

The Impact of Phenomenon-Based Learning on Awareness and Importance of Taxonomy Regulation through Green Product Labeling

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Abstract—To meet the United Nations Sustainable Development Goals and the 2050 Net Zero Emission Policy, the European Union introduced the EU Taxonomy and the Carbon Border Adjustment Mechanism (CBAM) in 2020, making green product environmental declarations crucial. Taiwan promotes Sustainable Finance Classification Standards through Green Building Materials Labels (GBMLs). This study utilizes Phenomenon-Based Learning (PBL) with a focus on green product labeling, delivering short-term seminars on sustainable environmental expertise. A one-day seminar was attended by 346 participants. Initially, a questionnaire assessed their understanding of green building material labeling. After the PBL session, a second questionnaire gauged cognitive and importance assessments from 98 participants. The Boston Consulting Group (BCG) matrix analyzed the impact of PBL on awareness and the importance of a sustainable economy through green product labeling. A two-factor categorical analysis using the Pearson chi-square test was also conducted. Results showed 80% were first-time attendees aware of green product labeling, and 51% had backgrounds in architecture, interior design, and materials. The BCG matrix analysis in the second stage revealed that the significance of green product labeling to Taxonomy Regulation activities was high, with 95.9% in the first quadrant (+,+) and only 3% in the third quadrant (-,-). The Pearson chi-square test indicated no significant association between professionals in interior design and the importance of green product labeling ($p > 0.05$), suggesting that awareness and importance of a sustainable economy were not influenced by professional occupation. However, individuals with professional backgrounds showed significant associations with the application of green product labeling in building regulations ($p < 0.05$), highlighting the influence of professional background.

Keywords—green building materials labels, phenomenon-based learning, taxonomy regulation, awareness, Boston Consulting Group (BCG) matrix, Pearson's chi-squared test

I. INTRODUCTION

In alignment with the United Nations Sustainable Development Goals and the 2050 net-zero emissions policy objectives, the European Union introduced the EU Sustainable Finance Taxonomy and the Carbon Border Adjustment Mechanism (CBAM) in 2020. These initiatives have underscored the significance of environmental declarations for green products.

The EU Taxonomy is a tool to help investors, companies,

issuers and project promoters navigate the transition to a low-carbon, resilient and resource-efficient economy. The Taxonomy sets performance thresholds (referred to as 'technical screening criteria') for economic activities which:

- [1, 2]
- 1) Make a substantive contribution to one of six environmental objectives:
 - a) Climate change mitigation
 - b) Climate change adaptation
 - c) Sustainable and protection of water and marine resources
 - d) Transition to a circular economy
 - e) Pollution prevention and control
 - f) Protection and restoration of biodiversity and ecosystems
- 2) Do No Significant Harm (DNSH) to the other five, where relevant;
- 3) Meet minimum safeguards (e.g., OECD Guidelines on Multinational Enterprises and the UN Guiding Principles on Business and Human Rights).

Taiwan has also promoted the implementation of its sustainable finance taxonomy standards through the identification method of Green Building Materials Labels (GBMLs) (Fig. 1). The GBMLs, certified by Taiwan's Ministry of the Interior [3], are defined as materials that have the least environmental impact and are harmless to human health throughout their lifecycle, including raw material extraction, product manufacturing, application, and post-use recycling. They are primarily categorized into four groups: ecological green building materials, healthy green building materials, high-performance green building materials, and recycled green building materials. Since the initiation of GBMLs in 2004, a total of 3,563 labels have been issued, covering 25,655 building material products. Among these, healthy green building materials account for 74.9%, high-performance green building materials 15.6%, recycled green building materials 9.2%, and ecological green building materials 0.4% [4]. In terms of building regulations, new constructions and interior renovations are required to use green building materials labeled products for 60% of the area, and 20% for exterior applications. These standards have become an integral part of Taiwan's Sustainable Finance Taxonomy Regulation.

This study explores the theme of green product labeling through the method of Phenomenon-Based Learning (PBL) in short-term lectures to understand the impact of green product identification on the awareness and importance of sustainable economy.



Fig. 1. Taiwan green building materials labels.

II. LITERATURE REVIEW

“Phenomenon-based Learning” (PBL) has been implemented for many years in Finland, the United States, New Zealand, and Japan. This pedagogical approach is characterized by the integration of significant contemporary societal issues or major historical events as “themes” into the curriculum design. It combines knowledge from different disciplines to explore these themes, making the curriculum more comprehensive and diverse. This approach aims to enhance students’ learning motivation and outcomes. In recent discussions, cross-disciplinary educational methods have been seen as an alternative to disciplinary-focused education and as especially suitable for meeting the contemporary and future challenges of local, national, and global societies. Achieving comprehension and possible solutions requires creativity, which demands ‘deep disciplinary knowledge—but at the same time it requires one to think broadly, across disciplines’. The aim of phenomenon-based learning is to provide such an educational approach [5]. The starting point in PBL is usually a phenomenon, something tangible or intangible. Since a phenomenon can be studied from many angles, PBL opposes strict and one-sided subject-based educational approaches. Instead, the emphasis lies on an approach to teaching and learning that is as broad as possible without losing the subject’s own depth [6, 7]. Therefore, PBL could be called an interdisciplinary approach to learning [8, 9]. In Taiwan, there is a push towards innovative teaching methods, transitioning from traditional structured learning to interdisciplinary Phenomenon-based Learning, a style of learning that transcends age and discipline. This approach encourages learners to progress from learning about phenomena to exploring themes, thereby enhancing their ability to solve problems diversely.

Particularly in the field of social education, the introduction of Phenomenon-based Learning can stimulate cognition and awareness, as well as improve learners’ attention and reflective abilities, focusing collectively on social phenomena. This study aims to employ Phenomenon-based Learning to educate participants with professional backgrounds on green product labeling, to understand the impact on their awareness and concern for the sustainable economy, and to provide feedback for future planning of theme-based learning.

III. MATERIALS AND METHODS

A. Phenomenon-Based Learning

The study utilizes Phenomenon-based Learning, with green product labeling as the theme, for short-term lecture-based learning of sustainable environmental knowledge. A total of 346 participants were provided with a one-day lecture series on theme-based learning, encompassing five PBL sessions, each lasting 50 minutes with a 10-minute break between sessions (Fig. 2). Following the learning, a two-phase survey was conducted: the first phase gathered data on participants’ understanding of the significance and background of green building materials labels, while the second phase involved distributing a questionnaire on awareness and importance to 98 participants after the PBL (Table 1). The impact of Phenomenon -based learning on Taxonomy Regulation awareness and importance was analyzed using the Boston Consulting Group (BCG) matrix.

Table 1. Phenomenon-based Learning course.

Phenomenon-based Learning course	object
PBL-1 (50 mins)	Green Product Labeling (TW-GBMLs) and its Significance and Correlation with SDGs and ESG
PBL-2 (50 mins)	Toward 2050 Net Zero: Low Embodied carbon Construction and Material Labeling Systems
PBL-3 (50 mins)	Eco-Green Building Materials (TW-GBMLs) and Low Embodied carbon Construction and Materials
PBL-4 (50 mins)	Circular Recycled Green Building Materials (TW-GBMLs) and Net Zero and Circular Economy
PBL-5 (50 mins)	Green Product Labeling and ESG Reporting Verification

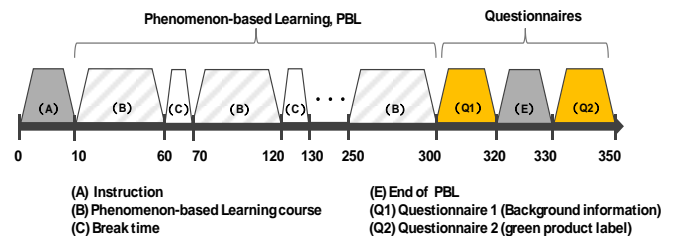


Fig. 2. Phenomenon-based learning.

Green Product Labeling (TW-GBMLs) and its Significance and Correlation with SDGs and ESG: This refers to the importance and relationship between Taiwan’s Green Building Materials Labels and Sustainable Development Goals (SDGs) as well as Environmental, Social, and Governance (ESG) criteria.

Toward 2050 Net Zero: Low Embodied carbon Construction and Material Labeling Systems: This indicates the movement towards achieving net zero carbon emissions by 2050 through the use of construction and materials that have low Embodied carbon, and the importance of labeling systems for these materials.

Eco-Green Building Materials (TW-GBMLs) and Low Embodied carbon Construction and Materials: This pertains to the role of Taiwan’s Green Building Materials Labels in promoting construction and materials that have low Embodied carbon, contributing to more sustainable and eco-friendly building practices.

Circular Recycled Green Building Materials (TW-GBMLs) and Net Zero and Circular Economy: This highlights the connection between Taiwan's Green Building Materials Labels for circular recycled materials, net zero carbon goals, and the circular economy, emphasizing the importance of recycling and reusing materials in the construction industry to achieve sustainability.

Green Product Labeling and ESG Reporting Verification: This denotes the relationship between Green Product Labeling and the verification process for Environmental, Social, and Governance (ESG) reporting, underscoring the role of green product labeling in enhancing the transparency and accountability of ESG practices.

B. BCG Matrix

For the second phase, a questionnaire on awareness and importance was distributed to 98 participants after the Phenomenon-Based Learning (PBL) session. The impact of theme-based learning on sustainable economic awareness and importance was assessed using the Boston Consulting Group (BCG) matrix [10, 11]. Subsequently, a bivariate categorical analysis was conducted using the Pearson chi-square test. The BCG matrix is divided into four quadrants, with importance and relevance serving as the X and Y axes, respectively. The first quadrant (+,+) indicates high importance and strong relevance, the second quadrant (-,+) indicates low importance and strong relevance, the third quadrant (-,-) indicates low importance and weak relevance, and the fourth quadrant (+,-) indicates high importance and low relevance (Fig. 3).

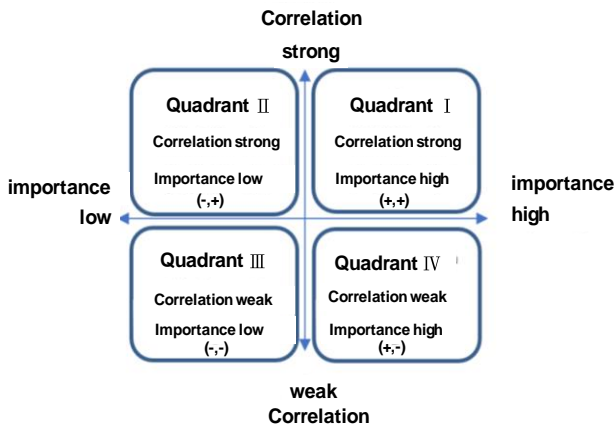


Fig. 3. BCG matrix.

IV. RESULT AND DISCUSSION

A. The Impact of Phenomenon-Based Learning (PBL) with Green Product Labeling on the Awareness and Importance of the Taxonomy Regulation.

After completing five PBL sessions, a first-phase questionnaire survey was conducted among the 346 participants to compile their understanding of the significance and background information of the Green Building Materials Labels (GBMLs). The results showed that 72% of the participants had backgrounds in architecture and construction, with 80% being unaware of the Taxonomy Regulation prior to the sessions (Fig. 4).

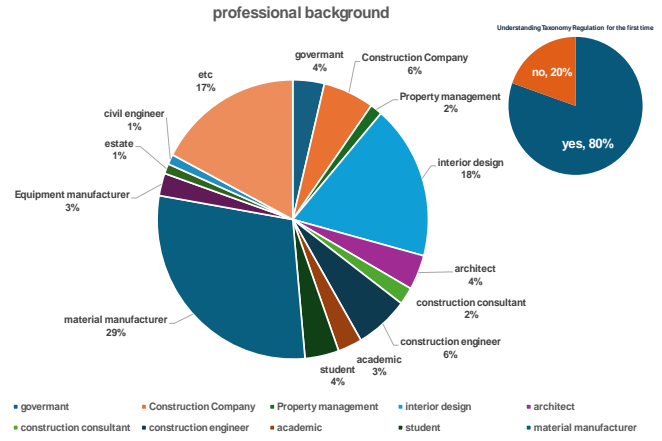


Fig. 4. Participants background.

The study further selected 98 participants for a second-phase questionnaire survey to examine the relationship between awareness and importance. The questionnaire used a 5-point Likert scale to inquire about the importance and relevance separately. The results indicated that 67.3% of the participants considered GBMLs to be very important and 22.4% considered them important for Taxonomy Regulation. Regarding the application of GBMLs in building regulations and their importance for Taxonomy Regulation, 58.2% found it very important and 31.6% found it important. In terms of relevance, 66.3% of the participants believed that GBMLs are highly relevant to Taxonomy Regulation, and 24.5% considered them to be relevant (Table 2).

Table 2. GBMLs Likert scale 5 points of importance and correlation.

N = 98	Green Building Materials Labels	GBMLs of Building regulations	GBMLs of Indoor Air Quality Law
Very Unimportant (1)	1.0%	3.1%	2.0%
Unimportant (2)	3.1%	4.1%	2.0%
Natural (3)	6.1%	3.1%	6.1%
Important (4)	22.4%	31.6%	25.5%
Very High Correlation (5)	67.3%	58.2%	64.3%
Very Low Correlation (1)	1.0%	0.0%	2.0%
Low Correlation (2)	2.0%	6.1%	2.0%
Moderate Correlation (3)	6.1%	5.1%	7.1%
High Correlation (4)	24.5%	30.6%	29.6%
Very High Correlation (5)	66.3%	58.2%	59.2%

B. Boston Consulting Group (BCG) Matrix Analysis Results

The second-phase questionnaire was analyzed using the Boston Consulting Group (BCG) matrix. The results showed that the importance and relevance of green product labeling to sustainable economic activities were placed predominantly in the first quadrant (+,+) of the matrix, with 95.9% of the responses, while only 3% of the responses were placed in the third quadrant (-,-), indicating low importance and low relevance. This demonstrates a high level of importance and relevance (Figs. 5 and 6).

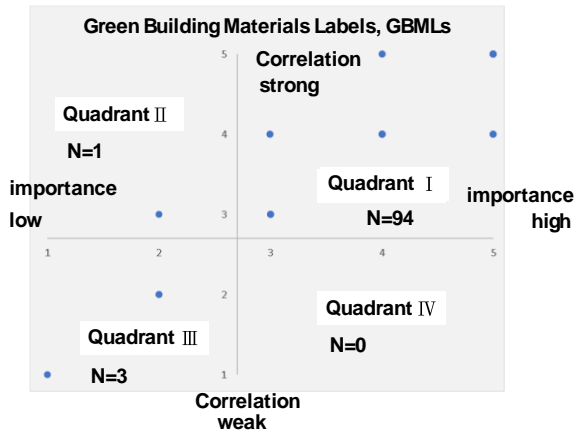


Fig. 5. BCG matrix analysis of green building materials labels.

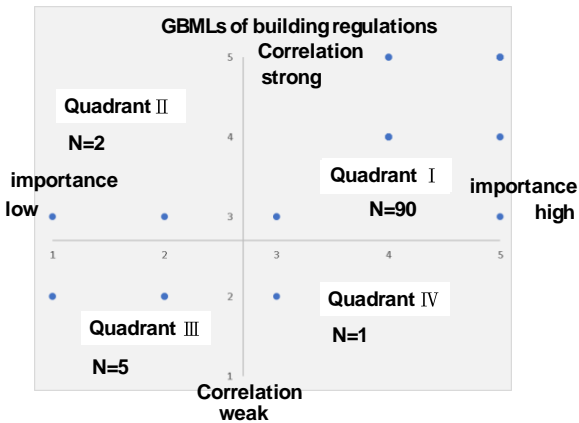


Fig. 6. BCG matrix analysis of GBMLs of building regulations.

C. Pearson Chi-Square Test Analysis of Bivariate Results

The bivariate analysis using the Pearson Chi-Square test revealed that professionals in interior design and interior decoration did not show significant differences in the relevance and importance of green product labeling ($p > 0.05$). This indicates that the awareness and importance attached to the sustainable economy are not influenced by professional occupation or specific knowledge of sustainable economic activities. However, individuals with professional backgrounds showed significant relevance ($p < 0.05$) in the application of green product labeling to building regulations, indicating that professional background does have an impact (Tables 3 and 4).

V. CONCLUSION

The impact of Phenomenon-Based Learning (PBL) with green product labeling on the awareness and importance of the sustainable economy was studied through five PBL sessions, using green product labeling as the theme. The results showed that 80% of the participants were hearing about the Taxonomy Regulation for the first time. After the Phenomenon-based Learning, regardless of the field of expertise, there was an increase in the awareness and importance attributed to the Taxonomy Regulation. Participants were able to understand the connection between green product labeling and the Taxonomy Regulation, which is very important for promoting the implementation of Taiwan's sustainable finance taxonomy standards.

Table 3. Modification of Pearson's chi-squared test for the importance of GBMLs and cross-comparison of correlation in professional backgrounds.

Test		Value	df	Asymptotic Significance (2-sided)
Importance	Pearson's chi-squared	51.084	40	0.113
	Likelihood Ratio	37.626	40	0.578
	N of Valid Cases	98		
Correlation	Pearson's chi-squared	46.053	40	0.236
	Likelihood Ratio	37.680	40	0.575
	N of Valid Cases	98		

Table 4. Modification of Pearson's chi-squared test for the importance of building regulations and cross-comparison of correlation in professional backgrounds.

Test		Value	df	Asymptotic Significance (2-sided)
Importance	Pearson's chi-squared	40.484	30	0.096
	Likelihood Ratio	37.996	30	0.150
	N of Valid Cases	98		
Correlation	Pearson's chi-squared	64.202	40	0.009*
	Likelihood Ratio	46.618	40	0.219
	N of Valid Cases	98		

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Chengchen Chen was primarily responsible for the article's structure and writing, literature analysis, article editing, and the discussion and conclusion of the related analytical data; Chiumi Chen mainly handled the analysis of questionnaire survey content and research methodology, and assisted in writing the article content and corresponding

author communication; Jinren Liou was mainly in charge of executing the PBL courses and conducting the questionnaire surveys; Fenya Chan was primarily responsible for research statistics and analysis; Shihchi Lo mainly assisted in research guidance, providing suggestions for the research and the article; all authors had approved the final version.

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