Does Knowledge Really Help?  
The Relationship Between Low-Carbon Knowledge and Low-Carbon Behavior  

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ABSTRACT

Drawing on the self-determination theory, this study explored the effect of three kinds of low-carbon knowledge (LCK), including system knowledge (SK), action-related knowledge (AK), and effectiveness knowledge (EK), on college students’ low-carbon behavior (LCB) by focusing on the mediating role of low-carbon intrinsic motivation (LCIM) and the moderating role of climate change risk perception (CCRP). Using a sample of 2846 college students in China, this study found that SK has an inverted U-shaped relationship with LCB, but AK and EK positively affect LCB. Moreover, LCIM mediates the relationship between three kinds of LCK and LCB. The moderated path analysis also indicated that CCRP could strengthen the impact of LCK on LCIM. Finally, this study discusses the theoretical significance of these findings and provides some policy suggestions and practical implications for the government.

KEYWORDS

Climate Change Risk Perception, Low-Carbon Behavior, Low-Carbon Intrinsic Motivation, Low-Carbon Knowledge

INTRODUCTION

Catastrophic weather patterns continue to increase as the greenhouse effect intensifies. The emission of greenhouse gas like carbon dioxide has been the primary cause of global warming (Indriani et al., 2019; Lin & Fei, 2015). To prevent further damage from the greenhouse effect to the ecological environment and human life, many governments have proposed targets for carbon neutrality (Lin & Fei, 2015). These targets have also attracted the attention of academia. In fact, a plethora of research has explored the issue of carbon emission reduction from the perspective of enterprise production, resulting in great theoretical and practical contributions (Lin et al., 2021; Lin & Zhang, 2016; Liu et al., 2017). However, carbon emissions from the household sector, including direct emissions from energy consumption and indirect emissions from products and services consumption, account for a major proportion of total carbon emissions (Bai & Lin, 2022; Li et al., 2017; Zhang et al., 2020).
developed countries, residential carbon emissions accounted for 50% to 80% of emissions (Nansai et al., 2012; Zhang et al., 2020). In developing countries like China, this share has also increased (Su & Ang, 2017). Hence, it is of value to explore how citizens can be encouraged to reduce carbon emissions on the consumption side.

Knowledge is one precondition for personal behavior (Cheng & Wu, 2015). Empirical evidence indicates that declarative environmental knowledge positively impacts several proenvironmental behaviors, including environmentally responsible behaviors, green product purchasing behaviors, and workplace green behaviors (Carmi et al., 2015; Cheng & Wu, 2015; Lin & Niu, 2018; Paço & Lavrador, 2017; Polonsky et al., 2012; Sukı, 2013). Residential low-carbon behavior (LCB) plays a pivotal role in controlling carbon emissions; therefore, the impact of low-carbon knowledge (LCK) on LCB is of importance (Su & Ang, 2017).

The impact of LCK on LCB is an open question. While studies have explored the role of knowledge in environmental protection, theoretical knowledge and empirical research implies that the effect of environmental knowledge on behavior may not be entirely positive. According to Frick et al. (2004), environmental knowledge can be classified into either theoretical, dull categories or practical, easily applicable categories. Additionally, it is implied that individual psychological changes will influence behavior and judgment when learning and applying knowledge. For example, complex, boring knowledge can make individuals feel disgusted and burned out or applied knowledge can enhance one’s tendency to act (Kalimo, 1999; Mi & Nie, 2012). Therefore, it is possible that the theoretical LCK factor may reduce an individual’s willingness to participate in LCB.

Moreover, some empirical studies have shown that an excess of knowledge may not be beneficial (Gifford, 2017; Russo & Vurro, 2019). While knowledge is an integration of useful information, studies have demonstrated that it may have a psychological impact on the individual during the process of knowledge learning and transformation. In turn, the knowledge could have a negative impact. Despite this possibility, few studies have found evidence of a curvilinear effect between environmental knowledge and behavior. This is an unfortunate oversight. Therefore, this study aims to clarify the effects of different types of LCK on LCB.

Several studies have explored how environmental knowledge affects behavior (Ardoin et al., 2015; Paço & Lavrador, 2017; Polonsky et al., 2012). It is far from sufficient to clarify the influence mechanism, especially in distinguishing the consequence of different types of knowledge. Using the self-determination theory (SDT) as a base (Deci & Ryan, 2000), this study explores how different types of LCK affect LCB by investigating the mediating role of low-carbon intrinsic motivation (LCIM).

SDT argues that individuals tend to engage in an activity to satisfy three basic psychological needs: (1) autonomy; (2) competence; and (3) relatedness (Deci & Ryan, 2000; Leung et al., 2021). In contrast, when the basic psychological needs are threatened by an activity, an individual’s intrinsic motivation will decrease. The characteristics of the three types of LCK vary and, therefore, are likely to have different effects on satisfying individual psychological needs. This will lead to different effects on LCIM. In addition, SDT posits that higher intrinsic motivation can result in higher discretionary behaviors, including LCB, because intrinsic motivation compensates for the costs associated with engaging in these behaviors (Grant, 2008). In sum, another objective of this research is to verify the mediating effect of LCIM in the relationships between various forms of LCK and LCB.

A limited amount of research has examined the boundary conditions of LCK. Thus, little is known about the factors that increase or impair the influence of LCK. Using SDT as a base, this study explores the moderating mechanism of LCK on LCB. This research proposes that individuals’ climate change risk perception (CCRP) makes LCK play a more positive role. Individuals who perceive climate change risk may pay more attention to and act on environmental protection as they consider LCK more important (Leiserowitz, 2006). LCK can better meet their psychological needs and promote the generation of LCIM. Hence, the third purpose of this study is to probe the moderating role of CCRP in the relationships between different kinds of LCK and LCIM.
Finally, this study collected data from college students, who serve as the backbone of our future societies. Encouraging young people to practice energy-saving activities and low-carbon lifestyles builds an ecological low-carbon society. Besides, college students have a higher average degree of knowledge than regular residents (Mars & Rios-Aguilar, 2010). It is, therefore, representative to select them as the research objective. This study verifies the influencing factors of LCB among young people with advanced degrees of education and explores the differences and/or similarities of the effect of various kinds of LCK on LCB.

The present study makes several contributions to the literature. First, this study distinguishes between various forms of LCK and identifies how they influence LCB. Second, this study gives a self-determination-based explanation of how LCK is connected to LCB by investigating the mediating role of LCIM. Third, by examining the moderating effect of CCRP, this research contributes to current knowledge of the LCK boundary conditions. Finally, this study considers college students as the research object as it collects and analyzes first-hand questionnaire data and puts forward targeted policy suggestions.

THEORY AND HYPOTHESES

LCK

LCK is a collection of facts, experiences, and opinions on reducing carbon dioxide emissions (Frick et al., 2004; Mi & Nie, 2012). There are two crucial factors to the conception of LCK. First, LCK involves both objective information and subjective experience and opinions (Bai & Liu, 2013; Li et al., 2017). That is, a single format of measurement may not be sufficient. Second, LCK refers to environmental knowledge focused on lowering carbon emissions rather than comprehensive environmental protection information (Mi & Nie, 2012).

Frick et al. (2004) introduced three dimensions of LCK:

1. **System Knowledge (SK)**: Reflects an individual’s basic understanding of carbon emissions and energy-saving efforts.
2. **Action-Related Knowledge (AK)**: Refers to behavior choice and usual practices of the residential LCB.
3. **Effectiveness Knowledge (EK)**: Refers to an understanding of the consequence of various LCB.

Researchers have verified that these three dimensions of LCK are independent constructs that fall into different categories (Frick et al., 2004; Mi & Nie, 2012). As a result, their impacts on dependent variables may differ.

LCK and LCB

LCB, defined as a set of actions to decrease carbon emissions (Chen & Li, 2019; Pelletier et al., 1998), has two essential features. First, the ultimate consequence of LCB is to reduce carbon emissions. Some pro-environment behaviors, such as the purchase of green products and energy conservation, are considered LCB. Other behaviors that have little to do with reducing carbon emissions, such as preventing garbage and water pollution, are not considered low carbon. Second, LCB goes beyond the requirements of law. It is a discretionary behavior by the resident. Individuals make decide whether to act.

Studies have focused on the relationships between personal quality and LCB (Ding et al., 2018). For example, researchers have found that understanding and awareness of low-carbon practices are positively related to LCB (Bai & Liu, 2013; Chen & Li, 2019). This research stream suggests that if someone has relevant cognition, capabilities, and resources, they will prefer to perform discretionary behavior like LCB.
A growing body of evidence challenges the conventional view that the relationship between resources and proactive behavior is more than positive. Several recent studies have revealed the dark side of knowledge (Gifford, 2017; Russo & Vurro, 2019). For example, Astakhova (2015) revealed a curvilinear relationship between personal passion and voluntary behavior in the workplace. Prior studies also show that knowledge is generally considered a promotional behavior and personal resource (Cheng & Wu, 2015; Frick et al., 2004). To extend this line of inquiry, this study explores the effects of LCK on LCB with a campus background.

Specifically, this study suggests that SK has an inverted U-shaped effect on LCB. College students with intermediate levels of SK are more likely to engage in LCB than students with low or high levels of SK. As mentioned, SK provides students with basic theoretical information on LCB (Frick et al., 2004). For students familiar with theoretical SK, engaging in LCB may be seen as an exploration based on grounded low-carbon cognition. Compared to those who know nothing about low-carbon issues, students with a basic understanding are more likely to be inspired by a curiosity to act (Carmi et al., 2015; Loewenstein, 1994). Previous research also provides evidence that a certain level of knowledge makes exploring behavior more attractive (Golman & Loewenstein, 2015; Safari et al., 2018). Hence, this study argues that students with moderate levels of SK have a stronger willingness to adopt LCB than those with low levels.

The positive relationship between SK and LCB is unlikely to last. SK is primarily theoretical and conceptual, with limited introductions to LCB in practice (Frick et al., 2004). It only serves to familiarize college students with fundamental facts and the concept of carbon emission. Therefore, compared with students with moderate levels of SK, college students high in SK may not have more advantages in low-carbon practice. On the contrary, too much theoretical knowledge will decrease an individual’s curiosity and desire to explore (Loewenstein, 1994). Therefore, with the accumulation of SK, the desire of college students to engage in LCB may gradually decrease. Besides, most SK acquired by college students comes through passive learning at school (Wu, 2010). In the process of passively learning theoretical knowledge, students’ emotional resources are constantly consumed (Kalimo, 1999), which may lead to a bad emotional experience for a rebound. Therefore, students with high levels of SK may be uninterested in or even resist LCB. Accordingly, this study proposes that students with higher levels of SK may engage in less LCB than those with moderate levels. In sum, this study proposes the following hypothesis:

**Hypothesis 1a:** SK has an inverted U-shaped effect on students’ LCB.

Besides, this study suggests that AK and EK are positively related to students’ LCB. AK directly provides students with practical information about LCB, which differs from SK (Frick et al., 2004). Students with a higher level of AK have more skills and capacities in low-carbon habits (Mi & Nie, 2012; Polonsky et al., 2012). Hence, the students have more opportunities to engage in LCB in their daily lives. EK consists of the benefit and consequences of LCB (Frick et al., 2004). This type of knowledge evolves from understanding how to do LCB to understanding its benefit (Indriani et al., 2019; Pagiaslis & Krantalis, 2014). That is, as EK accumulates, students’ cognition of the importance and benefit of low-carbon habits increases. In addition, the desire to participate in LCB becomes stronger. Moreover, because AK and EK are simple to apply, students tend to believe that this knowledge has practical value. Thus, they suffer from fewer emotional problems throughout the learning process (Paço & Lavrador, 2017; Wu, 2010). Accordingly, this study suggests that the effect of AK on LCB and EK on LCB are positive rather than an inverted U-shape. This study proposes the following hypotheses:

**Hypothesis 1b:** AK has a positive effect on students’ LCB.

**Hypothesis 1c:** EK has a positive effect on students’ LCB.
Mediating Role of LCIM

SDT contends that people have the following three fundamental psychological needs: (1) need for autonomy; (2) need for competence; and (3) need for relatedness (Deci & Ryan, 2000). The need for autonomy is a desire to take the initiative in making decisions and engaging in activities. The need for competence is a desire to interact with the environment; The need for relatedness is a desire to link with other people and social environments (Deci & Ryan, 2000; White, 1959). When basic psychological needs are satisfied, people tend to autonomously internalize the activity, resulting in intrinsic motivation (Ma et al., 2019; Vallerand et al., 2003).

Intrinsic motivation refers to being interested in or intrigued by an activity and engaging in it for the activity itself (Ali et al., 2020; Amabile, 1993; Utman, 1997). In this case, it is LCB. LCIM stems from peoples’ positive reaction to the low-carbon habit rather than seeking a benefit like monetary incentives (Tu & Lin, 2013). When LCIM is high, people tend to participate in LCB without an external push (Grant, 2008). Researchers believed that intrinsic motivation is a significant hub for linking personal understanding and pro-environmental behavior (Ali et al., 2020). Drawing on SDT, this research explores the mediating role of LCIM in relationships between different LCK and college students’ LCB.

First, as a series of theoretical information, SK may have an inverted U-shaped relationship with college students’ LCIM. On the one hand, a certain level of theoretical knowledge gives students a basic understanding of low-carbon habits (Frick et al., 2004). According to SDT, these students can make autonomous decisions to be low carbon based on their cognition, satisfying their needs for autonomy. SK may increase students’ ability of LCB to a certain extent, which is beneficial to meeting competence needs (Suki, 2003). Hence, this study suggests that students with moderate levels of SK have more LCIM than those with low levels. On the other hand, SK has limitations for competence improvement (Mi & Nie, 2012). In terms of engaging in LCB, a basic level of theoretical and conceptual knowledge may suffice. Therefore, there is a limit to the competence need that can be met by excess SK. More importantly, due to the less practical nature of SK, college students are more likely to experience emotional burnout when acquiring knowledge (Kalimo, 1999; Wu, 2010). As burnout builds, students will lose initiative (Brotheridge & Grandey, 2002; Halbesleben & Bowler, 2007). That is, the need for autonomy is no longer satisfied. Thus, this study argues that an excessive level of SK negatively influences LCIM. In sum, this study proposes that:

**Hypothesis 2a:** SK has an inverted U-shaped effect on students’ LCIM.

Second, this study speculates that, unlike SK, the positive effect of AK and EK on LCIM is likely to be continuous. AK consists of behavioral advice and practical information (Frick et al., 2004). Hence, students rich in AK are familiar with the methods to be low carbon. Similarly, EK provides students with the benefit of LCB (Mi & Nie, 2012; Polonsky et al., 2012). Students with a high level of EK have a better understanding of the meaning and importance of LCB. Therefore, students with higher levels of AK or EK feel they have more options and reasons for participating in LCB, which satisfies the need for autonomy. These two types of knowledge are efficient and can greatly meet students’ competence needs (Frick et al., 2004). Moreover, action-related, adequate knowledge is more likely to be actively learned in life, which is unlikely to cause emotional problems (Wu, 2010). Thus, this study proposes that action-related and effective knowledge induces a high level of LCIM in college students. This study proposes that:

**Hypothesis 2b:** AK has a positive effect on students’ LCIM.

**Hypothesis 2c:** EK has a positive effect on students’ LCIM.

Furthermore, this study expects that LCIM positively affects students’ LCB. Engaging in LCB, which often requires additional time or money, does not necessarily receive external incentives (Ali
et al., 2020). Therefore, those who adhere to a low-carbon lifestyle need inner drive. According to SDT, intrinsically motivated people participate in the corresponding activity autonomously (Liu et al., 2011). They can get pleasure and self-satisfaction from the specific activity (Deci & Ryan, 2000). For them, the experience of the activity itself is more important than the external factors (Deci & Ryan, 2000). Therefore, it is inferred that students with a high level of LCIM value the enjoyment and satisfaction of participating in LCB more than the cost. That is, they are more likely to engage in LCB compared to other students. Thus, this study hypothesizes that:

**Hypothesis 3:** LCIM has a positive effect on students’ LCB.

Based on SDT, this study infers that both low and high levels of SK lead to difficulties in meeting students’ psychological needs for autonomy, which negatively affects LCIM. Further, lower levels of LCIM make it difficult for students to gain from the LCB itself. Considering the time or monetary cost of engaging in LCB, such students may have a lower willingness to participate in LCB. Conversely, a moderate level of SK contributes to the satisfaction of both students’ autonomy needs and competence needs. This, in turn, can lead to higher levels of LCIM and positively influence LCB. Taken together, this study argues that LCIM acts as a mediator in the inverted U-shaped effect of SK on LCB. Hence, this study hypothesizes that:

**Hypothesis 4a:** LCIM mediates the inverted U-shaped relationship between students’ SK and LCB.

Moreover, in conjunction with this discussion, the study suggests that LCIM is a mediator in the positive effects of AK and EK on LCB. According to the SDT, AK provides practical information that greatly satisfies students’ psychological needs for autonomy and competence. EK provides students with options and reasons to engage in LCB, which also contributes to students’ needs for autonomy and competence. The satisfaction of these psychological needs leads to an increase in the level of LCIM, which promotes LCB. Thus, the following is proposed:

**Hypothesis 4b:** LCIM mediates the positive relationship between students’ AK and LCB.

**Hypothesis 4c:** LCIM mediates the positive relationship between students’ EK and LCB.

**Moderating Role of CCRP**

CCRP refers to the public’s perception of the seriousness of the current consequences of climate change (Leiserowitz, 2006). It expresses subjective affections about objective climate change (Bamberg, 2003; Leiserowitz, 2006). Students who perceive high levels of climate change risk may have more concerns about environmental issues and be more crisis-conscious (Lee, 2008). Thus, they have a stronger willingness to contribute personal efforts to solve environmental problems (Dunlap & Jones, 2002). In contrast, students low in CCRP are unaware of the severe consequences of climate change (Bostrom et al., 1994). They regard environmental problems as irrelevant, neglecting the existence of the greenhouse effect (Lee, 2008).

Drawing on SDT, this study argues that CCRP moderates between different kinds of LCK and LCIM. Specifically, this study suggests that CCRP moderates the curvilinear relationship between SK and LCIM, such that SK has an inverted U-shaped effect on LCIM when CCRP is low and a positive effect when CCRP is high. As mentioned, students high in CCRP are more likely to be passionate about protecting the environment (Fu et al., 2019). When acquiring SK, they will consider it as helpful information. Thus, they are less prone to emotional burnout in learning SK (Wu, 2010). In this case, the need for autonomy can be continuously satisfied during the enrichment of SK (Deci & Ryan, 2000). For students with a high level of CCRP, SK has a positive effect on LCIM.
In contrast, students with low CCRP hardly attach importance to low-carbon habits (Leiserowitz, 2006). When learning SK, they are more likely to treat the knowledge as useless, thus suffering from severe burnout (Wu, 2010). Therefore, although SK is beneficial to students’ need for competence, the decline of autonomy caused by burnout will gradually weaken and impair the promotion effect of SK on LCIM. In sum, this study proposes the following:

**Hypothesis 5a:** CCRP moderates the relationship between students’ SK and LCIM, such that SK has a positive effect on LCIM for students high in CCRP but an inverted U-shaped effect for students low in CCRP.

This study also proposes that the promoting effect of AK and EK on LCIM will be strengthened when students are high in CCRP. Students with a high level of CCRP have a strong willingness to protect the environment (Lee, 2008). Hence, the knowledge that can be directly applied to LCB, such as AK and EK, is valuable to them. These two types of knowledge can significantly satisfy their needs for competence and promote the generation of LCIM (Leiserowitz, 2006).

In contrast, students with low CCRP ignore the environmental problem (Fu et al., 2019). Hence, it is not an essential ability for them to know how to engage in and identify the benefits of LCB. AK and EK are limited in meeting their competence needs. As a result, the following hypotheses are proposed:

**Hypothesis 5b:** CCRP moderates the positive effect of students’ AK on LCIM, such that the positive effect is stronger for students high in CCRP than for students low in CCRP.

**Hypothesis 5c:** CCRP moderates the positive effect of students’ EK on LCIM, such that the positive effect is stronger for students high in CCRP than for students low in CCRP.

**METHOD**

**Participants and Procedures**

This study gathered data from a questionnaire survey of a national key university in Fujian, China. Participants were undergraduate and graduate students from different grades and academies. Before the formal research, the researcher conducted a presurvey, obtained 100 questionnaires, and optimized the questionnaires based on the feedback from participants. The formal research was conducted by stratified random sampling and face-to-face interviews. The research team determined the sample proportion based on the number of students in each college. Then, they used simple random sampling to invite students to participate in the research.

Researchers asked participants to report their demographic information and measured their LCK, CCRP, LCIM, and LCB with digital questionnaires. To ensure that the data were authentic and valid, the student documents of all the participants were verified after the questionnaire research. As a token of appreciation, students who completed the questionnaire were given gift cards worth CNY 50 (about USD 8). In sum, 2,987 questionnaires were collected. After deleting incomplete samples and duplicate cases, the final sample of 2,846 students had an effective recovery rate of 95.28%. Among valid samples, 1,679 were female and accounted for 59.00%. The average age was 23.16 years (SD = 2.88); the average monthly income was CNY 2238.09 (about USD 343, SD = 1652.50).

**Measures**

This study went through translation and back-translation procedures to guarantee that translations were equivalent (Brislin, 1986). Based on the translation, the research team made modifications to the original scales. This ensured that all items were appropriate for the university context. Moreover, students’ responses to all items in the five-point Likert scale ranged from “1” = strongly disagree to “5” = strongly agree, unless otherwise noted.
LCK

According to Frick et al. (2004), this research adapted a 10-item scale to measure LCK. Three items indicated SK, three indicated AK, and four indicated EK. Moreover, this study used the triangulation technique to improve accuracy of the measurement. Specifically, researchers selected different formats to estimate both students’ objective capability and subjective evaluation (Casaló et al., 2019; Frick et al., 2004). Three items were in multiple-choice format to estimate students’ LCK objectively. A representative question was: “How do greenhouse gases cause the greenhouse effect?” Six polytomous items aimed to measure students’ subjective perception of their knowledge reserve. One item included: “It is better to use the washing machine with a sufficient load of clothes.” Another included: “Energy-efficient light bulbs save about 60% of electricity compared to conventional bulbs.” To match the data in different formats, this research followed Frick et al. (2004) to recode polytomous items to a dichotomous response format. It collapsed “strongly disagree,” “disagree,” and “neutral” to a negative answer. It categorized “strongly agree” and “agree” as affirmative responses. Furthermore, the research team counted the proportion of affirmative responses and correct multiple-choice answers as the indicator to evaluate students’ LCK. The average level of SK, AK, and EK were .76, .80, and .68.

CCRP

This study measured students’ perception of climate change risk with a four-item scale adapted from Leiserowitz (2006). This scale focuses on subjects’ perceptions of the severity and hazards of current global climate change. A sample item is: “At present, the threat of global climate change is very serious.” The results of the reliability test showed that Cronbach’s alpha was .82, indicating that the adapted scale was concise and reliable.

LCIM

This study used a five-item scale adapted from Ali et al. (2020) to measure students’ intrinsic motivation of engaging in LCB. In Ali et al. (2020), the scale measured the extent to which consumers can derive self-motivation from the purchase of green electronics. To fit the scale to the research situation of this study, researchers adapted the wording of the original scale to shift the focus from electronic products to LCB. The adapted scale measured subjects’ propensity to self-direct their engagement in LCB. A sample item included: “Engaging in LCB gives me a sense of satisfaction.” The reliability of this scale was .88.

LCB

Based on Pelletier et al. (1998), this study adapted a nine-item scale to measure the LCB. The original scale was used to measure the frequency with which people engage in environmental behaviors. The researchers selected items related to the low-carbon lifestyle and consistent with the university context for measuring students’ LCB. A sample item included: “I will reduce the frequency of clothing purchases for energy saving and carbon emission reduction.” The reliability test results show that Cronbach’s alpha of the adapted scale was .90.

Control Variables

Demographic variables have been shown to impact environmental behavior (Amoah & Addoah, 2021). Thus, this research took students’ age, gender, and income as control variables. Researchers calculated the age of participants per the reported birth dates of students collected from the questionnaire. Gender was dummy coded as “1” = male and “2” = female. Average monthly income refers to the amount of money students received from family, part-time jobs, scholarships, and grants each month. This was also self-reported.

Common Method Issues

Common method bias could be a potential problem given that the data in this study came from the same source simultaneously. Thus, this study conducted Harman’s (1967) single-factor test. The
result showed that the first factor accounted for 33.58% of the total variance explained before rotation. Namely, common method bias was not a pervasive issue in this study.

RESULTS

Confirmatory Factor Analysis (CFA)

To verify the convergent and discriminant validity of key variables in the study, the researchers conducted a series of CFAs. First, this study adopted a standard approach to reduce the number of items (Hui et al., 2004). Specifically, researchers constructed three new indicators for each variable with more than three items. Regarding the factor analysis, this study first combined the items with the highest and lowest factor loadings. Then, it combined the next highest and next lowest. This continued until all items were combined into three indicators. Next, the study examined a six-factor CFA model, including SK, AK, EK, CCRP, LCIM, and LCB. As indicated in Table 1, the proposed six-factor model (baseline model) closely matched the data ($\chi^2_{(42)} = 590.33$, TLI = .95, CFI = .97, RMSEA = .07). The convergent validity was proven because all factor loadings were significant. Moreover, the study combined variables with potential causal relationships or conceptual proximity to construct the corresponding alternative models. According to model comparison results, the baseline model fits better compared to the alternative model. Thus, the discriminant validity of the six-factor model proposed in this study was supported; the six main variables in this study could be well distinguished.

Descriptive Statistics

As presented in Table 2, SK was significantly correlated with AK, EK, CCRP, LCIM, and LCB ($r = .10, .11, .24, .27, .06, p < .01$). AK was significantly correlated with EK, CCRP, LCIM, and LCB ($r = .34, .26, .22, .15, p < .01$). EK significantly correlated with CCRP, LCIM, and LCB ($r = .17$.

| Table 1. Results of the CFA for the measures of variables studied |
|-----------------|-------|-----|-----|-------|
| Model           | $\chi^2$ | df  | TLI | CFI  |
| Six factors model:          |        |     |     |      |
| Baseline model            | 590.33 | 42  | .95 | .97  |
| Five factors model 1:     |        |     |     |      |
| SK and AK combined into one factor | 830.91 | 46  | .93 | .95  |
| Five factors model 2:     |        |     |     |      |
| SK and EK combined into one factor | 952.11 | 46  | .92 | .95  |
| Five factors model 3:     |        |     |     |      |
| AK and EK combined into one factor | 637.35 | 46  | .95 | .96  |
| Five factors model 4:     |        |     |     |      |
| SK and LCIM combined into one factor | 6723.92 | 47  | .43 | .60  |
| Five factors model 5:     |        |     |     |      |
| AK and LCIM combined into one factor | 6919.29 | 47  | .42 | .59  |
| Five factors model 6:     |        |     |     |      |
| EK and LCIM combined into one factor | 7063.46 | 47  | .41 | .58  |
| Five factors model 7:     |        |     |     |      |
| CCRP and LCIM combined into one factor | 2021.02 | 47  | .83 | .88  |
| Five factors model 8:     |        |     |     |      |
| LCIM and LCB combined into one factor | 5409.01 | 47  | .55 | .68  |
| Four factors model 9:     |        |     |     |      |
| SK, AK, and EK combined into one factor | 981.32 | 49  | .92 | .94  |

Notes: $N = 2846$; TLI = Tucker-Lewis Index; CFI = Comparative Fit Index; RMSEA = Root-Mean-Square Error of Approximation
CCRp significantly correlated with LCIM and LCB (r = .59, .27, p < .01). LCIM significantly correlated with LCB (r = .42, p < .01). Hence, hypotheses were preliminarily supported. Furthermore, the square roots of average variance extracted (AVE) values of the key constructs exceeded its correlations with other variables, providing further evidence for their discriminant validity.

**Hypothesis Testing**

**Main Effect**

to examine hypotheses 1a, 1b, 1c, 2a, 2b, 2c, and 3, this study conducted a series of structural equation models (SEM). It created a quadratic term of SK and interactions of three kinds of LCK and CCRP after standardization (Aiken & West, 1991). Then, it followed the procedure of Cortina et al. (2001), setting the measurement path and error of the interaction. Table 3 presents the results of SEM.

Hypothesis 1a suggested that SK had an inverted U-shaped relationship with students’ LCB. As presented in Table 3, SEM testing the curvilinear effect of SK on LCB fit the data (χ² (10) = 62.61, TLI = .98, CFI = .99, RMSEA = .04, Model 1). Although the relationship between SK and LCB was not significant (β = .04, n.s., Model 1), SK squared had a significant negative effect on LCIM (β = -.11, p < .01, Model 1), which indicated curvilinear relationship (Aiken & West, 1991). Figure 1 also depicted that low and high levels of SK lead to lower levels of LCB, supporting Hypothesis 1a. These results suggest that SK has an inverted U-shaped effect on LCB.

Hypothesis 1b predicted that AK is positively related to students’ LCB. As indicated in Table 3, the model testing the effect of AK on LCB had acceptable fit (χ² (8) = 58.50, TLI = .98, CFI = .99, RMSEA = .05, Model 2). Besides, AK had a significantly positive effect on students’ LCB (β = .15, p < .01, Model 2), thus supporting Hypothesis 1b. That is, students are more likely to participate in LCB when their AK is significant.

Hypothesis 1c proposed that EK had a positive effect on students’ LCB. As shown in Table 3, the result of SEM, which tested the effect of EK on LCB, yielded an acceptable fit level for data (χ² (8) = 77.29, TLI = .97, CFI = .99, RMSEA = .05, Model 3). In addition, the relationship between
EK and LCB was positive ($\beta = .13, p < .01$, Model 3). Thus, Hypothesis 1c receives support. The results show that the accumulation of EK contributes to students’ participation in LCB.

Hypothesis 2a presented an inverted U-shaped relationship between SK and LCIM. Table 3 showed that the model testing the curvilinear effect of SK on LCIM yielded an acceptable fit level for data ($\chi^2 (10) = 88.98$, TLI = .96, CFI = .99, RMSEA = .05, Model 4). Besides, the relationship between SK and LCIM was positive ($\beta = .17, p < .01$, Model 4). SK squared significantly negatively affected LCIM ($\beta = -.31, p < .01$, Model 4), providing evidence for the inverted U-shaped relationship (Aiken & West, 1991). Figure 2 also presented that when SK is at low and high levels, the levels

Table 3. Results of main effect testing

| Model  | Path                        | $\beta$ (Standardized) | $\chi^2$ | df | TLI | CFI  | RMSEA |
|--------|-----------------------------|-------------------------|----------|----|-----|------|-------|
| Model 1 | SK $>$ LCB                  | .04                     | 62.61    | 10 | .98 | .99  | .04   |
|         | SK squared $>$ LCB          | -.11**                 |          |    |     |      |       |
| Model 2 | AK $>$ LCB                  | .15**                   | 58.50    | 8  | .98 | .99  | .05   |
| Model 3 | EK $>$ LCB                  | .12**                   | 62.38    | 8  | .97 | .99  | .05   |
| Model 4 | SK $>$ LCIM                 | .17**                   | 88.98    | 10 | .96 | .99  | .05   |
|         | SK squared $>$ LCIM         | -.31**                 |          |    |     |      |       |
| Model 5 | AK $>$ LCIM                 | .22**                   | 30.67    | 8  | .99 | .99  | .03   |
| Model 6 | EK $>$ LCIM                 | .17**                   | 29.03    | 8  | .99 | .99  | .03   |
| Model 7 | LCIM $>$ LCB                | .50**                   | 210.40   | 20 | .97 | .98  | .06   |

Notes: N = 2846; ** $p < .01$, * $p < .05$. 

Figure 1. Curvilinear relationship between SK and LCB
of LCIM are even lower. Hence, Hypothesis 2a was supported. These results show that SK has an inverted U-shaped relationship with LCIM.

Hypothesis 2b predicted that AK positively affected students’ LCIM. As presented in Table 3, the model testing the effect of AK on LCIM yielded a good fit ($\chi^2 (8) = 30.67$, TLI = .99, CFI = .99, RMSEA = .03, Model 5). Moreover, AK had a significant positive effect on LCIM ($\beta = .22$, $p < .01$, Model 5), further supporting Hypothesis 2b. Results indicate that higher levels of students’ AK lead to higher levels of LCIM.

Hypothesis 2c proposed the positive effect of EK on LCIM. Table 3 showed that the result of SEM testing the effect of EK on LCIM fit the data ($\chi^2 (8) = 29.03$, TLI = .99, CFI = .99, RMSEA = .03, Model 6). In addition, EK had a significant positive effect on LCIM ($\beta = .17$, $p < .01$, Model 6). Hence, Hypothesis 2c received support. That is, an increase in students’ EK leads to an increase in LCIM.

Hypothesis 3 suggested that students’ LCIM is positively related to LCB. As indicated in Table 3, the model that tested the effect of LCIM on LCB resulted in a good fit ($\chi^2 (20) = 210.40$, TLI = .97, CFI = .98, RMSEA = .06). LCIM was significantly positively related to LCB ($\beta = .50$, $p < .01$, Model 7). These results provided supporting evidence for Hypothesis 3.

In conclusion, LCIM is an important antecedent for promoting students’ engagement in LCB.

**Mediating and Moderating Effect**

Furthermore, this study conducted a nested model to test mediating and moderating effects. As indicated in Table 4, the hypothesized model yielded a satisfactory fit for data ($\chi^2 (99) = 834.77$, TLI = .94, CFI = .97, RMSEA = .05). Researchers calculated the chi-square change between the hypothesized (fully mediated) model and alternative (partially mediated) model based on the test results. Specifically, alternative model 1 contained all paths in the fully mediated model and a direct path from SK to LCB. Alternative model 2 contained all paths in the fully mediated model and a direct path from SK squared to LCB. Alternative model 3 contained all the fully mediated model paths and a direct path from AK to LCB. Alternative model 4 contained all paths in the fully mediated model and a direct path from EK to LCB.

The chi-square of the four alternative models was significantly reduced. This means that the direct paths in all four alternative models can significantly improve the fit of the hypothesized model ($\Delta \chi^2 (1) = 13.18, 11.80, 6.05, 5.28$, $p < .01, .01, .05, .05$). Thus, all the direct paths were retained.
The best-fitting model and coefficient for paths are shown in Figure 3. This implies that LCIM is likely to play a partially mediating role in the effects of SK, AK, and EK on LCB.

This study further analyzed the best-fitting model to examine Hypotheses 4a, 4b, 4c, 5a, 5b, and 5c. Hypothesis 4a predicted that LCIM mediates the curvilinear effect of SK on LCB. Table 5 showed that SK squared had a negative effect on LCIM ($\beta = -.12, p < .01$), SK had a positive effect on LCIM ($\beta = .07, p < .01$), LCIM had a positive effect on LCB ($\beta = .51, p < .01$), and the direct effect was diminished. These results indicated that LCIM partially mediated the inverted U-shaped relationship between SK and LCB. Thus, Hypothesis 4a received partial support. That is, students with low and high levels of SK engaged in fewer LCB because of lower levels of LCIM. Students with moderate levels of SK had more LCB because of higher levels of LCIM.

Table 4. Results of mediating and moderating effect testing

| Model                     | Direct path | $\chi^2$ | df | TLI | CFI | RMSEA | $\Delta\chi^2(\Delta df)$ |
|---------------------------|-------------|----------|----|-----|-----|-------|--------------------------|
| Hypothesis model          | -           | 834.77   | 99 | .94 | .97 | .05   | -                        |
| Alternative model 1       | SK > LCB    | 821.59   | 98 | .94 | .97 | .05   | 13.18**                  |
| Alternative model 2       | SK squared > LCB | 822.97   | 98 | .94 | .97 | .05   | 11.80**                  |
| Alternative model 3       | AK > LCB    | 828.72   | 98 | .94 | .97 | .05   | 6.05*                    |
| Alternative model 4       | EK > LCB    | 829.49   | 98 | .94 | .97 | .05   | 5.28*                    |

Notes: $N = 2846$; ** $p < .01$ ($\chi^2 (1) = 6.63$), * $p < .05$ ($\chi^2 (1) = 3.84$).
Hypothesis 4b suggested that LCIM mediates the relationship between AK and LCB. As presented in Table 5, AK had a positive effect on LCIM ($\beta = .04$, $p < .05$), LCIM had a positive effect on LCB ($\beta = .51$, $p < .01$), and the direct effect was diminished. The results revealed that LCIM partially mediated the positive relationship between AK and LCB. Hypothesis 4b was partially supported. That is, AK can influence students’ LCB by affecting LCIM.

Hypothesis 4c predicted that LCIM mediates the relationship between EK and LCB. Table 5 showed that EK had a significant positive effect on LCIM ($\beta = .04$, $p < .05$), LCIM had a significant positive effect on LCB ($\beta = .51$, $p < .01$), and the direct effect became insignificant. These results showed that LCIM fully mediated the relationship between EK and LCB; thus, Hypothesis 4c is supported. This also suggests that EK positively affects students’ LCIM, which, in turn, leads to an increase in LCB.

Hypothesis 5a speculated that CCRP would moderate the curvilinear relationship between SK and LCIM. As indicated in Table 5, although the effect of interaction between SK and CCRP on LCIM was insignificant ($\beta = .02, \text{n.s.}$), the interaction between SK squared and CCRP had a positive effect on LCIM ($\beta = .08$, $p < .05$). This provides evidence for Hypothesis 5a. Figure 4 illustrated the curvilinear relationship between SK and LCIM at both low and high levels of CCRP. As presented in Figure 4, when the CCRP level is high, SK can effectively promote the increase of LCIM. However, when the CCRP level is low, a high level of SK will negatively affect LCIM. In sum, Hypothesis 5a was supported. These results show that SK is beneficial for the LCIM of students with high levels of CCRP. However, it impairs the LCIM of students who have not perceived climate change risk when SK becomes excessive.

Hypothesis 5b proposed that CCRP strengthened the positive influence of AK on LCIM. As shown in Table 5, the positive effect of the interaction between AK and CCRP on LCIM was significant

| Path                  | $\beta$ (Standardized) |
|-----------------------|------------------------|
| SK > LCIM             | .07**                  |
| SK squared > LCIM     | -.12**                 |
| AK > LCIM             | .04*                   |
| EK > LCIM             | .04*                   |
| CCRP > LCIM           | .58**                  |
| SK > LCB              | -.06**                 |
| SK squared > LCB      | .06**                  |
| AK > LCB              | .04*                   |
| EK > LCB              | .04*                   |
| LCIM > LCB            | .51**                  |
| SK x CCRP > LCIM      | .02                    |
| SK squared x CCRP > LCIM | .08*   |
| AK x CCRP > LCIM      | .04*                   |
| EK x CCRP > LCIM      | .04*                   |

Notes: $N = 2846$; ** $p < .01$, * $p < .05$, + $p < .10$. 

Table 5. Path coefficients for the best fitting model
(β = .04, p < .05). Figure 5 illustrated the relationship between AK and LCIM at both low and high levels of CCRP. In sum, Hypothesis 5b was supported. The results indicate that students’ CCRP can strengthen the positive effect of AK on LCIM.

Hypothesis 5c predicted that CCRP strengthened the positive influence of EK on LCIM. Table 5 presented that the interaction between EK and CCRP had a positive effect on LCIM (β = .04, p < .05). Figure 6 showed the relationship between EK and LCIM was more positive when CCRP was
high. Hence, Hypothesis 5c received support. That is, students’ CCRP can reinforce the positive effect of EK on LCIM.

DISCUSSION

Theoretical Implications

This study has several contributions to the literature. First, this research adds to the body of knowledge on LCK by clarifying the differentiation of the effect of various types of LCK on LCB. Previous research on the consequences of environmental knowledge is focused on purchasing behavior and workplace environmental protection. It also examines the positive impact of knowledge (Carmi et al., 2015; Cheng & Wu, 2015; Lin & Niu, 2018).

First, few studies have explored the possibility that environmental knowledge has a curvilinear effect on pro-environmental behavior. This study distinguishes LCK according to the nature of knowledge and provides empirical evidence to verify the inverted U-shaped relationship between SK and LCB and the positive impact of AK and EK on LCB. The findings suggest that the effect of LCK on behavior is not entirely positive.

Second, this study delves into the “black box” that underpins the relationship between LCK and LCB. LCB is a type of nonmandatory voluntary behavior. Engaging in LCB usually requires extra time or money. Therefore, intrinsic motivation would be the mechanism to affect LCB. According to SDT, this study uncovers LCIM as an intrapsychic mediator. Knowledge changes students’ perceptions of how the low-carbon lifestyle meets their psychological needs, which in turn leads to changes in the individual LCIM and ultimately affects the LCB. The results of this study show that LCIM mediates both the inverted U-shaped effect of SK on LCB and the positive effect of AK and EK on LCB. It indicates that LCIM is an important and stable influence mechanism. These findings add to the field of LCK research by giving a self-determination-based explanation for how knowledge affects behavior.

Third, this study established the link between LCK and LCIM by examining the moderating effect of CCRP. Different individuals may have different psychological needs perceptions (Deci & Ryan,
According to this argument, the findings indicated that LCK has a more significant promoting effect on LCIM for students high in CCRP. For them, a higher level of knowledge, whether SK, AK, or EK, helps to facilitate the formation of LCIM. In contrast, LCK is less meaningful for students with low CCRP and has a more limited positive impact on LCIM. In particular, high levels of SK would decrease the LCIM of students who do not perceive climate change risk. The positive impact of AK and EK on students’ LCB is also weakened. These findings add to the literature on LCK by highlighting a critical boundary condition under which knowledge affects behavior.

**Practical Implications and Policy Suggestions**

This research also brings practical implications and policy suggestions. First, the findings indicate that college students’ SK has an inverted U-shaped effect on LCB. Yet, AK and EK have a positive effect on LCB. For college students and individuals with more environmental knowledge, carrying out AK and EK education can effectively promote LCB. Too much SK education may be detrimental. Therefore, this study proposes that colleges, enterprises, and governments should focus more on the popularization of the methods and skills to reduce carbon emissions rather than theoretical knowledge when formulating policies and activities in response to the call for low-carbon living. For example, some colleges and enterprises may hold knowledge competitions to attract students’ and employees’ attention to low-carbon lifestyles. According to this study, topics in the competitions should focus on practical knowledge rather than theoretical knowledge. Governments may place advertisements about low-carbon lifestyles in the community or through electronic media. This study suggests that the content of these ads would be more effective if they were practical tips and attractive benefits of low-carbon living.

Second, the findings suggest that LCK exerts its influence on LCK through LCIM. Thus, it is necessary to guide people to develop LCIM to engage in LCB. According to SDT, the formation of intrinsic motivation presupposes that the needs of autonomy, competence, and relatedness are met. Of these three psychological needs, relatedness is more likely to be directly influenced by policies. Therefore, the study suggests that the government, colleges, and enterprises improve peoples’ sense of social support through the provision of facilities. Thus, it will achieve the satisfaction of relatedness psychological needs. For instance, additional bicycle-sharing parking spots can be set up in universities, enterprises, and communities to facilitate peoples’ low-carbon travel. On the other hand, policies should lead the public to become more aware of their environmental identity through increased feedback. For example, government, colleges, and enterprises should give nonmaterial incentives to outstanding LCB participants by awarding them honorary titles.

Third, the findings of this study indicate that all kinds of LCK have a more positive impact on LCIM for people who perceive high levels of climate change risk. CCRP boosts the positive effect of AK and EK, which effectively compensates for the potential negative impact of SK. Therefore, governments, colleges, and enterprises should enhance public awareness of climate change through media channels like posters and public service announcements. Experience has shown that public service announcements can be effective. For example, in China, the advertisement against wildlife trade—“No trading, no killing”—has been widely disseminated and remembered. This study concludes that a good public service announcement related to climate change can be very beneficial in promoting residential LCB.

**Limitations and Future Research Directions**

This research was meticulously designed and executed; however, a few limitations deserve attention. First, the study took several measures to reduce common method variance like the use of the triangulation technique. Still, the data may still be susceptible. To assess the influence of common method variance, the study conducted Harman’s single-factor test. Although the results showed that common method bias was not a pervasive issue, the research recommends that future studies employ
an experimental or longitudinal research approach. Furthermore, an experimental or longitudinal research design can aid in confirming the causation shown by this study (Holland, 1986).

Second, the measuring instruments of this study were derived from well-established scales that were carefully adapted to match the actual content and scenarios of the measurement. The modification may still result in measurement errors. In this regard, researchers conducted a series of reliability analyses of the data to ensure validity. Despite this, researchers suggest that future studies develop new, contextualized scales to contribute to subsequent studies.

Third, this study was conducted in the college setting. The sample of college students is typical and in line with the research objectives; however, the generalization of the research conclusion may be limited. As a result, validation studies in other groups and contexts are required to verify the generalizability of the findings of this research.

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REFERENCES

Aiken, L. S., & West, S. G. (1991). Multiple regression: Testing and interpreting interactions. Sage (Atlanta, Ga.).

Ali, F., Ashfaq, M., Begum, S., & Ali, A. (2020). How “green” thinking and altruism translate into purchasing intentions for electronics products: The intrinsic-extrinsic motivation mechanism. Sustainable Production and Consumption, 24, 281–291. doi:10.1016/j.spc.2020.07.013

Amabile, T. M. (1993). Motivational synergy: Toward new conceptualizations of intrinsic and extrinsic motivation in the workplace. Human Resource Management Review, 3(3), 185–201. doi:10.1016/1053-4822(93)90012-S

Amoah, A., & Addoah, T. (2021). Does environmental knowledge drive pro-environmental behavior in developing countries? Evidence from households in Ghana. Environment, Development and Sustainability, 23(2), 2719–2738. doi:10.1007/s10668-020-00698-x

Ardoin, N. M., Wheaton, M., Bowers, A. W., Hunt, C. A., & Durham, W. H. (2015). Nature-based tourism’s impact on environmental knowledge, attitudes, and behavior: A review and analysis of the literature and potential future research. Journal of Sustainable Tourism, 23(6), 838–858. doi:10.1080/09669582.2015.1024258

Astakhova, M. N. (2015). The curvilinear relationship between work passion and organizational citizenship behavior. Journal of Business Ethics, 130(2), 361–374. doi:10.1007/s10551-014-2233-5

Bai, R., & Lin, B. (2022). Are residents willing to pay for garbage recycling: Evidence from a survey in Chinese first-tier cities. Environmental Impact Assessment Review, 95, 106789. doi:10.1016/j.eiar.2022.106789

Bai, Y., & Liu, Y. (2013). An exploration of residents’ low-carbon awareness and behavior in Tianjin, China. Energy Policy, 61, 1261–1270. doi:10.1016/j.enpol.2013.06.014

Bamberg, S. (2003). How does environmental concern influence specific environmentally related behaviors? A new answer to an old question. Journal of Environmental Psychology, 23(1), 21–32. doi:10.1016/S0272-4944(02)00078-6

Bostrom, A., Morgan, M. G., Fischhoff, B., & Read, D. (1994). What do people know about global climate change? Risk Analysis, 14(6), 959–970. doi:10.1111/j.1539-6924.1994.tb00065.x

Brislin, R. W. (1986). The wording and translation of research instrument. Sage Publications.

Brotheridge, C. M., & Grandey, A. A. (2002). Emotional labor and burnout: Comparing two perspectives of “people work.” Journal of Vocational Behavior, 60(1), 17–39. doi:10.1006/jvbe.2001.1815

Carmi, N., Arnon, S., & Orion, N. (2015). Transforming environmental knowledge into behavior: The mediating role of environmental emotions. The Journal of Environmental Education, 46(3), 183–201. doi:10.1080/00958964.2015.1028517

Casaló, L. V., Escario, J. J., & Rodriguez-Sanchez, C. (2019). Analyzing differences between different types of pro-environmental behaviors: Do attitude intensity and type of knowledge matter? Resources, Conservation and Recycling, 149, 56–64. doi:10.1016/j.resconrec.2019.05.024

Chen, W., & Li, J. (2019). Who are the low-carbon activists? Analysis of the influence mechanism and group characteristics of low-carbon behavior in Tianjin, China. The Science of the Total Environment, 683(3-4), 729–736. doi:10.1016/j.scitotenv.2019.05.307 PMID:31150893

Cheng, T. M., & Wu, H. C. (2015). How do environmental knowledge, environmental sensitivity, and place attachment affect environmentally responsible behavior? An integrated approach for sustainable island tourism. Journal of Sustainable Tourism, 23(4), 557–576. doi:10.1080/09669582.2014.965177

Cortina, L. M., Magley, V. J., Williams, J. H., & Langhout, R. D. (2001). Incivility in the workplace: Incidence and impact. Journal of Occupational Health Psychology, 6(1), 64–80. doi:10.1037/1076-8998.6.1.64 PMID:11199258

Deci, E. L., & Ryan, R. M. (2000). The “what” and “why” of goal pursuits: Human needs and the self-determination of behavior. Psychological Inquiry, 11(4), 227–268. doi:10.1207/S15327965PLI1104_01

Deci, E. L., & Ryan, R. M. (2008). Facilitating optimal motivation and psychological well-being across life’s domains. Canadian Psychology, 49(1), 14–23. doi:10.1037/0708-5591.49.1.14
Ding, Z., Jiang, X., Liu, Z., Long, R., Xu, Z., & Cao, Q. (2018). Factors affecting low-carbon consumption behavior of urban residents: A comprehensive review. *Resources, Conservation and Recycling*, 132, 3–15. doi:10.1016/j.resconrec.2018.01.013

Dunlap, R. E., & Jones, R. E. (2002). *Environmental concern: Conceptual and measurement issues*. In *Handbook of Environmental Sociology*. Greenwood Press.

Frick, J., Kaiser, F. G., & Wilson, M. (2004). Environmental knowledge and conservation behavior: Exploring prevalence and structure in a representative sample. *Personality and Individual Differences*, 37(8), 1597–1613. doi:10.1016/j.paid.2004.02.015

Fu, L., Sun, Z., Zha, L., Liu, F., He, L., Sun, X., & Jing, X. (2019). Environmental awareness and pro-environmental behavior within China’s road freight transportation industry: Moderating role of perceived policy effectiveness. *Journal of Cleaner Production*, 252, 119796. doi:10.1016/j.jclepro.2019.119796

Gifford, E. (2017). *Exploring knowledge intensity in entrepreneurship: A quantitative study of knowledge, innovation and performance in entrepreneurial firms*. Göteborgs Universitet.

Golman, R., & Loewenstein, G. (2015). Curiosity, information gaps, and the utility of knowledge. SSRN Electronic Journal.

Grant, A. M. (2008). Does intrinsic motivation fuel the prosocial fire? Motivational synergy in predicting persistence, performance, and productivity. *The Journal of Applied Psychology*, 93(1), 48–58. doi:10.1037/0021-9010.93.1.48 PMID:18211134

Halbesleben, J. R., & Bowler, W. M. (2007). Emotional exhaustion and job performance: The mediating role of motivation. *The Journal of Applied Psychology*, 92(1), 93–106. doi:10.1037/0021-9010.92.1.93 PMID:17227154

Harman, H. H. (1967). *Modern factor analysis*. University of Chicago Press.

Holland, P. W. (1986). Statistics and causal inference. *Journal of the American Statistical Association*, 81(396), 945–960. doi:10.1080/01621459.1986.10478354

Hui, C., Lee, C., & Rousseau, D. M. (2004). Psychological contract and organizational citizenship behavior in China: Investigating generalizability and instrumentality. *The Journal of Applied Psychology*, 89(2), 311–321. doi:10.1037/0021-9010.89.2.311 PMID:15065977

Indriani, I. A. D., Rahayu, M., & Hadiwidjojo, D. (2019). The influence of environmental knowledge on green purchase intention the role of attitude as mediating variable. *International Journal of Multicultural and Multireligious Understanding*, 6(2), 627–635. doi:10.18415/ijmmu.v6i2.706

Kalimo, R. (1999). Knowledge jobs: How to manage without burnout? *Scandinavian Journal of Work, Environment & Health*, 25(6), 605–609. doi:10.5271/sjweh.487 PMID:10884160

Lee, K. (2008). Opportunities for green marketing: Young consumers. *Marketing Intelligence & Planning*, 26(6-7), 573–586. doi:10.1108/02634500810902839

Leiserowitz, A. (2006). Climate change risk perception and policy preferences: The role of affect, imagery, and values. *Climatic Change*, 77(1), 45–72. doi:10.1007/s10584-006-9059-9

Leung, G. S. K., Cho, V., & Wu, C. H. (2021). Crowd workers’ continued participation intention in crowdsourcing platforms: An empirical study in compensation-based micro-task crowdsourcing. *Journal of Global Information Management*, 29(6), 1–28. doi:10.4018/JGIM.202111010a

Li, Q., Long, R., & Chen, H. (2017). Empirical study of the willingness of consumers to purchase low-carbon products by considering carbon labels: A case study. *Journal of Cleaner Production*, 161, 1237–1250. doi:10.1016/j.jclepro.2017.04.154

Lin, B., & Fei, R. (2015). Regional differences of CO2 emissions performance in China’s agricultural sector: A Malmquist index approach. *European Journal of Agronomy*, 70, 33–40. doi:10.1016/j.eja.2015.06.009

Lin, B., Jia, Z., & Song, M. (2021). Economic impact of information industry development and investment strategy for information industry. *Journal of Global Information Management*, 29(1), 22–43. doi:10.4018/JGIM.2021010102
Lin, B., & Zhang, Z. (2016). Carbon emissions in China’s cement industry: A sector and policy analysis. *Renewable & Sustainable Energy Reviews, 58*, 1387–1394. doi:10.1016/j.rser.2015.12.348

Lin, S. T., & Niu, H. J. (2018). Green consumption: Environmental knowledge, environmental consciousness, social norms, and purchasing behavior. *Business Strategy and the Environment, 27*(8), 1679–1688. doi:10.1002/bse.2233

Liu, D., Chen, X. P., & Yao, X. (2011). From autonomy to creativity: A multilevel investigation of the mediating role of harmonious passion. *The Journal of Applied Psychology, 96*(2), 294–309. doi:10.1037/a0021294 PMID:21058804

Liu, Y., Yang, D., & Xu, H. (2017). Factors influencing consumer willingness to pay for low-carbon products: A simulation study in China. *Business Strategy and the Environment, 26*(7), 972–984. doi:10.1002/bse.1959

Loewenstein, G. (1994). The psychology of curiosity: A review and reinterpretation. *Psychological Bulletin, 116*(1), 75–98. doi:10.1037/0033-2909.116.1.75

Ma, J., Zhou, X., Chen, R., & Dong, X. (2019). Does ambidextrous leadership motivate work crafting? *International Journal of Hospitality Management, 77*, 159–168. doi:10.1016/j.ijhm.2018.06.025

Mars, M. M., & Rios-Aguilar, C. (2010). Academic entrepreneurship (re)defined: Significance and implications for the scholarship of higher education. *Higher Education, 59*(4), 441–460. doi:10.1007/s10734-009-9258-1

Mi, L., & Nie, R. (2012). An empirical research on the effect of low-carbon knowledge of the urban residents on their low-carbonized energy consumption behavior. *Asian Journal of Business Research, 2*(1), 37–54. doi:10.14707/ajbr.120003

Nansai, K., Kondo, Y., Kagawa, S., Suh, S., Nakajima, K., Inaba, R., & Tohno, S. (2012). Estimates of embodied global energy and air-emission intensities of Japanese products for building a Japanese input-output life cycle assessment database with a global system boundary. *Environmental Science & Technology, 46*(16), 9146–9154. doi:10.1021/es2043257 PMID:22881452

Paço, A., & Lavrador, T. (2017). Environmental knowledge and attitudes and behaviours towards energy consumption. *Journal of Environmental Management, 197*, 384–392. doi:10.1016/j.jenvman.2017.03.100 PMID:28410516

Pagiaslis, A., & Krontalis, A. K. (2014). Green consumption behavior antecedents: Environmental concern, knowledge, and beliefs. *Psychology and Marketing, 31*(5), 335–348. doi:10.1002/mar.20698

Pelletier, L. G., Tuson, K. M., Green-Demers, I., Noels, K., & Beaton, A. M. (1998). Why are you doing things for the environment? The motivation toward the environment scale (MTES). *Journal of Applied Social Psychology, 28*(5), 437–468. doi:10.1111/j.1559-1816.1998.tb01714.x

Polonsky, M. J., Vocino, A., Grau, S. L., Garma, R., & Ferdous, A. S. (2012). The impact of general and carbon-related environmental knowledge on attitudes and behaviour of US consumers. *Journal of Marketing Management, 28*(3-4), 238–263. doi:10.1080/0267257X.2012.659279

Russo, A., & Vurro, C. (2019). Alliance management knowledge and alliance performance: Unveiling the moderating role of the dedicated alliance function. *Industrial and Corporate Change, 28*(4), 725–752. doi:10.1093/icc/dty037

Safari, A., Salehzadeh, R., Panahi, R., & Abolghasemian, S. (2018). Multiple pathways linking environmental knowledge and awareness to employees’ green behavior. *Corporate Governance, 18*(1), 81–103. doi:10.1108/CG-08-2016-0168

Su, B., & Ang, B. W. (2017). Multiplicative structural decomposition analysis of aggregate embodied energy and emission intensities. *Energy Economics, 65*, 137–147. doi:10.1016/j.eneco.2017.05.002

Suki, N. M. (2003). Young consumer ecological behaviour: The effects of environmental knowledge, healthy food, and healthy way of life with the moderation of gender and age. *Management of Environmental Quality, 24*(6), 726–737. doi:10.1108/MEQ-02-2013-0010

Tu, Y., & Lin, X. (2013). How ethical leadership influence employees’ innovative work behavior: A perspective of intrinsic motivation. *Journal of Business Ethics, 116*(2), 441–455. doi:10.1007/s10551-012-1509-x
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Utman, C. H. (1997). Performance effects of motivational state: A meta-analysis. *Personality and Social Psychology Review, 1*(2), 170–182. doi:10.1207/s15327957pspr0102_4 PMID:15647124

Vallerand, R. J., Blanchard, C., Mageau, G. A., Koestner, R., Ratelle, C., Léonard, M., Gagné, M., & Marsolais, J. (2003). Les passions de l’âme: On obsessive and harmonious passion. *Journal of Personality and Social Psychology, 85*(4), 756–767. doi:10.1037/0022-3514.85.4.756 PMID:14561128

White, R. W. (1959). Motivation reconsidered: The concept of competence. *Psychological Review, 66*(5), 297–333. doi:10.1037/h0040934 PMID:13844397

Wu, W. (2010). Study on college students’ learning burnout. *Asian Social Science, 6*(3), 132–134. doi:10.5539/ass.v6n3p132

Zhang, H., Shi, X., Cheong, T. S., & Wang, K. (2020). Convergence of carbon emissions at the household level in China: A distribution dynamics approach. *Energy Economics, 92*, 104956. doi:10.1016/j.eneco.2020.104956