

# The Guidelines to Promote the Perception of the Bio-Circular-Green Economy (BCG) Model of Student Teachers in Thailand

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## ABSTRACT

The research aimed to 1) study the student teachers' level of perception relating to the Bio-Circular-Green (BCG) economy model in Thailand, 2) analyze the factors influencing the perception of the BCG economy model, and 3) synthesis the principles to promote the perception of the BCG economy model. The research used a mixed method. The quantitative sample was 500 student teachers who collected the data by a questionnaire. Descriptive statistics and stepwise multiple regression analyzed the data. In addition, the qualitative data were collected through focus group discussions with 15 participants, such as course coordinators and lecturers, student teachers, and experts in driving the BCG economy model. The qualitative data were analyzed through content analysis. The research results found that 1) the level of perception of the BCG economy model was at a high level overall. Especially, the three main perceptions (basic concepts, vision and strategic goals, and driven strategies) were at a high level. 2) According to the stepwise multiple regression analysis, the six factors that predicted the perception of the BCG economy model at a significant level of .05 were family support, institute administrators, lecturers, interaction of lecturers and students, extracurricular activities, and role models of prominent figures. It explained that the variance of perception was 58.2 percent ( $R^2 = .582$ ). 3) The principal's encouragement included family support through activities; interaction of lecturer and student based on the Constructivism and Social Learning Approaches; integration of the BCG economy model in curriculum and project-based and problem-based learning processes; environmental development in the university to permit the environmental learning; organizing extracurricular activities in participation; and using lecture and administrators as practical role models in driving BCG economy model. The results reflected that the perception encouragement of the BCG economy model among student teachers requires holistic integration of all sectors to strengthen teachers' role models in sustainable development.

**Keywords:** BCG economy model, Perception, Student teachers, Sustainable development, Experiential learning

## INTRODUCTION

The 13th National Economic and Social Development Plan (2023–2027) is a development plan under the national strategy (National Economic and Social Development Board, 2023). It applies the Sufficiency Economy Philosophy as the principle for driving and scheming the country's development plan to achieve goals in various dimensions (Sachayansrisakul, 2009; Mongsawad & Thongpakde, 2016). Currently, Thailand faces challenges in the country and overseas due to the outbreak of coronavirus disease 2019 and the limitations of the domestic structure requiring improvement in various dimensions. Therefore, national development needs to attach great importance to external and internal factors, as well as the change of factors influencing the country's structure in various dimensions to define the direction for the country's development focusing on the future based on sufficiency economic philosophy corresponding with the Sustainable Development Goals (SDGs) of the world. It begins to lead Thailand as a prosperous and balanced economic nation in the long term (United Nations Thailand, 2022; UNDP Thailand, 2023).

In the past, Thailand has faced the problem of management in its diverse resources. The country's economic

development could not efficiently add the value of its resources. It had efforts to apply technology and innovation reducing the limitation in resource utilization to cause sustainable economic growth (Office of the Higher Education, Science, Research and Innovation Policy Council, 2021). The BCG economy model is the approach of holistic economic development advancing three dimensions of economy: the Bio-economy with the Circular Economy, under the Green Economy. The drive of country development based on the BCG economic model from 2021 to 2026 included four strategies: agriculture and food, health and medicine, energy, biomaterials and biochemicals, and tourism and creative economy (National Science and Technology Development Agency, 2022).

The student's perception of the new economic concepts has promoted and systematically developed the overall national development, especially in the group of student teachers who have to communicate, understand, and educate the youth, considered an important population for the future. Therefore, encouraging student teachers' understanding of new economic concepts and developing students' knowledge and practice is crucial and the beginning of the sustainable development cycle. The teacher production emphasizes the competencies of student teachers to cooperate with communities. It determines the main competencies in the relationship of parents and community as an ability to analyze and plan to create a network, cooperating with parents and community in learning development and desirable characteristics of students, as well as the encouragement and preservation of culture and local wisdom (The Government Gazette, 2023; 2025). As for the main competencies, it stated that the teacher production process currently focuses on developing teachers who understand and work effectively with communities and society. The student teachers' perception of the BCG economy model is an important point that teacher education institutions should consider factors influencing perception and cultivating the concepts to student teachers as a thinking base in developing and training teachers for the community. The research also defined the objectives: 1) To study the level of perception of teacher students in the BCG economy model, 2) To analyze factors influencing student teachers' perception of the BCG economy model, and 3) To synthesis the principles to promote teacher students' perception of the BCG economy model.

## LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

### Concepts of Bio-Circular-Green (BCG) Economy

The BCG (Bio-Circular-Green) economic concept is a holistic economic model that integrates the bio-economy, circular economy, and green economy. It utilizes science, technology, and innovation to create added value from biological resources, reduce waste, and maximize resource utilization, while ensuring environmental sustainability. The goal is to enhance national competitiveness, distribute income to communities, and achieve the Sustainable Development Goals (SDGs) (National Science and Technology Development Agency (NSTDA), 2020).

The development of the bioeconomy, circular economy, and green economy concepts shares a common foundation: a growing awareness of resources and the environment since the 1960s. The bioeconomy emphasizes the use of local biological resources as the basis for economic growth and evolves towards the application of knowledge, research, and innovation to efficiently create added value (Birner, 2018). Meanwhile, the circular economy aims to manage resources and waste from production and consumption for reuse. To reduce environmental losses and problems (Blomsma & Brennan, 2017), these two concepts have merged into the Green Economy and Sustainable Development, which emphasizes restructuring investment, utilizing economic mechanisms, and protecting ecosystems as public goods to improve quality of life, social justice, and reduce the risk of long-term resource and environmental crises (Barbier, 2009).

### The BCG Economic Model in the Context of Thailand

Thailand's BCG economic model reflects a development framework that systematically integrates resource, economic, and social dimensions. Its main objectives are to conserve and restore biological and cultural resources, create added value from these resource bases through science, technology, and innovation, and strengthen the country's self-reliance (Ministry of Higher Education, Science, Research and Innovation, 2021 and National Science and Technology Development Agency, 2022).

The process of driving the BCG economic model emphasizes development throughout the value chain, from upstream to downstream, under a quadrilateral cooperation mechanism between the government, private sector, educational and research institutions, and the public. Key activities include sustainable resource management, waste reduction, efficient resource utilization, and strengthening economic and social resilience. Furthermore, the implementation of the BCG economic model is linked to the country's target industries, namely the agricultural and food industries. Health and medicine, energy, biomaterials and chemicals, and tourism and creative economy are developed together to form a large-scale value-added base for the country. All development addresses at least five Sustainable Development Goals: sustainable production and consumption, climate change adaptation, biodiversity conservation, and sustainable development partnerships. This supports the United Nations Sustainable Development Goals and aligns with the Sufficiency Economy Philosophy, a crucial foundation for Thailand's long-term development (Suparek Bhupongsak, 2021; National Science and Technology Development Agency, 2020; Maolanont & Pochanart, 2023; Jaroenkietkajorn et al., 2024).

## **The Concept of Perception**

Perception is a semantic process that humans use to interpret and respond to information from the environment, relying on the senses along with an individual's framework of experience, knowledge, and context (Gibson et al., 2012; Overgaard, 2014). This process encompasses stimulus reception, neural processing, and interpretation, leading to human behavior and decision-making (Liu et al., 2024). Perception and learning are mutually reinforcing. Perception is both the starting point and the outcome of learning. Learning develops the accuracy, depth, and speed of perception through mental processes such as organizing thoughts, forming concepts, and shaping attitudes (Xie & Yu, 2020).

In the educational context, understanding the factors affecting learners' perception is crucial for designing effective instruction. In teacher education, enhancing authentic experiences through practice and participation in school settings plays a vital role in developing the perception, professional thinking, and teaching competence of student teachers (Tongle & Kalpana, 2025).

## **Factors Affecting Perception: Theoretical and Empirical Perspectives**

Factors influencing an individual's perception can be explained through multidimensional theoretical frameworks that reflect the relationship between personal factors, behavior, and environment in the perceptual process. Self-Perception Theory indicates that individuals construct perceptions by interpreting their own behavior and using those observations to determine their attitudes and beliefs, reflecting that perception depends on internal interpretation (Bandura, 1986). Social and environmental structures play a significant role according to Social Learning Theory, which states that behavior and social environment continuously influence an individual's perception and learning (Bandura, 1977).

Constructivist theory views perception as being constructed through engagement in a learning context via experiential learning. Prior experiences, foundational knowledge, and social interactions help learners construct meaning and enhance the quality of perception (Taber, 2024). Gibson et al. (2012), advocating for learning ecology, state that perception arises from the coordination between the perceiver and an environment with communicative properties that indicate appropriate use, influencing the interpretation of stimuli and individual responses.

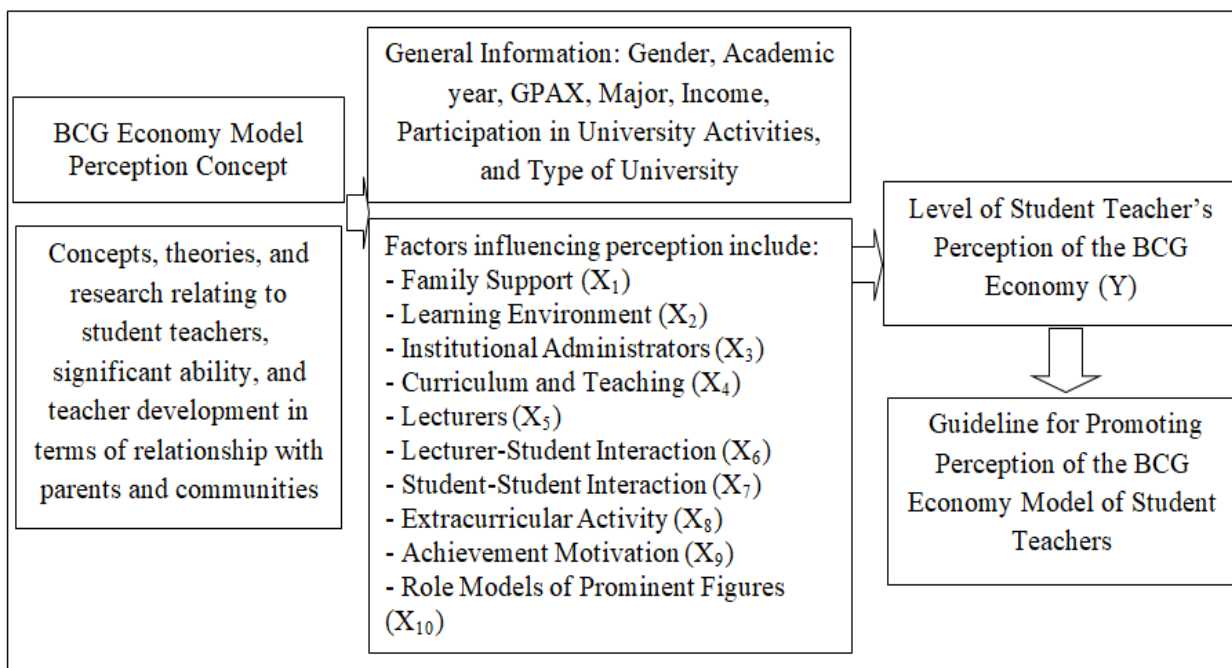
Related research indicates that perception is related to the learning environment, such as learning atmosphere, teacher-student relationships, and student relationships, which can predict both learner motivation and learning behavior (Brandmiller et al., 2020). Teacher perception also depends on learner characteristics, such as background and gender, which affect decision-making and educational interaction (Wisniewski et al., 2022). Educational research therefore points out that personality, beliefs, social systems, and the educational context are crucial variables determining perception within the learning context and the interpretation of both learners and teachers.

In conclusion, although the BCG economic model is designated as a key policy in Thailand for driving sustainable development, while numerous studies have been conducted at the policy, industry, and community

levels, significant empirical gaps remain regarding "perception," particularly the lack of research focusing on the level of perception and influencing factors of the BCG economic concept among teacher trainees. Teacher trainees are a crucial mechanism in the education system for long-term policy implementation. Furthermore, there is a lack of an integrated analytical framework that systematically considers perception, learning, and the context of teacher education. This research aims to fill these gaps and provide an academic database for developing curricula and learning processes that sustainably align with the BCG economic model.

Based on the synthesis of related research on factors influencing individuals' perceptions, the following 10 factors can be summarized: 1) family support, 2) learning environment, 3) institution administration, 4) curriculum and teaching management, 5) lecturers, 6) lecturers-student interaction, 7) student-student interaction, 8) extracurricular activities, 9) achievement motivation, 10) role model of the prominent figure (Quinn, 1985; Slameto, 2010; Kotchasi & Charoontham, 2022; Fuady et al., 2017).

Figure 1. Conceptual Framework



## METHODOLOGY

### Research Design

This study adopted an explanatory sequential mixed methods design, in which quantitative data were collected and analyzed in the first phase, followed by qualitative data collection to further explain and elaborate on the quantitative findings. This approach is particularly suitable for studies aiming to both identify statistical relationships and develop contextually grounded explanations (Creswell & Plano Clark, 2018).

In the quantitative phase, the study examined the level of perception of the Bio-Circular-Green (BCG) economy model among student teachers and identified the factors influencing such perception through statistical analysis. In the qualitative phase, focus group discussions were conducted to explore in depth the mechanisms and practical approaches for promoting BCG awareness based on the statistically significant predictors identified in the first phase. The integration of findings occurred at the interpretation stage, thereby enhancing the validity and comprehensiveness of the results through methodological triangulation.

### Population and Sampling Procedures

The population consisted of 119,757 student teachers enrolled in teacher education programs in Thailand during the academic year 2024. The population data were derived from the national higher education statistics database based on the International Standard Classification of Education (ISCED).

The sample size was calculated using Yamane’s formula (Yamane, 1973) at a 95% confidence level, yielding a minimum required sample of 399 participants. To mitigate potential non-response bias and increase statistical power, the sample size was increased by 25%, resulting in a total sample of 500 participants.

A multi-stage stratified random sampling technique was employed to ensure representativeness. First, the population was stratified into three categories based on institutional type: public institutions, private institutions, and non-government institutions. Second, proportional allocation was applied to determine the sample size within each stratum according to its population share. Third, institutions within each stratum were selected using simple random sampling. Finally, student teachers within the selected institutions were randomly sampled using student enrollment lists. This procedure minimized sampling bias and enhanced the generalizability of the findings.

For the qualitative phase, 15 key informants were selected using purposive sampling with a maximum variation strategy. The informants included teacher educators, student teacher representatives, and experts in BCG-related policy and implementation. All participants met the inclusion criteria of having at least three years of relevant experience and demonstrated engagement in teacher education or BCG-related initiatives.

Table 1. Simple Random Sampling by lottery in each group of higher education institutions

Name of Universities	Population size (person)	Percentage	Sample Size (person)
<b>Public Institutions</b>	<b>108,694</b>	<b>90.76</b>	<b>454</b>
• Public University-limited acceptance rates	6,494	5.42	27
• Rajamangala University of Technology	1,515	1.27	7
• Rajabhat University	60,174	50.25	251
• Autonomous University	23,694	19.78	99
• Public University – unlimited acceptance rates	16,817	14.04	70
<b>Private Institution</b>	<b>5,239</b>	<b>4.38</b>	<b>22</b>
<b>Non-government Institution</b>	<b>5,824</b>	<b>4.86</b>	<b>24</b>
<b>Total Number of Students in all sample</b>	<b>119,757</b>	<b>100.00</b>	<b>500</b>

### Research Instruments

The primary instrument for quantitative data collection was a structured questionnaire developed based on an extensive review of literature related to the BCG economy model, educational theory, and factors influencing learning and perception. The questionnaire consisted of four parts: (1) demographic information, (2) perception of the BCG economy model, (3) factors influencing perception, and (4) guidelines for promoting BCG awareness. A five-point Likert scale was used to measure perception levels and influencing factors.

Content validity was assessed by three experts using the Index of Item-Objective Congruence (IOC), with values ranging from 0.67 to 1.00, indicating acceptable alignment between the items and research objectives (Rovinelli & Hambleton, 1977).

Reliability was assessed using Cronbach’s alpha coefficient. The perception scale yielded a reliability coefficient of 0.91, and the influencing factors scale yielded 0.89, indicating high internal consistency (Nunnally & Bernstein, 1994). Additional reliability indicators, such as composite reliability (CR) and average variance extracted (AVE), are recommended for further validation.

For the qualitative phase, a semi-structured focus group discussion guide was developed and validated by experts. The guide included open-ended questions designed to explore participants' perspectives on the importance of the BCG economy model and strategies for integrating it into teacher education. The instrument was pilot-tested to ensure clarity and appropriateness.

### **Data Collection Procedures**

Quantitative data were collected from 17 higher education institutions after obtaining institutional approval. Participants were informed of the study's objectives, and ethical considerations such as voluntary participation and confidentiality were emphasized. The questionnaires were administered in a standardized manner, and completed responses were checked for accuracy and completeness.

In the qualitative phase, focus group discussions were conducted with 6–8 participants per session. Each session lasted approximately 60–90 minutes and was audio-recorded with participants' consent. The researcher presented key findings from the quantitative phase to stimulate discussion and generate insights into practical strategies for promoting BCG awareness. Data collection continued until thematic saturation was achieved.

To ensure the trustworthiness of qualitative data, the study employed member checking, peer debriefing, and the maintenance of an audit trail (Lincoln & Guba, 1985).

### **Data Analysis**

Quantitative data were analyzed using descriptive and inferential statistics. Descriptive statistics, including frequency, percentage, mean, and standard deviation, were used to summarize participant characteristics and perception levels. The interpretation of mean scores followed the criteria proposed by Best (1977).

Mean 4.51–5.00 was the highest level of perception.

Mean 3.51–4.50 was the high level of perception.

Mean 2.51–3.50 was the moderate level of perception.

Mean 1.51–2.50 was the low level of perception.

Mean 1.00–1.50 was the lowest level of perception.

Prior to inferential analysis, statistical assumptions were tested. Normality was assessed using skewness and kurtosis values, while multicollinearity was examined using variance inflation factor (VIF), with values below 5 indicating acceptable levels (Hair et al., 2019). Additional assumptions, including linearity, homoscedasticity, and independence of errors, were also evaluated.

Pearson's correlation coefficient was used to examine relationships among variables. Multiple regression analysis was conducted to identify significant predictors of BCG perception. The results were interpreted based on statistical significance ( $p < .05$ ), standardized regression coefficients, and explanatory power ( $R^2$  and adjusted  $R^2$ ). Where appropriate, hierarchical regression analysis may be employed to control for demographic variables.

Qualitative data were analyzed using thematic content analysis. The analysis process involved open coding, axial coding, and selective coding to identify key themes and patterns. The credibility, transferability, dependability, and confirmability of the findings were ensured through rigorous qualitative procedures.

### **Integration of Data**

The integration of quantitative and qualitative findings was conducted at the interpretation stage using a joint display approach. The qualitative findings were used to explain and contextualize the quantitative results, particularly in relation to significant influencing factors. This integrative process enabled the development of comprehensive and actionable guidelines for promoting the perception of the BCG economy model among student teachers.

## RESULTS AND DISCUSSION

General information about the student teachers who responded to the survey is as follows: 49.75% (249 people) are female, the majority (70.29%, 351 people) have a cumulative GPA above 3.00, 46.58% (233 people) major in Physical Education and Health Education; and the majority (56.90%, 284 people) have a family income below 5,000 baht per month. The majority of respondents did not play a leadership role in student activities. The majority, 85.64% (428 people), participated in the activities as volunteers, while 75.63% (378 people) did so. The majority studied at Rajabhat Universities (47.91%, 240 people), followed by state-run universities (28.05%, 140 people). The universities were located in the Central region (48.91%, 245 people), the Northeastern region (23.21%, 116 people), and Bangkok (17.53%, 88 people), respectively.

### Student teachers' level of perception of the BCG economy model

Student teachers have a high overall perception of the BCG economy model ( $\bar{x} = 3.75$ , S.D. = 0.99). Content 1: basic concepts of the BCG economy model; Content 2: vision and strategic goals of the BCG economy model; and Content 3: strategy, plans, and implementation of the BCG economy model are at a high level (Table 3). It is a sign reflecting academic awareness, policy encouragement, and the process of knowledge integration with teacher productions in Thailand relating to the BCG economy model in recent years. The National Economic and Social Development Council and the Ministry of Higher Education, Science, Research, and Innovation have encouraged the BCG economy model as a national agenda, especially in 2021. The BCG economy model was included in Thailand's 13<sup>th</sup> National Economic and Social Development Plan, causing higher education institutions to integrate the concept into curricula and student learning activities, especially in the faculty of education, which has an important role in creating next-generation teachers.

Furthermore, the BCG economy model has been integrated into general subjects such as science, technology, and environmental science, professional teaching courses, and interdisciplinary learning. It allowed student teachers to learn theory and implementation based on Constructivist Learning Theory (Faikhamta et al., 2023). Learning occurs through interaction with media, environment, and learner's experience, which can create knowledge and perception. The research of Masdiana et al. (2020) aimed to enhance students' awareness of the environment through project-based learning, in the project-based learning process it was confirmed that students had increased awareness of the school environment, valued it and were able to solve the waste management problems in school.

Similarly, Prasoplarb et al. (2024) development of the BCG economy model-integrated STEM education has been widely promoted as a significant driver of Thai education, with its three dimensions of bio-economy, circular economy, and green economy serving as the main features of integrated STEM activities in promoting learners' competencies. These steps promote integration among the learners' community, economy, and local innovation, ultimately enabling learners to meaningfully apply STEM-BCG to their lives.

Many higher education institutions have also launched academic service projects and teaching training that emphasize the BCG economy model in collaboration with communities such as "University to Tambon (U2T)" and "Eco-Conscious Teachers." It helps students connect concepts and practices based on experiential learning theory, which states that effective learning results from the circle of 4 processes: concrete experience, reflective observation, abstract conceptualization, and active experimentation. The research of Jermisittiparsert et al. (2020) demonstrated that participation in policy activities caused learners to have a high level of sustainable development and circular economy awareness.

Table 2. Student teachers' level of perception of the BCG economy model

Lists	$\bar{x}$	S.D.	Level
Content 1: Basic Concepts of the BCG Economy Model	3.78	0.99	high
Content 2: Vision and Strategic Goals of the BCG Economy Model	3.76	0.96	high

Content 3: Strategy, Plans, and Implementation of the BCG Economy Model	3.72	1.01	high
Overall Average Score	3.75	0.99	high

**Level of factors influencing student teacher’s perception of the BCG economy model**

The result found that factors influencing student teachers' perception of the BCG economy model were at a high level in all factors. The Factor of lecturer-student interaction was at the highest mean value ( $\bar{x} = 4.20$ , S.D. = 0.76). The following factors were student-student interaction ( $\bar{x} = 4.17$ , S.D. = 0.78) and achievement motivation ( $\bar{x} = 4.17$ , S.D. = 0.77) at the same mean value, as well as the factor of extracurricular activities ( $\bar{x} = 4.01$ , S.D. = 0.80), respectively (Table 4).

Table 3. Level of factors influencing student teacher’s perception of the BCG economy model

Factors Influencing Student Teacher’s Perception of the BCG Economy Model	$\bar{x}$	S.D.	Level
Family Support	3.89	0.91	high
Learning Environment	3.99	0.83	high
Institutional Administrators	3.91	0.85	high
Curriculum and Teaching -Learning Management	3.91	0.85	high
Lecturers	3.98	0.81	high
Lecturer-Student Interaction	4.20	0.76	high
Student-Student Interaction	4.17	0.78	high
Extracurricular Activity	4.01	0.80	high
Achievement Motivation	4.17	0.77	high
Role Models of Prominent Figure	3.83	0.94	high

**Factors influencing student teacher’s perception of the BCG economy model**

The researcher examined the correlation coefficients of the variables by using Pearson’s Correlation Coefficient. The primary data were analyzed by discussing the issue of multicollinearity considered from tolerance values and variance inflation factors (VIF). Hoffmann (2010) stated that examining the multicollinearity problem should not consider only the correlation matrix table, which is any pair of independent variables with a correlation coefficient greater than .900 because a low correlation coefficient does not mean any multicollinearity problem. The details of the data analysis results are as follows.

The analysis result of the correlation coefficient of the dependent variable on the perception of the BCG economy model and the factors influencing the perception of the BCG economy model using Pearson’s Correlation Coefficient Formula found that all variables had positive correlation with significant statistic at the .01. To consider the independent variables, it was found that the factors with the highest correlation were the learning environment factor (X2) and the institutional administrator factor (X3), with a positive correlation coefficient value at .856. The following factors were institutional administrators (X3) and lecturer (X5), lecturer (X5), and extracurricular activities (X8), with a positive correlation coefficient value of .820, respectively. Even though the independent variables have high correlation ( $r_{xy}$  values of 0.80 or 0.90 or higher, which are at risk of

multicollinearity (Hair et al., 2010; Tabachnick & Fidell, 2014), considering the VIF (Variance Inflation Factor) values between 1.719-4.494, which are below 5 or 10, it indicates that the independent variables are not too strongly correlated (Hair et al., 2010). In this regard, Simmarun (2018) proposed a solution to the risk of multicollinearity using stepwise regression. This method is considered the best way to select independent variables for multiple regression because it inherently attempts to eliminate the problem of multicollinearity.

As for considering the factor variables affecting the dependent variable, it was found that family support (X<sub>1</sub>) and the perception of the BCG economy model (Y) had the highest positive correlation coefficient value at .680 (Table 5).

Table 4. The results of the correlation coefficient analysis of the dependent variable (on the perception of the BCG economy model) and the factors influencing the perception of the BCG economy model

Variables	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>	X <sub>7</sub>	X <sub>8</sub>	X <sub>9</sub>	X <sub>10</sub>	Y
Family Support (X <sub>1</sub> )	-										
Learning Environment (X <sub>2</sub> )	.748**	-									
Institutional Administrators (X <sub>3</sub> )	.695**	.856**	-								
Curriculum and Teaching (X <sub>4</sub> )	.648**	.780**	.802**	-							
Lecturers (X <sub>5</sub> )	.654**	.812**	.820**	.770**	-						
Lecturer-Student Interaction (X <sub>6</sub> )	.509**	.641**	.632**	.606**	.717**	-					
Student-Student Interaction (X <sub>7</sub> )	.523**	.572**	.535**	.530**	.613**	.777**	-				
Extracurricular Activity (X <sub>8</sub> )	.664**	.772**	.778**	.703**	.820**	.749**	.682**	-			
Achievement Motivation (X <sub>9</sub> )	.540**	.624**	.587**	.566**	.657**	.735**	.794**	.727**	-		
Role Models of Prominent Figure(X <sub>10</sub> )	.541**	.533**	.537**	.521**	.560**	.473**	.505**	.622**	.548**	-	
The Perception of the BCG Economy Model (Y)	.680**	.648**	.651**	.582**	.651**	.454**	.429**	.663**	.479**	.561**	-

\*\* p < 0.01 (Correlation is significant at the 0.01 level (2-tailed))

According to Stepwise Multiple Regression Analysis, it was found that family support (X<sub>1</sub>), institutional administrators (X<sub>3</sub>), lecturer (X<sub>5</sub>), lecturer-student interaction (X<sub>6</sub>), extracurricular activities (X<sub>8</sub>), role models of prominent figure (X<sub>10</sub>) could predict the perception of the BCG economy model, explaining 58.2 percentage of the variance of the dependent variable (R<sup>2</sup> = .582). The standardized score (β) regression coefficients were .326, .238, .152, .184, -.163, and .110 respectively in significant statistic at the .05 level (Table 6).

The findings reflected that family support (X<sub>1</sub>, β = .326) was the factor with the highest value in prediction. Ecological Systems Theory principle indicates that the family is the primary context for creating thoughts and

values regarding social and environmental responsibility (Grønhoj & Thøgersen, 2012). The results of this research are consistent with the recommendations from Wongpinpech (2018) research, which stated that social factors affecting the environmental behavior of undergraduate students in public universities include the influence of peer groups, social transmission of environmental issues from family institutions and educational institutions. According to the research report of Mishra et al. (2024) and Hoondée et al. (2025), it was found that factors affecting the academic achievement of students include family support.

The institutional administrators (X3,  $\beta = .238$ ) were in the university’s academic and policy leadership roles, influencing organizational culture and curriculum direction and creating a “learning space” for the BCG economy model. According to Transformational Leadership Theory (Bass & Riggio, 2006), visionary leaders can inspire and energize the power of change in university organizations. The research of Panwilai et al. (2024) reveals that administrators who seriously enhance in active learning management can concretely drive learning at the institutional level.

As for the lecturers (X5,  $\beta = .152$ ) and lecturer-student interaction (X6,  $\beta = .184$ ), the two factors reflect the role of the “teacher as an intellectual leader” and influence the cultivation of knowledge, understanding, and attitudes, through critical learning and meaningful guideline. Social Learning Theory has emphasized that the patterns of learners’ behavior and thoughts result from observation, particularly with academic authority such as lecturers (Bandura, 2001; Witt et al., 2004). The research of Saenprachan et al. (2021) confirms that building relationships between teachers, students, and staff by promoting teamwork in environmental management within educational institutions helps students develop greater skills and awareness about environmental conservation, and can stimulate thinking analysis and create an understanding of systemic issues for learners.

In addition, although the factor of extracurricular activities (X8,  $\beta = -0.163$ ) was the negative coefficient correlation, the statistical significance may reflect the characteristic of activities, not consistent with the learners’ interests and learning styles or are organized in an imperative and unnatural form. According to the Self-Determination Theory (Ryan & Deci, 2000), learners need activities that satisfy their internal needs (autonomy, competence, relatedness). If the activities do not satisfy their needs, it may cause a negative perception. The research of Ana Cano-Ortiz et al. (2025) and Shutaleva (2023) indicates that BCG economy and environmental education activities should be designed to emphasize participation, not narration or memorizing activities.

Finally, the role models of prominent figures (X10,  $\beta = .110$ ), such as scientists, entrepreneurs, or environmental figures, inspire the power of changing their thinking, especially in the youth. Reference to Role Model Theory (Gibson, 2004) states that role models can motivate and inspire long-term learning and social behavior. The research of Saenprachan et al. (2021) found that to raise environmental management awareness, educational institutions must collaborate with communities by inviting role models as speakers to disseminate community ideas and promote creative environmental conservation efforts, and Yang et al. (2022) confirmed that narrative-based environmental education from role models can effectively promote children's environmental awareness, which was mainly reflected in their environmental knowledge and environmental attitudes. These findings support the implementation of environmental education in educational institutions in the future.

The finding of this research has reflected that “the student teacher’s perception of the BCG economy model” does not only derive from learning in the classroom but the result of influences in various dimensions such as family, institutions, lectures, and social media, especially when the factors are integrated systematically.

Table 5. The result analysis of factors influencing the perception of the BCG economy model

The Factors	B	SE	$\beta$	T	P	VIF	Tolerance
(Constant)	.303	.149	-	2.033*	.042	-	-
Family Support (X <sub>1</sub> )	.331	.040	.326	8.297*	.000	2.183	.458
Extracurricular Activity (X <sub>8</sub> )	.282	.067	.238	4.218*	.000	4.494	.223

Influential Role Models ( $X_{10}$ )	.148	.034	.152	4.360*	.000	1.719	.582
Lecturers ( $X_5$ )	.212	.064	.184	3.299*	.001	4.421	.226
Lecturer-Student Interaction ( $X_6$ )	-.204	.052	-.163	-3.910*	.000	2.467	.405
Institutional Administrators ( $X_3$ )	.119	.056	.110	2.146*	.032	3.739	.267
$R = .763$ $R^2 = .582$ $R^2$ Adjusted = .578 $F = 137.281$ $SE_{est} = .559$							

\*  $p < .05$

The equation could be constructed in unstandardized scores and standardized scores:

$$\hat{Y} = .303 + .331(X_1) + .282(X_8) + .148(X_{10}) + .212(X_5) - .204(X_6) + .129(X_3)$$

$$Z_y = .326(Z_{X1}) + .238(Z_{X8}) + .152(Z_{X10}) + .184(Z_{X5}) - .163(Z_{X6}) + .110(Z_{X3})$$

### **Guidelines for Promoting the Perception of the BCG Economy Model among Student Teachers in Thailand: A Critical Analytical Perspective**

The promotion of the Bio-Circular-Green (BCG) economy model within teacher education in Thailand must be understood not as a set of isolated interventions, but as a systemic transformation process that operates across multiple, interdependent layers of the educational ecosystem. While prior approaches have tended to emphasize descriptive recommendations, the present findings reveal that effective promotion of BCG perception requires critical alignment between theory, institutional structures, pedagogical practices, and socio-cultural contexts. This section, therefore, advances a more analytical interpretation of the eight key dimensions identified.

#### **1. Family Dimension: From Passive Background to Active Co-educator**

Although family influence is often assumed to diminish at the higher education level, this study reveals a more nuanced reality. Consistent with Social Learning Theory, the family remains a primary site of value formation and behavioral modeling, particularly in relation to sustainability practices. Empirical support from Seemüller et al. (2024), Jia et al. (2022), and Grønhoj and Thøgersen (2009) reinforces the role of parents as proximal role models shaping environmental behaviors.

However, a critical tension arises: while theoretically significant, family-related factors often demonstrate limited direct statistical influence in higher education contexts. This suggests that family influence is indirect, mediated, and contingent upon institutional reinforcement. Studies by Fu and Zailani (2025) and Kotchaisit and Charoontham (2022) further indicate that early environmental socialization has long-term effects, yet these effects require continuous reinforcement through formal education.

Therefore, rather than treating the family as an external variable, this study argues for its repositioning as an active co-educator within a broader learning ecosystem. Practical strategies should move beyond awareness campaigns toward structured intergenerational engagement, such as community-based sustainability projects and family-integrated learning modules. Without such intentional integration, the family's potential remains underutilized and disconnected from formal teacher education processes.

#### **2. Institutional Leadership: Bridging Policy Rhetoric and Organizational Practice**

The findings identify institutional leadership as a critical enabling condition for BCG integration, yet also expose a persistent gap between policy articulation and operational implementation. While transformational leadership has been highlighted as essential (Tanchaisak et al., 2025), many institutions remain constrained by bureaucratic inertia and compliance-driven governance models.

This creates a paradox in which BCG is formally endorsed but insufficiently embedded in institutional culture and practice. The effectiveness of leadership, therefore, lies not merely in vision-setting but in its capacity to institutionalize sustainability through concrete mechanisms, including curriculum mandates, infrastructure investment, and performance evaluation systems.

Critically, this suggests that leadership must transition from symbolic endorsement to structural transformation, where sustainability is integrated into decision-making processes, resource allocation, and accountability frameworks. Without such systemic alignment, BCG initiatives risk becoming performative rather than transformative, limiting their long-term impact on student perception.

### **3. Lecturer–Student Interaction: The Pedagogical Nexus of Transformation**

The strong influence of lecturer–student interaction underscores its role as the central mechanism through which BCG concepts are internalized. This finding is theoretically grounded in Bandura’s (2001) social cognitive theory, which emphasizes reciprocal interaction between individuals and their environment, as well as constructivist perspectives that position learners as active participants in knowledge construction (Hmelo-Silver, 2004; Kudryashova et al., 2016).

However, the persistence of traditional lecture-based approaches in many teacher education programs reflects a misalignment between pedagogical theory and practice. While active learning strategies are widely advocated, their implementation often remains superficial or inconsistent.

Furthermore, evidence from Emslander et al. (2025) highlights that positive teacher–student relationships significantly influence not only academic outcomes but also motivation and well-being. This suggests that promoting BCG perception requires more than methodological change; it necessitates a reconceptualization of the educator’s role—from knowledge transmitter to facilitator, mentor, and co-learner.

Thus, faculty development initiatives must address both pedagogical competencies and epistemological orientations, ensuring that lecturers are equipped to foster critical, reflective, and sustainability-oriented learning environments.

### **4. Curriculum Integration: Beyond Fragmentation toward Systemic Coherence**

The integration of BCG concepts into teacher education curricula represents a necessary but insufficient condition for meaningful learning. While initiatives such as specialized courses and STEM-BCG integration (Prasoplarb et al., 2024) demonstrate promising outcomes, they often operate within fragmented curricular structures.

This fragmentation limits the development of systems thinking, which is essential for understanding the interconnected nature of the BCG model. The current findings suggest that curriculum reform should move beyond additive approaches toward holistic integration, where sustainability principles are embedded across disciplines and learning experiences.

Such an approach aligns with the broader goal of teacher education: not merely to impart knowledge, but to cultivate transformative competencies that enable future teachers to address complex societal challenges. Without systemic coherence, curriculum integration risks becoming symbolic compliance rather than substantive transformation.

### **5. Teaching and Learning Processes: Addressing the Implementation Gap**

The adoption of active learning approaches—such as project-based, problem-based, and phenomena-based learning—is strongly supported by both theory and empirical evidence (Klomim & Kuayngern, 2023; Onpraphai et al., 2021; Freeman et al., 2014; Wattanasettanukula, 2025). These approaches align with experiential learning theory, which emphasizes learning through action and reflection.

However, a critical issue lies in the implementation gap between pedagogical ideals and classroom realities. Structural constraints, including large class sizes, rigid curricula, and limited institutional support, often hinder the effective application of these methodologies.

Consequently, promoting BCG perception requires not only pedagogical innovation but also institutional restructuring, including flexible curriculum design, supportive learning environments, and assessment systems that value higher-order thinking and real-world application. Without these enabling conditions, active learning risks being reduced to surface-level engagement rather than deep conceptual transformation.

## **6. University Environment: From Symbolic Green Practices to Embedded Sustainability**

The concept of the “Green University” reflects the importance of the physical and social environment as a hidden curriculum influencing student perception. Research by Mani and Pollitt (2024) suggests that institutional environments play a significant role in shaping sustainable behaviors.

However, a critical concern is the prevalence of symbolic or performative sustainability initiatives, which prioritize visibility over impact. For environmental interventions to meaningfully influence perception, they must be authentic, integrated, and participatory, enabling students to engage directly with sustainability practices.

Thus, the university environment should function not merely as a backdrop, but as an active learning space, where sustainability is experienced, practiced, and reflected upon.

## **7. Extracurricular Activities: Toward a Coherent Learning Ecosystem**

Extracurricular activities provide valuable opportunities for experiential and social learning, as evidenced by Limtasiri (2017) and Arranz et al. (2016). However, their effectiveness is often limited by their episodic and disconnected nature.

To enhance their impact, extracurricular initiatives must be integrated within a coherent institutional strategy, linking them with curricular objectives and learning outcomes. This requires a shift from isolated activities to systematic program design, where formal and informal learning mutually reinforce each other.

## **8. Role Models: Aligning Symbolic Influence with Authentic Practice**

The influence of role models, as highlighted by Pandam (2021), underscores the importance of behavioral consistency in sustainability education. According to Social Learning Theory, individuals are more likely to adopt behaviors that are modeled by credible and respected figures.

However, a critical challenge arises when there is a disconnect between institutional rhetoric and individual behavior, leading to reduced credibility and engagement. Therefore, promoting BCG perception requires not only formal instruction but also the authentic embodiment of sustainability values by lecturers and institutional leaders.

The findings reflect that promoting the perception of the BCG economy model of teacher students should be an integrated process in various individual, family, organization, and social dimensions based on Society based on Learning Theory, Constructivism, Experiential Learning, and Ecological Systems Theory. The operations must be continuous and systematic to produce a new generation of teachers conscious of sustainable development. Geissdoerfer et al. (2017) stated that understanding the circular economy is important to sustainable development. The high level of perception concept of students reflects the trend in the education sector to promote more knowledge about the circular economy.

## **CONCLUSION**

This study provides empirical and theoretical evidence that student teachers in Thailand exhibit a high level of perception of the Bio-Circular-Green (BCG) economy model, reflecting the effective translation of national

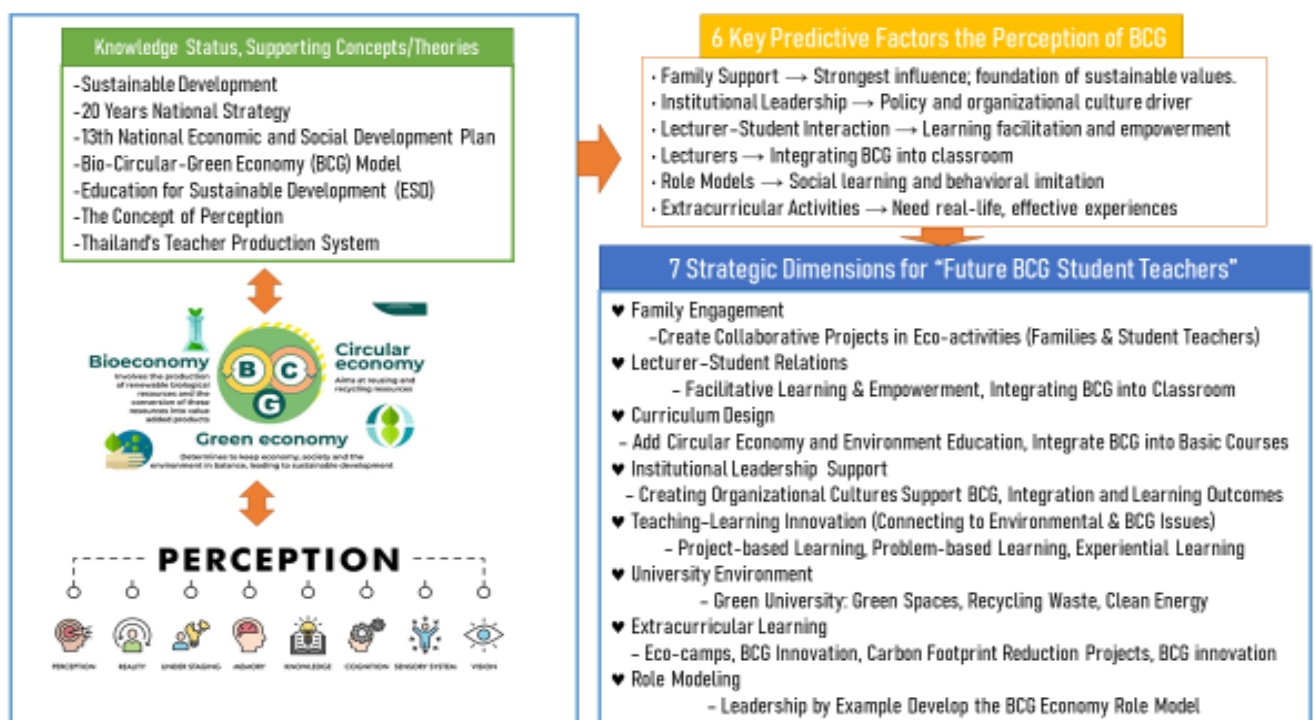
sustainability policy into teacher education practices. However, through content analysis and thematic synthesis, the findings suggest that such perception should not be interpreted as a final outcome, but rather as a dynamic and evolving construct shaped by multiple interacting factors within a broader educational ecosystem.

Three key themes emerge from the analysis. First, interactional and motivational dimensions, particularly lecturer–student interaction, peer engagement, and achievement motivation, are identified as the most influential drivers of meaningful learning. These findings emphasize the critical role of relational pedagogy in fostering deep understanding beyond cognitive awareness. Second, BCG perception is best explained through a multi-level ecological framework, in which family support, institutional leadership, learning environments, extracurricular engagement, and role models operate as interconnected mechanisms, collectively accounting for 58.2% of the variance. Third, a significant gap persists between policy-level integration and pedagogical realization, indicating that while BCG concepts are structurally embedded, their transformation into professional competencies remains uneven.

The study contributes to contemporary academic discourse by positioning sustainability education at the intersection of social learning theory, constructivist pedagogy, and ecological systems thinking, thereby conceptualizing BCG perception as a context-dependent and relationally constructed process. This perspective highlights the need for systemic coherence across curriculum design, teaching practices, and institutional culture.

In practical terms, the findings underscore the necessity of developing a holistic BCG-oriented learning ecosystem within Thailand’s teacher education system, integrating experiential pedagogy, leadership, and community engagement. Ultimately, the study advances the argument that promoting BCG perception is not merely an educational objective but a strategic imperative, requiring transformative approaches to prepare future teachers as agents of sustainable development.

Figure 2. Model for Promoting BCG Perception among Thai Student Teachers



## RECOMMENDATIONS

### Policy recommendations

1) The Ministry of Higher Education, Science, Research, and Innovation (MHESI) should establish guidelines and policies to integrate the BCG economy model into teacher production. It should promote the improvement of teacher production curricula corresponding with sustainable development approaches.

2) The parent organization responsible for teacher education institutions should determine indicators in internal and external quality assurance, requiring student teachers to demonstrate the ability to apply the BCG economy model in learning planning and student development activities.

3) Teacher education institutions should support budgets and resources for developing learning materials, learning innovation, and model activities promoting the BCG economy model. They should also expand learning outcomes to the school network of the university. It determines cooperation mechanisms between universities, communities, and the private sector to organize the learning integration project from actual practice in community areas, builds on student teacher's learning in the BCG economy, and develops a system for monitoring and evaluating the ability of student teachers to apply the BCG economy model in education institution, based on measurable criteria in terms of knowledge, skills, and desired attitudes.

### Recommendations for future research

1) Future research should study appropriate learning models to enhance the BCG economy competence of student teachers in each academic field, especially in the fields relating to science, technology, and innovation.

2) Future research should compare the ability to apply the BCG economy model between teacher students in urban and rural areas to develop specific approaches corresponding with the context of the area and the impact of integrating the BCG economy model on student teacher's learning, teaching, and behaviors, in the short and long term.

3) Future research should develop a model of participation of local network partners (such as local administrative organizations, community enterprises, working groups, etc.) with the university to drive the BCG economy model through the process of training experience for student teachers and explore the opinions and perceptions of mentors in the institutions of professional experience relating to the ability of student teachers to apply BCG economy model in the learning management.

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