Science and Industrial Park in Taiwan, and has limited the applicability of the findings to other parts of the country and sectors. As such, a more representative sampling population should be sought and tested, so that the findings can be further generalized. Secondly, further research is also needed to provide comparisons between other countries to determine the similarities or differences in such a context. In addition, follow-up studies can be conducted to gain further in-depth understanding about the relationship of smartphone usage, and other psychological variables (such as attitudes, beliefs) towards environmental knowledge and behaviors.

Conclusions

In conclusion, this study has investigated the impact of social norms, personal norms, and perceived behavioral control on children's pro-environmental behavior in Taiwan. Research results revealed that social norms were the key factor affecting the pro-environmental behavior of excessive smartphone usage children. Conversely, personal norms, through the indirect path of perceived behavioral control, had the greatest level of influence on moderate smartphone usage children's pro-environmental behavior. The findings clearly distinguished the pro-environmental behavior path modes between the excessive smartphone usage children and moderate smartphone usage children. Excessive smartphone usage children would only exhibit pro-environmental

behavior through social norms, whereas moderate smartphone usage children displayed higher personal norms and perceived behavioral control towards more environmentally friendly behaviors.

Declarations

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Availability of data and materials

The datasets generated and analyzed during the current study are not publicly available due to ethical guidelines around confidentiality but can be made available from the corresponding author on reasonable request.

Authors' contributions

W-T.F. coordinated this research project and designed the questionnaire. M-C.C. and W-T.F. conducted the survey. Y-T.C. and W-T.F. carried out the data analysis. W-T.F., E.N., and Y-T.C. were responsible for the result discussion, and provided revision of the manuscript for important intellectual content. All authors read and approved the final manuscript.

Competing interest:

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

Ethics approval and consent to participate

All children, parents, school principals and class teachers from the respective selected elementary schools and grade levels were provided with written information about the nature of the study and its objectives. In addition, their rights to withdraw from the study at any time were also conveyed to them. Participants were again informed verbally about the purpose of the study and procedures to follow, as well as given the opportunity to have their queries answered prior to completing the survey. All participants provided written informed consent. This study was approved by the National Taiwan Normal University Research Ethics Committee research and ethics committee (201707HS001) and agreed with active informed consent by the class teachers and school principals with parents having the option to opt their child out of the study.

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Figures

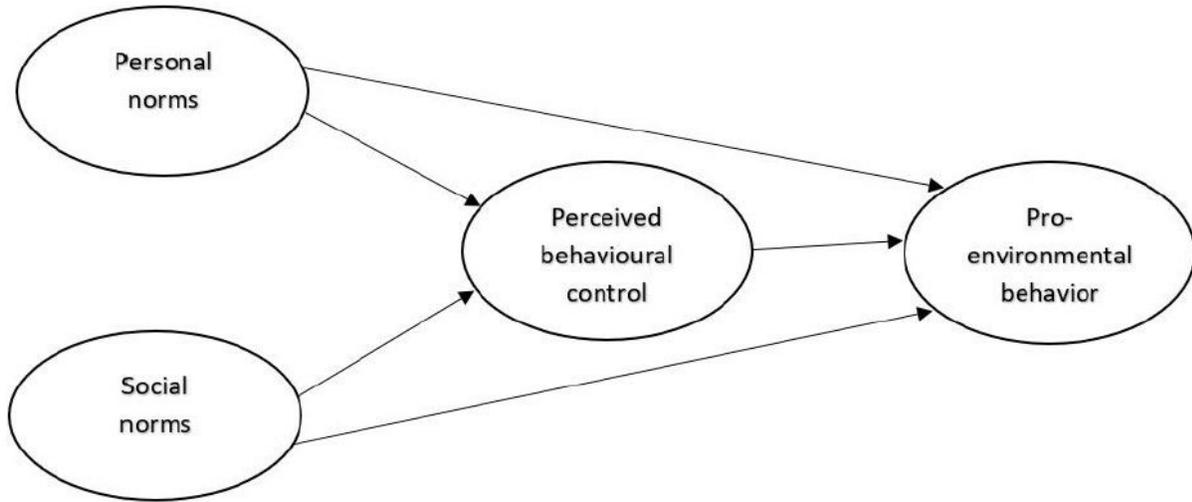


Figure 1

Proposed research framework

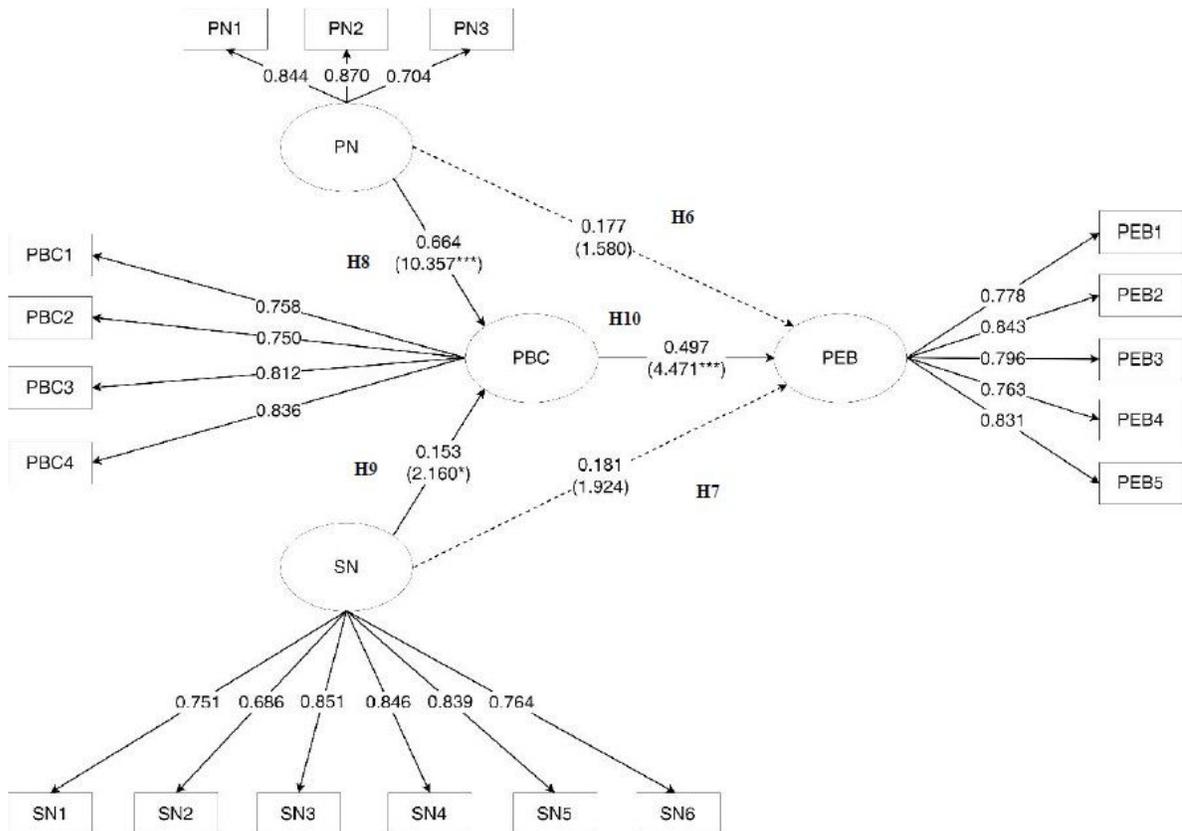


Figure 2

Path diagram on personal norms (PN), social norms (SN), perceived behavioral control (PBC), and pro-environmental behavior (PEB) of moderate smartphone usage children