

Exploring green performance and its antecedents: The moderating role of problem-based learning

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Abstract

Drawing upon self-determination theory and situated learning theory, this work proposes a theoretical model that shows how self-determined motivation influences workplace green performance. In the model, workplace green performance is indirectly influenced by perceived autonomy, competence, and relatedness as three predictors via the mediation of green learning goal orientation (Green-LGO). In the meantime, the effects of the three predictors on Green-LGO are hypothetically moderated by problem-based learning. An anonymous field survey on engineers was conducted across two large semiconductor companies. This study presents research implications about on-the-job learning and training that facilitate workplace green performance.

Keywords: Green training and education, learning goal orientation, problem-based learning, workplace green performance.

Introduction

An important theory that theoretically justifies workplace green performance is self-determination theory. It suggests that three major psychological needs (i.e., perceived autonomy, competence, and relatedness) fulfilled by workplace activities or contingencies (Maybee & Flierl, 2016; Minnaert et al., 2011) are likely to boost workplace green performance. For example, Zhang et al., (2021) have found that employees' green behavioral outcome is directly promoted by fulfilled psychological needs such as autonomy, competence, and relatedness.

Previous research based on self-determination theory indicates that when employees' psychological needs for autonomy, relatedness and competence are fulfilled, they are likely to strengthen subsequent self-determined motivation (Deci & Ryan, 2000) that eventually facilitates performance outcomes. Although certain types of self-determined motivation have been discussed (e.g., conceptual learning, learning attention) across different contexts (e.g., Leptokaridou et al., 2015), a specific self-determined learning goal motivation that helps transform autonomy, relatedness and competence into workplace green performance has not been discussed yet, leading to the first research gap of this study. The second research gap relates to

whether there exists a key moderator that may intensify or lessen the effects of the three predictors (i.e., autonomy, relatedness and competence), which has been relatively understudied in the literature. Based on the above research gaps, two research questions are answered by this study, including (1) through what mediating self-determined learning goal mechanism is workplace green performance developed? and (2) by what moderating mechanism are the effects of the three predictors influenced?

To answer the first research gap, this study proposes green learning goal orientation (Green-LGO) as a critical self-determined motivation that mediates the relationships between the three predictors and workplace green performance. Green-LGO is defined as a craving to develop the self as a goal by self-regulatively acquiring new environmental knowledge or understanding up-to-date environmental solutions. Green-LGO is likely encouraged by fulfilled needs (e.g., autonomy, relatedness and competence) that trigger self-initiated learning behavior targeted at seeking green challenges for improvement (Matsuo, 2018) in order to increase workplace green performance. To answer the second research question, this study draws upon situated learning theory to propose problem-based learning as a critical factor that moderates the effects of the three predictors on Green-LGO. Problem-based learning is defined as a type of learning that is carried out by solving or dealing with ill-defined problems in real life (Astuti et al., 2021), which may buffer or stimulate the effects of the three predictors on Green-LGO. Extending previous

research that has postulated the approach of problem-based learning as a moderator of learners' performance (Jabarullah & Hussain, 2019), this study theoretically justifies how the development of Green-LGO is moderated by problem-based learning.

All in all, the purpose of this study aims to explore the mediating role of Green-LGO and the moderating role of problem-based learning in order to explain workplace green performance to a large extent. Without recognizing these roles, our knowledge about the formation process of workplace green performance will remain quite disputable, and on-the-job training and educational initiatives administered to spur employees' efforts on workplace green performance will become senseless and invalid based on prejudices or unscientific faith.

Theory and research model

Drawing upon self-determination theory and situated learning theory, this study proposes a model to justify how workplace green performance is fostered. In the model, workplace green performance is influenced by Green-LGO that is motivated by three predictors such as perceived autonomy, perceived competence, and perceived relatedness. At the same time, the effects of the three predictors on Green-LGO are moderated by problem-based learning. Note that self-determination theory and situated learning theory are complementary: whereas self-determination theory yields insight into the development of self-determined motivation (e.g.,

Green-LGO), situated-learning theory sheds light on problem-based learning as a situational context that moderates the development of self-determined motivation.

The literature has linked learning goal orientation to a wide range of positive outcomes (Elliot, 1999). Employees with a strong learning goal orientation strengthen their role capabilities by proactive learning and thus engage in a high level of task performance (Capezio et al., 2014). In terms of green performance, since employees with strong Green-LGO tend to work hard with a belief that greater green (or environmental) efforts lead to success (Porath & Bateman, 2006), their workplace green performance is likely achieved. In other words, Green-LGO positively influences workplace green performance because employees who possess strong Green-LGO have a strong preference for learning novel green approaches and solutions to improve environmental challenges (e.g., Bettencourt, 2004), suggesting the positive effect of G-LGO on workplace green performance. At the same time, employees' Green-LGO is likely strengthened by how their three major psychological needs (autonomy, competence, and relatedness) are fulfilled. Previous research has suggested that these three needs are important in supporting motivation towards learning (Puhakka et al., 2021).

Perceived autonomy is defined as self-regulation of workplace green actions or encounters (Ross & Barnes, 2018). Perceived autonomy represents the degree of employees' perception of their self-regulation over environmental proactivity that facilitates Green-LGO. For example,

when employees are free to perform specific green behavior in the workplace, they are more likely to develop a strong desire to learn about green practices (e.g., Green-LGO). Self-determination theory suggests that strong perceived autonomy are likely to foster employees' self-determined learning goal orientation (e.g., Green-LGO) (Yang & Lee, 2021). As a result, workplace green performance is thus improved. To sum up, the first hypothesis is rationalized as below.

H1: Green-LGO mediates the positive relationship between perceived autonomy and workplace green performance.

Perceived competence is defined as employees' belief that they are capable of performing specific green behavior effectively (Williams et al., 2006). When they perceive competent to implement green practices in the workplace, their desire to keep engaging in learning activities related to environmental sustainability (i.e., Green-LGO) is more likely aroused or encouraged. Previous research has found that perceived competence (e.g., being capable of dealing with green issues) influences employee's intrinsic motivation (e.g., Green-LGO) to perform their workplace duties (Rahi et al., 2022), consequently boosting workplace green performance. Hence, the second hypothesis is derived as below.

H2: Green-LGO mediates the positive relationship between perceived competence and

workplace green performance.

Perceived relatedness is defined as employees' perception of being socially related to significant others who value green practices and environmental protection (e.g., Rahi et al., 2022). When employees perceive being connected with friends and colleagues who demonstrate pro-environmental attitude or acts (i.e., high perceived relatedness), the purpose of their learning green practices as a goal is thus strengthened (i.e., increased Green-LGO). For example, employees assigned to work on environmentally sustainable projects or tasks are more likely to persist with Green-LGO if they are aware of coworkers who care and are truly concerned about environmental sustainability. Thus, the third hypothesis is described as below.

H3: Green-LGO mediates the positive relationship between perceived relatedness and workplace green performance.

Situated learning theory (Brown et al., 1989) indicates that meaningful problem-based learning is best used when the learning is embedded in a physical and environmental context (e.g., pollution reduction or recycling). Situated learning suggests that learning by seeking green solutions for our surrounding pragmatic situations and open-ended problems is essential (Hung, 2002). In other words, learning is, at its root, improved via interactions between the mind and the

ecological environment in which the learning is situated and occurs. From a perspective of problem-based learning, the “situation” or the meaningful setting is to a large extent offered by ill-structured and complex ecologically environmental problems the learners think of solving (Marra et al., 2014).

According to situated learning theory, all ecological situations are filled with learning opportunities by solving their problems (Marra et al., 2014). Problem-based learning focuses on the centrality of generating self-directed learning to solve indefinite and ill-structured environmental problems without the need for supervision (Marra et al., 2014). For that reason, the effect of perceived autonomy (built upon delegation and support by supervision) becomes less influential among employees with strong problem-based learning because they are able to monitor their own understanding in a state of mindfulness and learn to adjust problem-solving strategies regardless of perceived autonomy. Hence, the hypothesized negative moderation is stated below.

H4: Problem-based learning negatively moderates the relationship between perceived autonomy and Green-LGO such that the relationship is weaker when problem-based learning is stronger.

Hmelo-Silver (2004) describes that the beneficial effects of employees’ skills and competence

are likely diminished without the establishment of “appropriate metacognitive and reasoning strategies” (i.e., weak problem-based learning) (p.240). On the contrary, strong problem-based learning helps employees improve their thinking skills and demonstrate the richness of the cognitive structures and processes (Eviyanti et al., 2017), their competence is more likely to kick in to boost Green-LGO effectively. In other words, the positive effect of perceived competence on Green-LGO becomes larger when stronger problem-based learning comes into play with logic and rationality. To sum up, employees must be aware of environmental problems they encounter and learn solving the problems (e.g., problem-based learning) in order to identify tasks (Marra et al., 2014) and unleash their potential competence to accomplish green learning goals to a larger extent. Accordingly, the positive moderation of problem-based learning is hypothesized below.

H5: Problem-based learning positively moderates the positive relationship between perceived competence and Green-LGO such that the relationship is stronger when problem-based learning is stronger.

As employees with strong problem-based learning focus on learning to solve problems, their knowledge construction is stimulated by questions or needs to know (Marra et al., 2014). These employees often perform learning by addressing simulations of real green issues or environmental problems. The content and challenges to be learned are organized and centered

around existing ecological challenges rather than as a hierarchical list of social networking concerns. For that reason, they pay more attention to green issues but less attention to how significant others view the issues. Accordingly, the effect of perceived relatedness is less influential to Green-LGO when problem-based learning (e.g., the learning focus on pollution problems) is stronger, suggesting the negative moderation of problem-based learning hypothesized below.

H6: Problem-based learning negatively moderates the relationship between perceived relatedness and Green-LGO such that the relationship is weaker when problem-based learning is stronger.

Methods

Subjects and procedures

This study collected field survey data from process engineers in two leading semiconductor firms in Taiwan for testing its hypotheses. These engineers were considered appropriate research subjects for this study because they played a critical role for environmental sustainability that was substantially influenced by their production process development. Researchers obtained the help of their university alumni who were senior managers in high-tech industry to conduct a field investigation. Research subjects were invited to voluntarily take part in the investigation. They

were assured that all the responses to survey questionnaires would be assessed only in an aggregated manner and thus no personal information would be individually reported.

Measures

The research variables of this study were measured by the psychometric scales modified from the literature. Before starting its actual field investigation, this study executed a pilot study with the data from 67 people to verify the quality of research scales. These people in the pilot study were ultimately excluded from the actual investigation. The data were analyzed based on exploratory factor analysis to show the acceptable quality of scale items.

Data collection and analyses

This study surveyed the same number of process engineers across two firms (i.e., 180 subjects each firm). A total of 249 usable questionnaires (i.e., 145 from one firm and 104 from another firm) were eventually returned with the overall response rate of 69.17%. The pooled sample showed that 145 were male (58.23%), 156 were the age of 40 or less (62.65%), 199 had a bachelor degree (79.92%), 50 had a master degree or above (20.08%), 197 had work experience of 5 years or more (79.12%), and 117 had a management-related position (46.99%). These sample characteristics were all controlled in the latter analyses of this study.

The test results of confirmatory factor analysis indicated that NFI, NNFI, and CFI values were equal to or larger than 0.9. The RMR value was smaller than 0.05 and the RMSEA value was smaller than 0.08. These results supported a good fit between the proposed CFA model and the primary data.

Convergent validity was supported due to (1) significant factor loadings ($p < 0.001$), (2) AVE (average variance extracted) values larger than 0.50, and (3) Cronbach's alpha values larger than 0.70. In the meantime, discriminant validity was demonstrated by AVE tests in which the square root of AVE values were all larger than corresponding correlations (i.e., off-diagonal numbers) (see Table 1).

Insert Table 1 about here

Testing of hypotheses

This study utilized hierarchical moderated regression analysis to verify its research hypotheses (see Table 2). In Model 1, three determinants (i.e., perceived autonomy, perceived competence, and perceived relatedness) significantly related to workplace green performance with the coefficients of 0.29 ($p < .01$), 0.15 ($p < .01$), and 0.25 ($p < .01$) respectively. In Model 2, the three

determinants significantly related to Green-LGO with the coefficients of 0.26 ($p<.01$), 0.10 ($p<.01$), and 0.27 ($p<.01$) respectively. In Model 3, the three determinants and Green-LGO were included together to explain workplace green performance. The test result revealed that the significance of the three determinants in Model 1 became insignificant in Model 3, suggesting that the three determinants had only indirect effects on workplace green performance via the mediation of Green-LGO. Collectively, H1, H2, and H3 were supported.

In Model 4, the interaction terms of problem-based learning were included to test the hypothesized moderation of this study. The statistical results showed (1) problem-based learning did not moderate the relationship between perceived autonomy and Green-LGO (thus H4 was not supported), (2) problem-based learning positively moderated the relationship between perceived competence and Green-LGO (thus H5 was supported), and (3) problem-based learning negatively moderated the relationship between perceived relatedness and Green-LGO (thus H6 was supported).

Insert Table 2 about here

Discussion

This study elaborated the moderating mechanism of problem-based learning and the mediating mechanism of Green-LGO in the development process of workplace green performance. The findings of this study indicated Green-LGO as a key intermediary that facilitates workplace green performance. At the same time, problem-based learning is a key leverage that can fine-tune the effects of fulfilled psychological needs (i.e., autonomy, competence, or relatedness) to maximize Green-LGO. Based on its supported hypotheses, this study contributes to prior research by providing following judicious implications.

This study offers practical implications for on-the-job learning and training practices that facilitate workplace green performance. To begin with, the positive effect of perceived autonomy on Green-LGO indicates that employees should learn taking part in decision-making related to green issues, which provides them with a sense of psychological ownership that meets their intrinsic needs and strengthens their autonomous motivation to consequently boost Green-LGO.

The positive effect of perceived competence on Green-LGO suggests that green training for increasing employees' domain knowledge in the context of environmental sustainability is fundamental for the development of Green-LGO. For example, employees may be provided with active learning programs that introduce a wide variety of green skills (e.g., communication skills, environmental knowledge, green values and technology) and train employees to apply knowledge in practical workplace situations, consequently facilitating Green-LGO.

The positive effect of perceived relatedness on Green-LGO reveals that employees are likely susceptible to the viewpoints of others in their social circles. Therefore, collaborative learning may be used as a learning strategy in which two or more workers participate in jointly solving environmental problems. Workers can learn by mirroring their own attitude, views, and values with those of others. To sum up, collaborative learning by learning with others together can develop shared thoughts and feelings that facilitate perceived relatedness and then Green-LGO.

The positive moderating effect of problem-based learning (i.e., H5) suggests that perceived competence is more influential to Green-LGO when people get used to learn things under open-ended, yet “fuzzy,” situations (i.e., high problem-based learning). Therefore, experienced workers with high competence may be guided to use problem-based learning tactics (e.g., brainstorming training forums, consultation and debate activities, and case studies) in order to exert their expertise and competence to effectively bring about Green-LGO.

The negative moderating effect of problem-based learning (i.e., H6) suggests that perceived relatedness is more influential to Green-LGO when problem-based learning is low. Hence, inexperienced or novice employees who are not good at problem-based learning in the workplace may be provided with empathy training as the first priority for the purpose of increasing perceived relatedness and then Green-LGO. Specifically, training methods such as social sharing

of emotions, role playing exercises, and collaborative group activities may be applied for employees to feel what it is like in others' shoes.

In summary, it is not realistic to assume that Green-LGO can be simply enhanced to increase workplace green performance without taking into account its determinants and moderator simultaneously. In the contingency in which problem-based learning is at a moderate level, employees' perceived autonomy, competence, and relatedness may be equally important. Nevertheless, managers may prioritize increasing employees' competence more in case of their high problem-based learning but concentrate on increasing employees' relatedness more in case of their low problem-based learning. In summary, by fine-tuning the mediating and moderating processes discussed in this study, employees are likely motivated to develop sound Green-LGO to show high workplace green performance.

Limitations and future research

In this study, two major limitations may be taken into account for future scholars' reference. The first limitation relates its generalizability of research findings due to the limited number of sample subjects from two large semiconductor enterprises in Taiwan. For that reason, the empirical findings obtained by this study may not be highly generalizable to workers in different industries such as servicing, financial, or agricultural ones. Second, due to its theoretical

foundation based on self-determination theory and situated learning theory, this study was unable not address emotional, cultural, or political variables (e.g., positive affect, power distance, or organizational politics) to explain workplace green performance. Future studies may approach diverse industry workers by longitudinal investigations, integrate different theories to study workplace green practices, and evaluate multiple moderators simultaneously so that effective on-the-job learning and training activities that help fulfill psychological needs (e.g., autonomy) and boost Green-LGO can be provided. Finally, future research can link the concept of green learning goal orientation to different types of workplace performance (e.g., green innovation performance, green creativity, green business models).

Data availability statements

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Funding and/or Conflicts of interests/Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the research work reported in this article.

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Table 1. AVE tests for confirming discriminate validity

	Mean	S.D.	1	2	3	4	5	
1. Workplace green performance	3.52	0.91	0.87					
2. Green-LGO	3.80	0.79	0.68**	0.87				
3. Perceived autonomy	4.14	0.64	0.41**	0.49**	0.84			
4. Perceived competence	3.85	0.85	0.36**	0.38**	0.34**	0.90		
5. Perceived relatedness	3.51	0.93	0.41**	0.47**	0.23**	0.36	0.93	
6. Problem-based learning	4.25	0.63	0.33**	0.47**	0.50**	0.23**	0.17**	0.83

** $p < .05$

Note: The diagonal numbers are the square root of AVE (averaged variance extracted) and the off-diagonal numbers are pair-wise correlations.

Table 2. Test results of hierarchical moderated regression analysis

	<u>Model 1</u> Workplace green performance	<u>Model 2</u> Green-LGO	<u>Model 3</u> Workplace green performance	<u>Model 4</u> Green-LGO
Control variables				
Sex	0.11	0.18**	0.00	0.19**
Age	0.00	0.00	0.00	0.00
Education	-0.15	-0.15	-0.05	-0.14
Tenure	0.00	0.00	0.00	0.00
Firm	-0.06	-0.01	-0.05	-0.02
Management position	-0.18*	-0.12	-0.10	-0.13
Problem-based learning (PBL)	0.19**	0.34**	-0.03	0.03
Determinants:				
Perceived autonomy	0.29**	0.26**	0.12	0.28
Perceived competence	0.15**	0.10**	0.08	-0.87**
Perceived relatedness	0.25**	0.27**	0.07	0.95
Mediator:				
Green-LGO			0.65**	
Interaction terms:				
PBL x Perceived autonomy				0.00
PBL x Perceived competence				0.23**
PBL x Perceived relatedness				-0.15**
Adj. R-square	0.28	0.43	0.46	0.46

* $p < 0.05$; ** $p < 0.01$