Connecting environmental sustainability education to practical applications for tourism students in Thailand

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> "There must be a plan of action because delaying will be dangerous. Kingfisher is unsure if he is too worried, but every time he counts the fish in the pond, the number of fish seems to decrease. The hot and stressful weather also makes his feathers molt and grow slower. The situation seems life-threatening!"
>
> - In "GHG Emissions"; *Wild Wise Weird* (2024).

Abstract. Tourism education plays a key role in shaping students' engagement with sustainability by providing them with the knowledge and skills to address environmental challenges and encouraging them to promote sustainable practices in the industry. This study explores how four years of tourism education at Prince of Songkla University in Phuket, Thailand, influence students' knowledge, attitudes, and intentions toward sustainability. Despite gaining theoretical knowledge of sustainability principles, the findings reveal a decline in students' willingness to adopt environmental sustainability practices as their years of education increase. This may reflect a disconnect between classroom lessons and practical application, potentially due to limited practical learning experiences and the prevalent "eco-deficit culture" within the tourism industry, which often prioritizes profit over environmental responsibility. As a result, students may filter out information regarding environmental sustainability despite their sustainability education at the university. To support long-term engagement in sustainability, the paper recommends revising curricula to include more experiential learning opportunities, interdisciplinary collaboration, and stronger partnerships with industry stakeholders.

Keywords: tourism education; higher education; environmental sustainability; eco-deficit culture;

1. Introduction

The increasing awareness of global environmental challenges, such as climate change, biodiversity loss, and resource depletion, highlights the urgent need for sustainability education. In response, higher education institutions play a crucial role in equipping students with the knowledge, attitudes, and skills to address these pressing issues (Abo-Khalil, 2024; Idoiaga Mondragon et al., 2023). Integrating sustainability into academic curricula is important, as universities help foster environmentally conscious behaviors among students. This effort aligns with the United Nations' Sustainable Development Goals (SDGs), which emphasize the importance of universities in promoting sustainable development (Baena-Morales et al., 2021). By embedding sustainability into education, universities prepare future leaders to tackle and resolve today's critical environmental challenges.

Existing research consistently shows a correlation between higher levels of education and positive attitudes toward sustainability. As individuals progress through their educational journeys, they gain exposure to a broader range of knowledge and critical

thinking skills, which enhances their understanding of environmental issues. For instance, Wang et al. (2022) found that students with higher educational attainment demonstrated a greater awareness of ecological concerns and a stronger commitment to sustainable practices. This increased awareness of the connections between human activities and the environment fosters a greater appreciation for sustainable practices and a commitment to addressing environmental challenges.

Education can significantly shape individuals' attitudes and behaviors regarding sustainability (Van De Wetering et al., 2022). Higher education institutions, in particular, contribute to this process by offering specialized courses and degree programs focused on environmental science, sustainability, and related fields. These programs provide students with essential knowledge that enables them to engage with various environmental issues. Research by Christou et al. (2024) highlights the importance of these academic settings, which not only grant access to contemporary research but also involve students in practical sustainability projects and collaborative problem-solving activities.

In addition to formal academic programs, various sustainability initiatives contribute to improving students' environmental literacy. For example, programs like "green school certification" incorporate sustainability into school operations, curricula, and community outreach, encouraging environmental awareness at different levels (Goldman et al., 2018). Experiential learning activities, such as environmental education workshops, field trips, eco-clubs, recycling campaigns, tree-planting events, and energy-saving challenges, offer students practical opportunities to apply theoretical concepts (Cincera et al., 2023; Firinci Orman, 2024; Gal, 2024; Shutaleva, 2023; Whitburn et al., 2023). These experiences may help improve their understanding of ecological systems and strengthen their connection to the environment, encouraging eco-friendly habits and values. By observing the impact of their actions, students can gain insights into how individual efforts might address environmental challenges. This process helps develop a mindset focused on living sustainably and caring for the planet over the long term (Altassan, 2023).

Sustainability education is especially important in tourism, as the industry significantly affects both the environment and local communities (Baloch et al., 2023). Many higher education programs now incorporate eco-friendly practices, responsible travel, and community engagement to address challenges such as climate change and resource depletion (Baloch et al., 2023). These efforts aim to prepare future tourism professionals

to promote sustainable tourism that minimizes environmental impact and supports local economies (Mínguez et al., 2021). The focus of this education is on balancing tourism growth with environmental conservation and socioeconomic development (Ekka et al., 2023).

Within this context, Thailand serves as a good case study for integrating sustainability into hospitality education. As a prominent tourist destination, the country has long recognized the importance of embedding sustainability in its hospitality programs, with educational initiatives dating back to 1955 at institutions like Chulalongkorn University (Chaisawat, 2012). The Thai government has actively implemented policies to improve educational standards in this field, establishing a framework that emphasizes essential skills such as social competence and the ability to navigate environmental challenges. These competencies are crucial for students engaging in internships and pursuing careers in the hospitality sector (Yordudom et al., 2024). This educational approach not only strengthens Thailand's competitiveness in the global tourism market but also prepares students to address emerging challenges within the industry.

Despite these positive developments, significant research gaps remain concerning the long-term impact of sustainability education on tourism students' pro-environmental intentions (Douglas et al., 2024). Specifically, there is a lack of understanding regarding why increased knowledge of sustainability does not always lead to stronger intentions to engage in sustainable practices — a phenomenon often referred to as the "knowledge-action gap." This gap is particularly relevant in tourism education, where students may understand sustainability concepts but struggle to apply that knowledge in their future professional roles.

To address these gaps in sustainability education, this study aims to investigate how tourism students in Thailand internalize sustainability values. Utilizing the Bayesian Mindsponge Framework (BMF), the research will model changes in students' sustainability knowledge, attitudes, and intentions over time. The central research question guiding this study is: "How does education influence sustainability knowledge, attitudes, and intentions among tourism university students in Thailand over time?" To answer this, the study has two key objectives: (1) to assess the impact of sustainability education on undergraduate students' knowledge, attitudes, and intentions, and (2) to provide policy recommendations for educators and institutions to improve sustainability education.

By assessing the long-term impacts of sustainability education, this research seeks to encourage stronger pro-environmental behaviors among tourism students, providing them with the skills to incorporate sustainability principles into their lives. These findings will inform curriculum design, ultimately supporting a more sustainable future for Thailand's tourism industry and aligning with global efforts toward sustainable development.

2. Methodology

2.1. Theoretical foundation

The current study utilized the mindsponge theory, an information-processing theory explaining model construction and interpreting results (Vuong, 2023). Originating from a study on acculturation and the global mindset by Quan-Hoang Vuong and Nancy Napier, the "mindsponge mechanism" concept was introduced to elucidate the cognitive process of assimilating or disregarding cultural values. This metaphorical representation conceptualizes the mind as a sponge that squeezes out inappropriate values and absorbs new ones fitting the context (Vuong & Napier, 2015).

Recently, MT has evolved into a granular interaction thinking theory (Vuong & Nguyen, 2024c). This evolution integrates concepts from quantum physics (Keppens, 2018; Rovelli, 2016, 2018) and Shannon's information theory (Shannon, 1948). In this updated version, information is viewed as possible alternatives, aligning with Shannon's definition. As a granular interaction thinking theory, MT introduces an entropy-based value system to explain better the complexities of human behavior (Vuong & Nguyen, 2024a). The core focus of this revised framework is the granular interaction thinking mechanism, which allows MT to describe how information units interact within the mind and with information beyond the mind.

According to the mindsponge theory, the mind functions as an information processor within its environment, known as the "infosphere." The system, outlined by Vuong (2023) includes dynamic self-balancing, cost-benefit assessment, goal alignment, energy conservation, and ensuring existence through survival, growth, and reproduction. Within the mind, the mindset holds deeply ingrained information like core values stored in memory, influencing subsequent cognitive processes and behavioral responses. Core values act as benchmarks during the multi-filtering process, guiding the assessment of new information. The evaluation determines acceptance or rejection based on perceived benefits versus costs. Accepted information becomes core values, serving as cognitive

references for future processing (Vuong et al., 2022). MT has been applied in various socio-psychological studies, including environmental and conservation psychology (Alzahrani et al., 2023; Huang et al., 2023; Nguyen & Jones, 2022a).

In the context of this research, the MT provides a framework for understanding students' intentions toward environmental sustainability by emphasizing how cognitive processes — shaped by knowledge, attitudes, and perceived behavioral control — impact these intentions. Students' perceptions and internalization of sustainability-related information, such as the benefits of sustainable behaviors, are critical for enhancing their support for pro-environmental actions. For students to cultivate stronger intentions toward sustainability, they must evaluate information in a manner that perceives the benefits as outweighing the costs, thereby driving positive engagement with environmental goals. If students believe that the advantages of adopting sustainable practices surpass the associated challenges, their support and participation are likely to increase. Research by Casola et al. (2022) supports this idea, showing that students with access to practical resources and support for sustainability efforts are more likely to adopt and promote these practices, demonstrating greater engagement and intention toward environmental sustainability. Therefore, we presume that if the education is effective, students with higher school years will have higher sustainability knowledge, attitude, and intention. On the contrary, if the education is ineffective, students with higher school years will have no higher or even lower sustainability knowledge, attitude, and intention.

Additionally, there may be an indirect relationship between students' year levels and their intentions. Higher year levels may lead to increased knowledge and more positive attitudes, which in turn enhance students' intentions to adopt sustainable practices. This suggests that the connection between year level and intention can operate both directly and indirectly through knowledge and attitudes.

2.2. Model construction

2.2.1. Variable selection and rationale

This study utilized data from a survey conducted at Prince of Songkla University, Phuket, Thailand, from October to December 2021 (Fuchs, 2022). The bilingual questionnaire (available in both Thai and English) was administered to assess students' knowledge, attitudes, perceived behavioral control, and intentions regarding environmental sustainability. The secondary dataset is published in *Data in Brief* and can be accessed at the Mendeley Data repository under the title

"Survey_StudentPerceptions_SongklaUniversity_2024.xlsx". The final dataset includes 312 valid responses.

The survey was aimed at hospitality and tourism students aged 18 and older. It covered different academic years, degree programs, and exchange students, providing a broad perspective on sustainability attitudes and perceptions. A pilot survey with ten students helped refine the questionnaire to improve clarity and effectiveness. The final dataset provides insights into student demographics and attitudes, allowing for a better understanding of how knowledge, attitudes, and perceived behavioral control may influence intentions toward sustainability.

The questionnaire focused on factors affecting students' intentions toward sustainability, such as environmental awareness, actions, and perceptions of control over sustainable behaviors. Most questions were mandatory, while demographic questions included a "prefer not to answer" option. Participation was voluntary, and students had the flexibility to complete the survey at their convenience. A stratified random sampling method was used to ensure representation across different academic years, genders, and nationalities.

For the research objective of the current study, four variables were employed for the statistical analysis (see Table 1). The data includes one outcome variable and three predictor variables. *Intention* (students' intentions regarding environmental sustainability) is the outcome variable, while *Knowledge*, *Attitude*, and *Year* are predictor variables. *Knowledge* measures awareness and understanding of environmental issues, *Attitude* assesses personal beliefs and feelings about sustainability, and *Year* is the students' academic year or cohort.

Table 1. Variable Description

Variable	**Variable in the original dataset**	**Description**	**Data type**	**Value**
Year	Year	The year of study the student is currently in	Numerical	1 = Year 1 2 = Year 2 3 = Year 3

				4 = Year 4
Intention	Question 13 - 16	Expectation of increasing support for the environment	Numerical	1 = Strongly Disagree 2 = Disagree 3 = Somewhat Disagree 4 = Neither Agree or Disagree 5 = Somewhat Agree 6 = Agree 7= Strongly Agree
Knowledge	Question 17-20	Being well-informed about current environmental issues.	Numerical	1 = Strongly Disagree 2 = Disagree 3 = Somewhat Disagree 4 = Neither Agree or Disagree 5 = Somewhat Agree 6 = Agree 7= Strongly Agree

Attitude	Question 6	Perception of environmental sustainability as a waste of time and effort.	Numerical	1 = Strongly disagree 2 = Disagree 3 = Somewhat disagree 4 = Neither agree or disagree 5 = Somewhat agree 6 = Agree 7 = Strongly agree

2.2.2. Statistical model

To validate the assumptions presented in Subsection 2.1, we constructed three different analytical models (see Figure 1). The first model was constructed to examine the relationship between the year of study and the level of knowledge about environmental sustainability. Model 1 is shown as follows:

$$Knowledge \sim normal(\mu, \sigma) \quad (1.1)$$

$$\mu_i = \beta_0 + \beta_1 * Year_i \quad (1.2)$$

$$\beta \sim normal(M, S) \quad (1.3)$$

In this model, μ_i represents the expected level of knowledge about environmental sustainability for individual i, predicted based on their year of study. The coefficients β are distributed normally with a mean M and standard deviation S.

Next, the second model was constructed to examine the relationship between the year of study and attitudes toward environmental sustainability. The model is as follows:

$$Attitude \sim normal(\mu, \sigma) \quad (2.1)$$

$$\mu_i = \beta_0 + \beta_1 * Year_i \quad (2.2)$$

$$\beta \sim normal(M, S) \quad (2.3)$$

In this model, μ_i represents the expected attitude toward environmental sustainability for individual i, also predicted based on their year of study. The coefficients β are distributed normally with a mean M and standard deviation S.

Finally, Model 3 was constructed to examine the relationships between knowledge, attitude, year of study, and intention toward environmental sustainability. The model is as follows:

$$Intention \sim normal(\mu, \sigma) \tag{3.1}$$

$$\mu_i = \beta_0 + \beta_1 * Knowledge_{\ i} + \beta_2 * Attitude_i + \beta_3 * Year_i \tag{3.2}$$

$$\beta \sim normal(M, S) \tag{3.3}$$

Here, μ_i represents the expected level of Intention for individual i. The variables are defined as follows $Knowledge_i$: denotes the level of knowledge about environmental sustainability for individual; $Attitude_i$: reflects the attitude toward environmental sustainability for individual. $Year_i$: represents the year of study or another time-related variable for individual i, indicating progression or changes over time.

The probability around μ is determined by the form of the normal distribution, where the width of the distribution is determined by the standard deviation σ. This σ represents the unexplained variability or noise in the model. The coefficients $\beta_1 - \beta_3$ are distributed normally with mean M and standard deviation S.

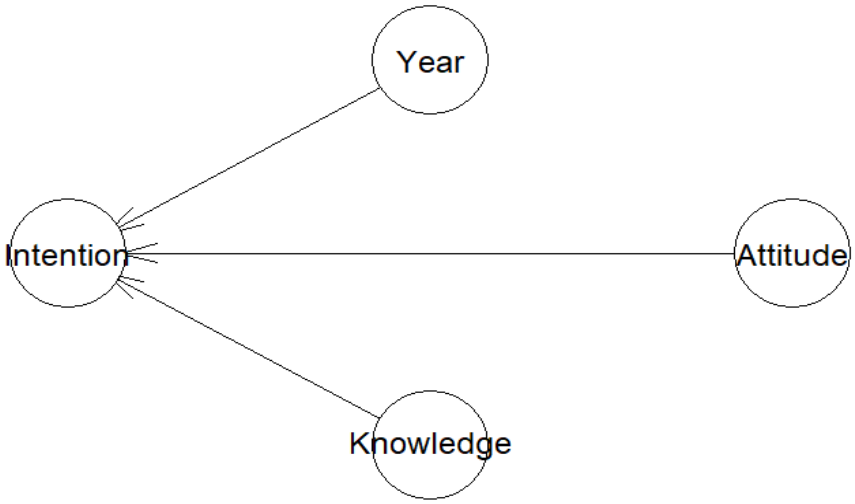

Figure 1. Analytical Model

2.2.3. Analysis and validation

The current study utilized Bayesian Mindsponge Framework (BMF) analytics for several reasons (Nguyen et al., 2022; Vuong et al., 2022). Firstly, BMF combines the logical reasoning of Mindsponge Theory with the inferential strengths of Bayesian analysis, making them highly compatible (Nguyen et al., 2022). Secondly, Bayesian inference is a statistical approach that treats all parameters probabilistically (Csilléry et al., 2010; Gill, 2014), allowing for the reliable prediction of parsimonious models. Thirdly, Bayesian inference has several advantages over the frequentist approach, such as using credible intervals for result interpretation instead of solely relying on *p*-values for binary decisions (Halsey et al., 2015; Wagenmakers et al., 2018). Moreover, Bayesian analysis with informative priors can address multicollinearity problems by handling weak data issues (Adepoju & Ojo, 2018; Jaya et al., 2019; Leamer, 1973).

In Bayesian analysis, choosing the appropriate prior is crucial during the model-building phase (van de Schoot et al., 2021). As the current study is exploratory, we

employed the uninformative priors to avoid subjectivity. However, we also utilized a prior-tweaking method, re-running the analysis with informative priors reflecting our disbelief in the associations, employing a normal distribution with a mean of 0 and a standard deviation of 0.5. If the estimated outcomes remain consistent with the results generated using uninformative priors, we can consider the results robust (Vuong et al., 2022).

Following the model fitting process, we employed Pareto-smoothed importance sampling leave-one-out (PSIS-LOO) diagnostics to assess the goodness-of-fit of the model (Vehtari & Gabry, 2019; Vehtari et al., 2017). The LOO computation procedure is outlined as follows:

$$LOO = -2LPPD_{loo} = -2\sum_{i=1}^{n} \log \int p(y_i|\theta) p_{post(-i)}(\theta) d\theta$$

The posterior distribution $p_{post(-i)}(\theta)$ is calculated based on the data excluding data point i. In the PSIS method, k-Pareto values are used to compute leave-one-out cross-validation, which helps identify observations with a high degree of influence on the PSIS estimate. Observations with k-Pareto values greater than 0.7 are often considered influential and may pose problems for accurately estimating leave-one-out cross-validation. Generally, a model is considered well-fitted when the k values are below 0.5.

If the model demonstrated a good fit with the data, we proceeded with convergence diagnostics and result interpretation. The convergence of Markov chains is typically validated using both statistical measures and visual illustrations. Statistically, the effective sample size (*n_eff*) and the Gelman–Rubin shrink factor (*Rhat*) are used to assess convergence. The *n_eff* value represents the number of iterative samples that are not auto-correlated during stochastic simulation, with values larger than 1000 indicating sufficient effective samples for reliable inference (McElreath, 2018). The *Rhat* value, also known as the potential scale reduction factor or Gelman–Rubin shrink factor (Brooks & Gelman, 1998), should be equal to 1 for the model to be considered convergent; values exceeding 1.1 indicate non-convergence. Visually, convergence is also validated using trace plots of the Markov chains.

The Bayesian analysis was conducted in R using the open-access **bayesvl** package, which offers robust visualization capabilities (La & Vuong, 2019). To ensure data transparency and facilitate reproducibility, all data and code snippets from this study have been deposited on a preprint server for public access and reuse (Vuong, 2018). The dataset and code can be accessed at https://zenodo.org/records/13927647.

3. Results

Model fitting of all models was performed on R version 4.4.0 using four Markov chains, each consisting of 5000 iterations, with 2000 used for the warmup period.

3.1. Model 1: The relationship between year of study and knowledge about environmental sustainability

Model 1 was estimated to investigate the relationship between years of study and knowledge about environmental sustainability among students. The model included a single predictor variable, *Year*, which represents the student's year of study, to predict their expected level of environmental knowledge. Initially, the PSIS-LOO (Pareto-smoothed importance sampling leave-one-out cross-validation) test was conducted to evaluate the goodness of fit between Model 1 and the data. The visualized PSIS-LOO plot indicated that all k values were below 0.5, suggesting that Model 1 fit the dataset well (see Figure 2).

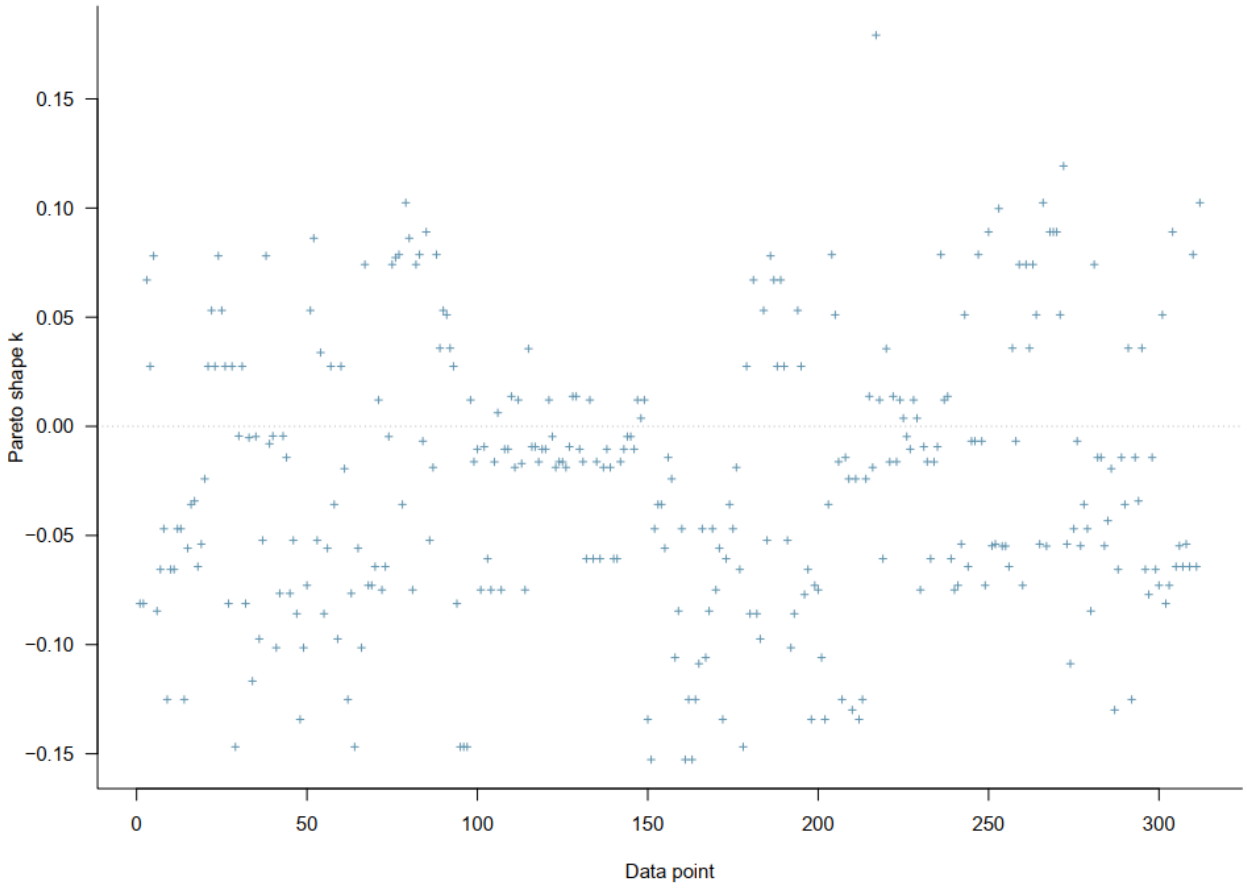

Figure 2. PSIS-LOO diagnosis of Model 1 using an uninformative prior

Next, it is necessary to diagnose Markov chain convergence using the *n_eff* and *Rhat*. All the coefficients' *n_eff* values are greater than 1000, and the *Rhat* values are equal to 1, so we can conclude that the Markov chains converge well (see Table 2). We also visualized trace plots to validate the Markov chain's convergence (or the Markov chain central limit theorem). The *y*-axis of the trace plots represents the posterior values of each parameter, while the *x*-axis represents the iteration order of the simulation. Figure 3 demonstrates the healthy mixing of all coefficients' Markov chains around an equilibrium, which is a good signal of convergence.

Table 2. Model 1's estimated posterior results

Parameters	**Uninformative prior**				**Informative prior reflecting disbelief**			
	Mean	**SD**	***n_eff***	***Rhat***	**Mean**	**SD**	***n_eff***	***Rhat***
Constant	5.48	0.14	4655	1	5.48	0.13	4632	1
Year_Knowledge	-0.01	0.05	4768	1	-0.01	0.05	4776	1

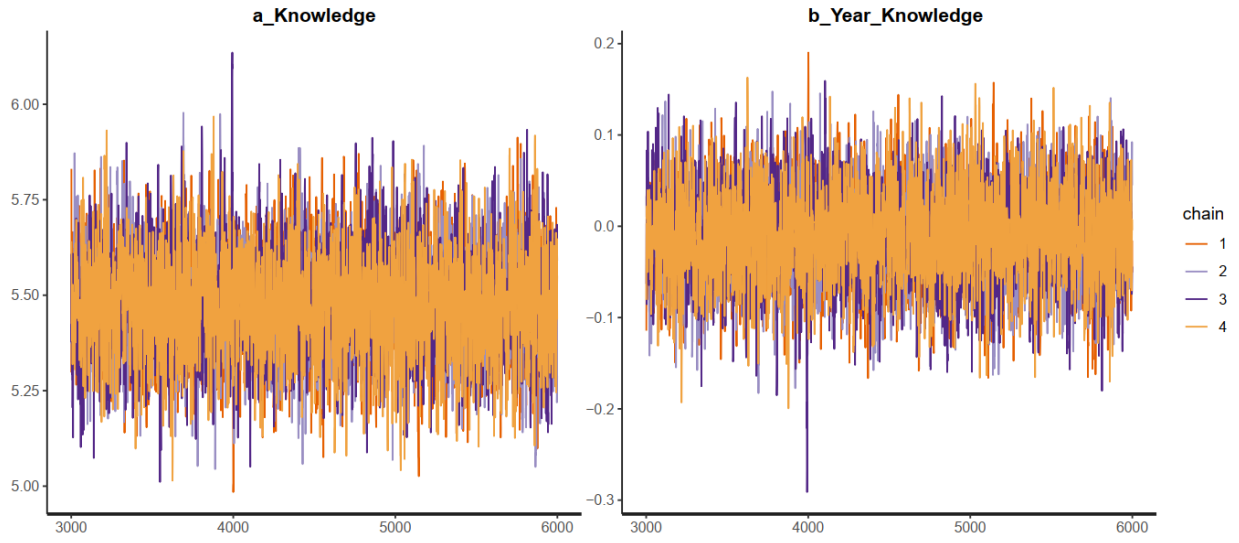

Figure 3. Trace plots of Model 1 using an uninformative prior

The estimated posterior distribution using uninformative prior shows that year of education has an ambiguous association with the level of knowledge about environmental sustainability ($M_{Year\_Knowledge}$ = -0.01 and $S_{Year\_Knowledge}$ = 0.05). The

estimated results using informative prior also provide a nearly identical result, suggesting that the association is robust.

The posterior distribution of the coefficient "Year_Knowledge" is shown in Figure 4. The thick black lines in the middle represent the 95% highest posterior density intervals (HPDI), indicating where 95% of the probability mass is distributed. As can be seen, the HPDIs of "Year_Knowledge" illustrate an unclear tendency of the relationship between *Year* and *Knowledge*.

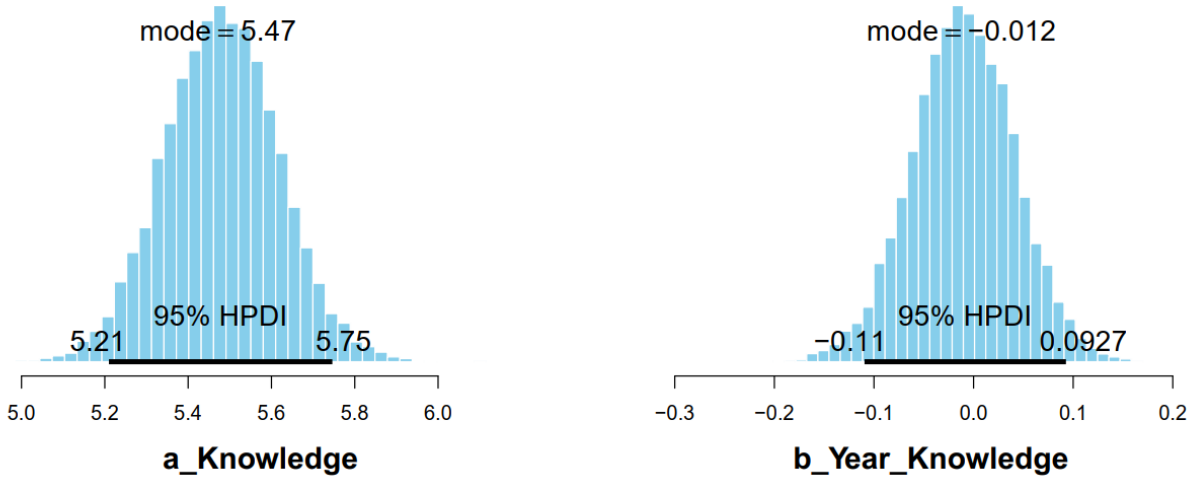

Figure 4. Estimated posterior distributions of Model 1 using an uninformative prior

3.2. Model 2: The relationship between the year of study and attitude about environmental sustainability

Model 2 was estimated to investigate the relationship between the year of study and attitudes toward environmental sustainability among students. The model included a single predictor variable, *Year*, which represents the student's year of study, to predict their level of environmental attitude, *Attitude*. The visualized PSIS-LOO plot indicates that all k values are below 0.5, suggesting that Model 2 fits the dataset well (see Figure 5).

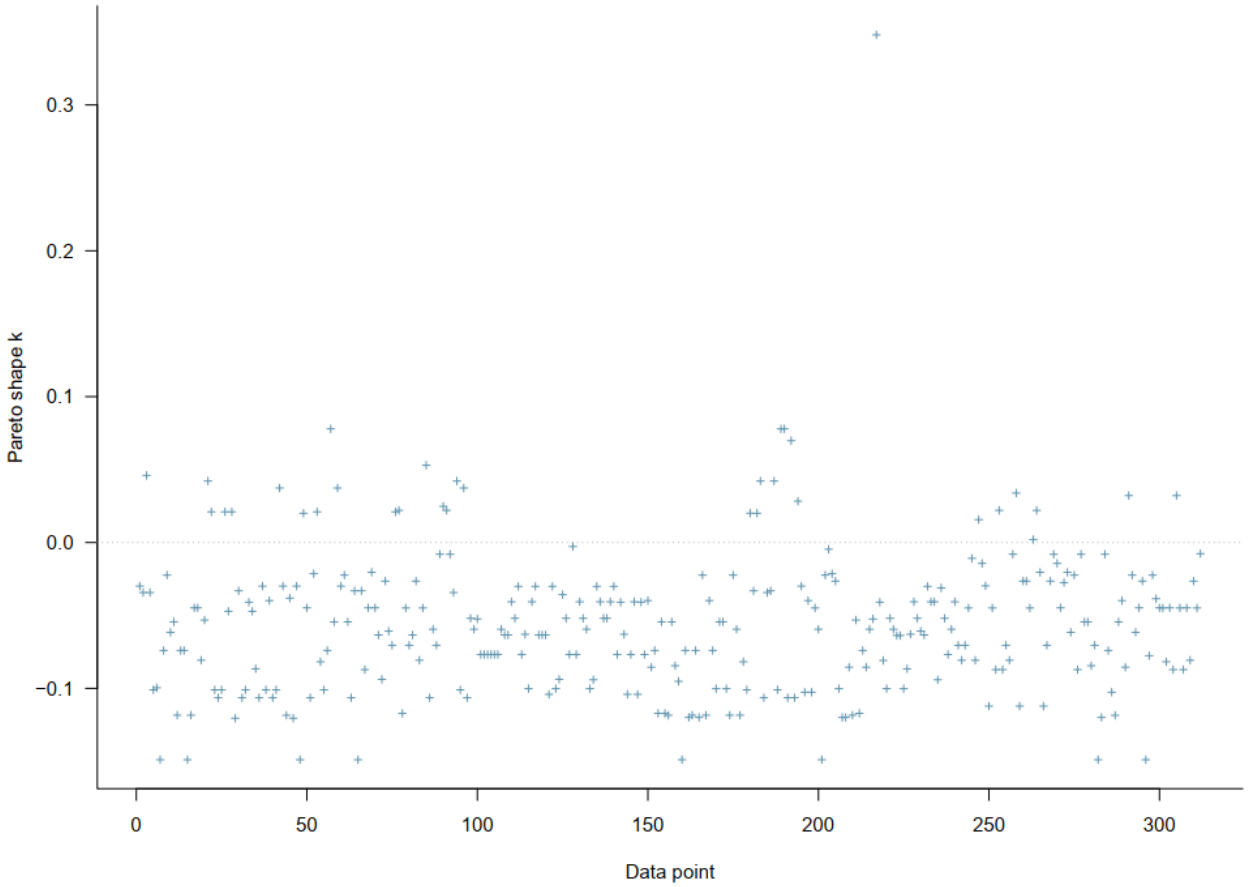

Figure 5. PSIS-LOO diagnosis of Model 2 using an uninformative prior

Convergence diagnostic values (*n_eff* and *Rhat*) of Model 2 indicate that Markov chains are convergent (see Table 3). The trace plots also confirm the convergence of Markov chains (see Figure 6).

Table 3. Model 2's estimated posterior results

Parameters	**Uninformative prior**				**Informative prior reflecting disbelief**			
	Mean	**SD**	***n_eff***	***Rhat***	**Mean**	**SD**	***n_eff***	***Rhat***
Constant	5.50	0.09	4776	1	5.50	0.09	4764	1
Year_Attitude	0.01	0.04	4760	1	1	0.04	4776	1

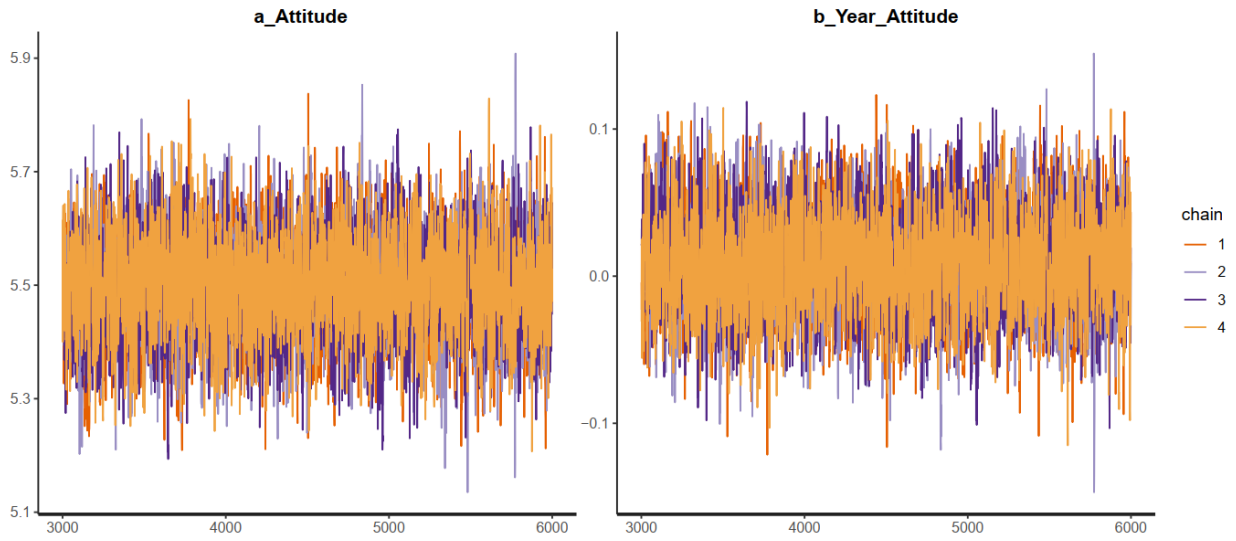

Figure 6. Trace plots of Model 2 using an uninformative prior

Similar to Model 1, the estimated posterior distribution using the uninformative prior of Model 2 also implies an ambiguous relationship between *Year* and *Attitude* ($M_{Year\_Attitude}$ = 0.01 and $S_{Year\_Attitude}$ = 0.04). The result generated using an informative prior reflecting our disbelief in the association also confirms the ambiguous association (see Table 3). 95% HPDI of the coefficient "Year_Attitude" in Figure 7 is not distributed clearly on the negative or positive side of the x-axis, highlighting the unclear tendency.

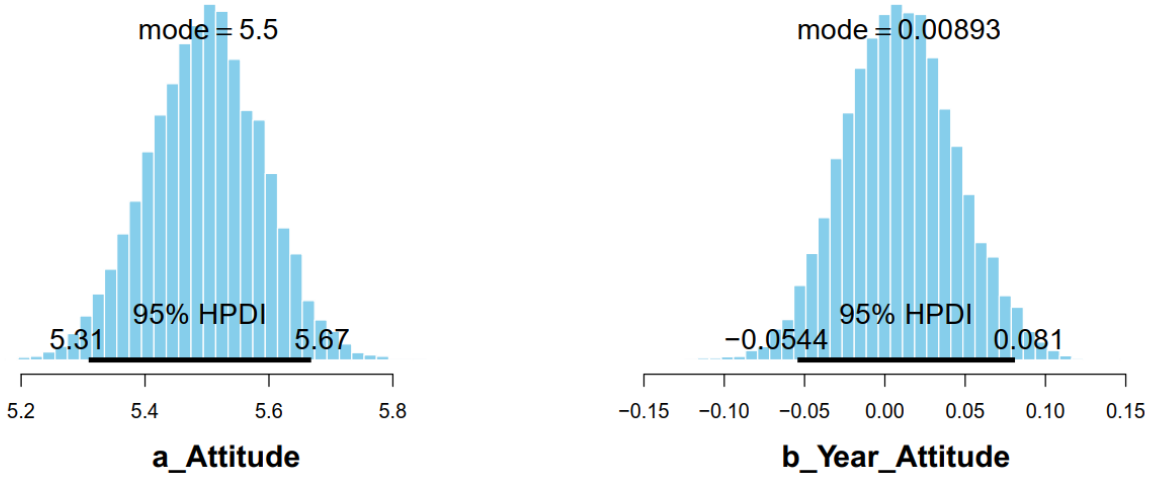

Figure 7. Estimated posterior distributions of Model 2 using an uninformative prior

3.3. Model 3: The associations between the year of study, knowledge, attitude, and intention about environmental sustainability

Model 3 was estimated to investigate the relationships between the year of study, knowledge, attitude, and intention toward environmental sustainability. The visualized PSIS-LOO plot indicates that all *k* values are below 0.3, suggesting that Model 3 fit the dataset well (see Figure 8).

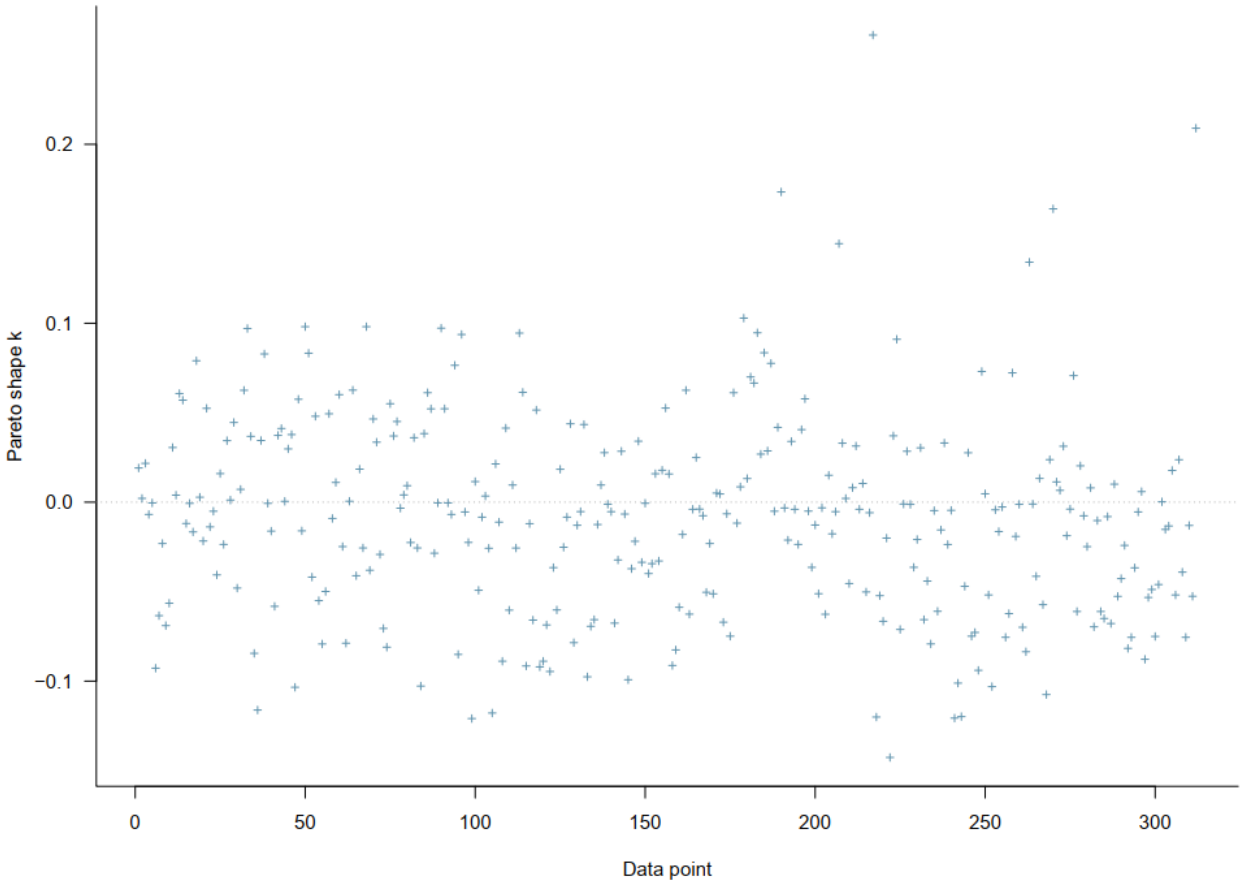

Figure 8. PSIS-LOO diagnosis of Model 3 using an uninformative prior

The posterior distribution statistics of Model 3 are shown in Table 4. All *n_eff* values are greater than 1000, and *Rhat* values are equal to 1, so Model 3's Markov chains are deemed well-convergent (see Table 4). The convergence of Markov chains is also reflected in the trace plots of Figure 9. In particular, after the 2000th iteration, all chains' values fluctuate around the central equilibrium.

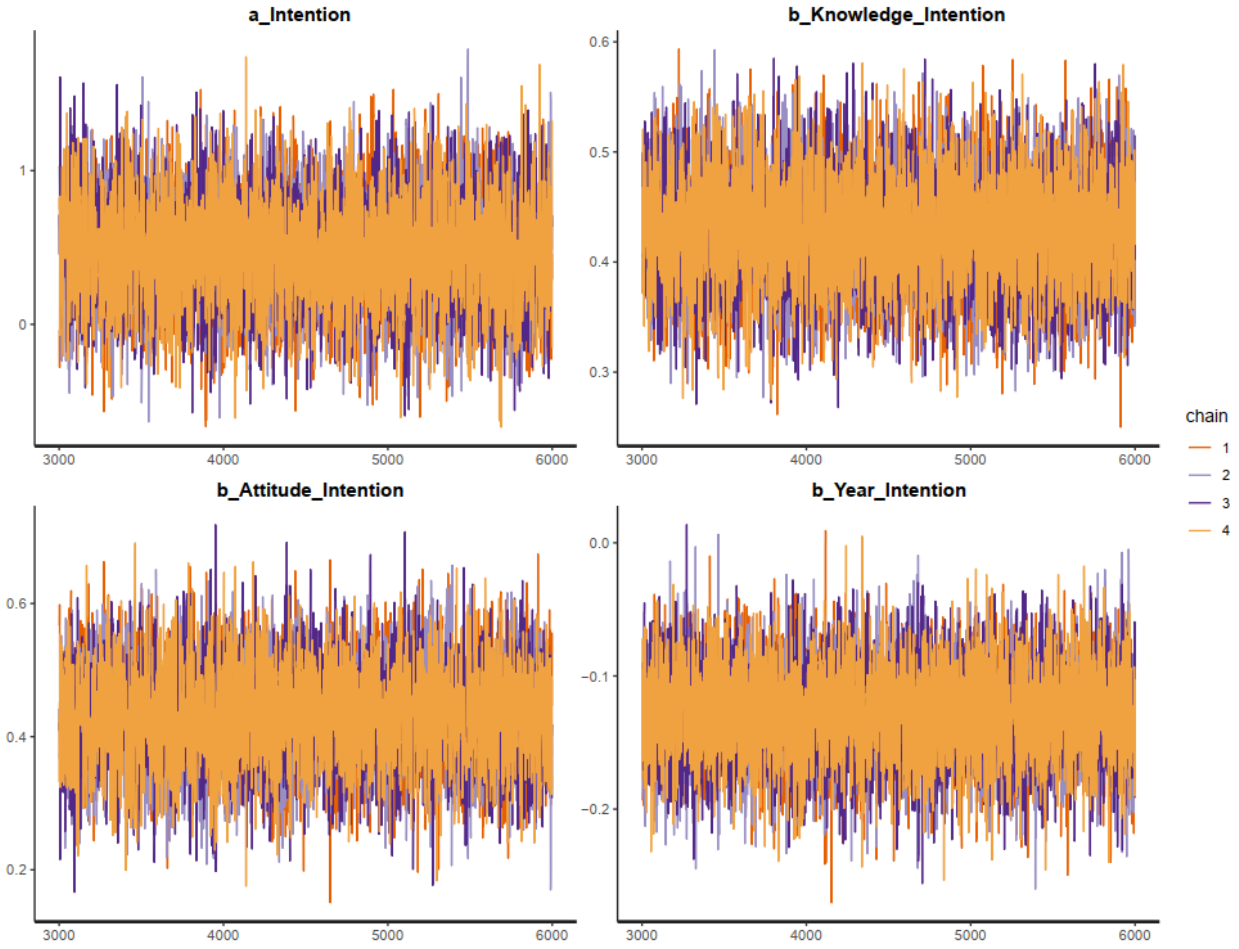

Figure 9. Trace plots of Model 3 using an uninformative prior

Table 4. Estimated results of Model 3

Parameters	**Uninformative prior**				**Informative prior reflecting disbelief**			
	Mean	**SD**	***n_eff***	***Rhat***	**Mean**	**SD**	***n_eff***	***Rhat***
Constant	0.47	0.34	7515	1	0.49	0.33	7682	1
Knowledge_Intention	0.43	0.05	8125	1	0.43	0.05	8006	1
Attitude_Intention	0.43	0.07	6296	1	0.43	0.07	6845	1

Year_Intention	-0.13	0.04	9032	1	-0.13	0.04	9638	1

Additionally, the posterior distributions of the three coefficients in Model 3, illustrated in Figure 11, display the HPDIs at 95% (i.e., the thick blue lines). As can be seen, all distributions lie entirely on either the positive or negative side of the x-axis, underscoring the high reliability of the results. The estimation using informative priors reflecting our disbelief in the associations also produces similar results, suggesting that the results are robust.

Specifically, we found that students with higher school years tend to have a lower level of intention to support environmental sustainability ($M_{Year\_Intention}$ = -0.13 and $S_{Year\_Intention}$ = 0.04). Meanwhile, the levels of knowledge and attitude toward environmental sustainability are positively associated with intention. However, there is no indirect association between $Year$ and $Intention$ through the mediation of $Knowledge$ and $Attitude$ because $Year$ was found to have no clear associations with both $Knowledge$ and $Attitude$.

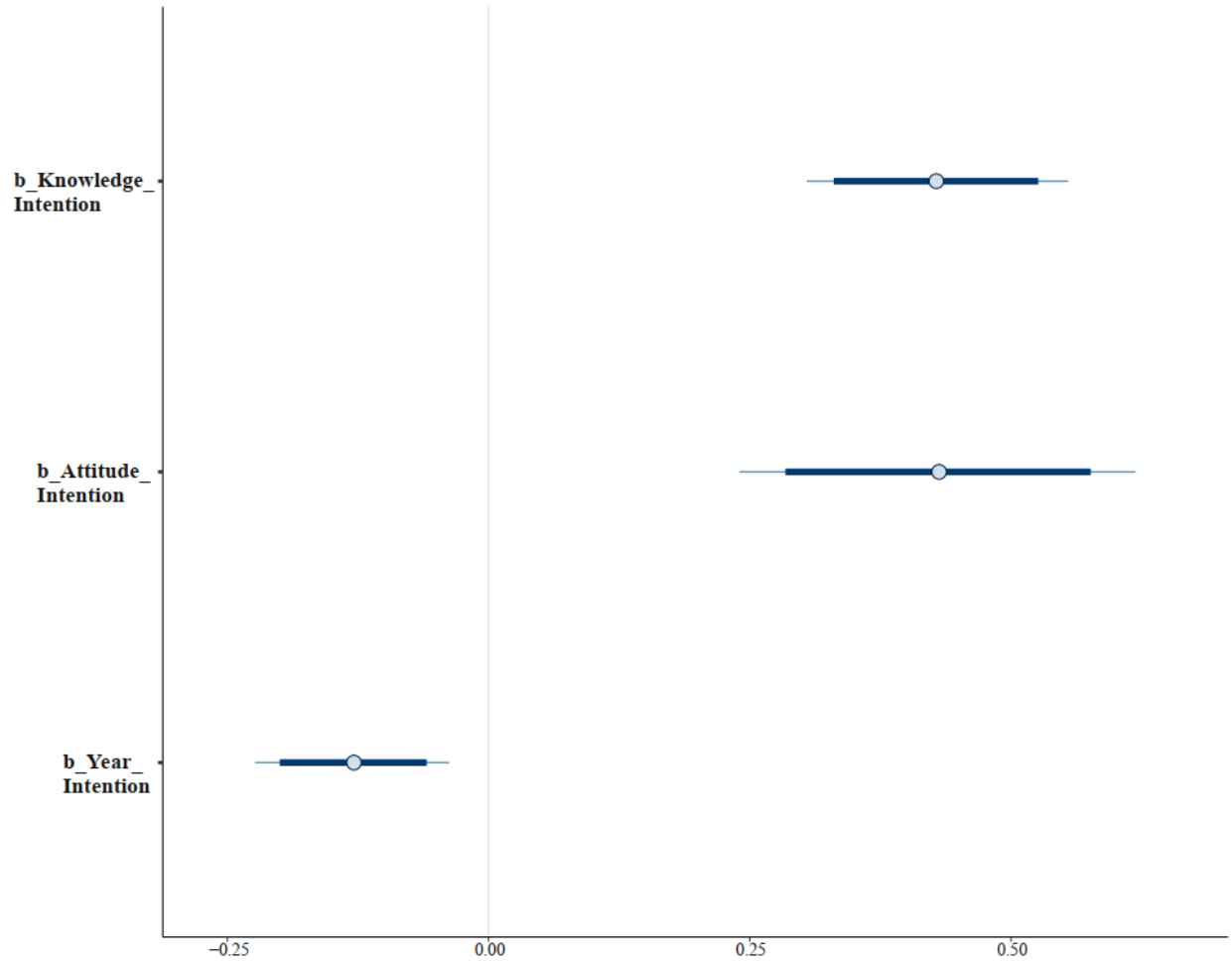

Figure 10. Estimated posterior distributions of Model 3 using an uninformative prior

4. Discussion

4.1. Limited impact and curriculum disconnect in tourism education

The findings of this study reveal that four years of tourism education have had a limited impact on students' knowledge and attitudes regarding sustainability. More strikingly, students with higher school years were even found to have lower intention to support environmental sustainability, suggesting that the theoretical knowledge provided by the current tourism curriculum is largely not effective in promoting an environmental sustainability mindset among students.

One possible reason for the gap between sustainability knowledge and its practical application in the tourism industry could be the limited availability of experiential learning opportunities within the curriculum. While students are taught important theoretical frameworks — such as ecotourism principles and responsible tourism

practices (Baloch et al., 2023) — the lack of practical application may make it more challenging for them to translate these concepts into action. For example, students might learn about the importance of minimizing environmental impact and engaging local communities. Still, without opportunities to engage in real-world projects or simulations, they may find it difficult to see how these principles are applied in practice. This absence of experiential learning could contribute to a disconnect between their knowledge and its implementation (Boyle et al., 2015; Dias et al., 2024; Nguyen, Nguyen, et al., 2023).

Traditionally, tourism education has focused on theoretical content, addressing topics such as environmental ethics and sustainable development goals (Schweinsberg et al., 2013). However, this lecture-based approach leaves students ill-equipped to navigate the practical challenges of integrating sustainability into the tourism sector. Without direct engagement with real-world issues, students miss the opportunity to develop the critical skills needed to balance economic profitability with environmental responsibility.

Another factor contributing to the disconnect between sustainability education and its practical application in tourism may arise from the influence of an "eco-deficit culture" (Q.-H. Vuong, 2021; Vuong & Nguyen, 2024a; Q. H. Vuong, 2021). As students advance in their studies, they often encounter societal and industry pressures that widen the gap between theoretical knowledge and real-world practices. Although sustainability is emphasized in tourism curricula, students frequently adopt unsustainable mindsets shaped by industry norms that prioritize economic growth, resource exploitation, and profit maximization (Manzoor et al., 2019; Q. H. Vuong, 2021).

This exposure to industry pressures — focused on cost-cutting and increasing visitor numbers — can lead students to internalize the belief that financial success is more important than sustainability. Additionally, educational systems may inadvertently promote unsustainable behaviors by presenting natural resource use as a necessary part of economic development. This approach can weaken sustainability education and increase the gap between what students learn in school and what actually happens in the tourism industry (Kioupi & Voulvoulis, 2019). Students often receive mixed messages: while academic programs advocate for eco-friendly tourism, the industry tends to emphasize profitability. This inconsistency can reduce their dedication to sustainability in their future jobs (Baloch et al., 2023; Juvan & Dolnicar, 2014) and create challenges in integrating sustainable values into professional practice, as financial success is frequently viewed as a higher priority than environmental considerations.

Furthermore, the "eco-deficit culture" intensifies the perceived conflict between sustainability and profitability, reinforcing the belief that achieving environmental goals is unrealistic or unattainable within tourism careers (Vuong & Nguyen, 2024a). This societal mindset, which consistently prioritizes short-term economic gains over long-term environmental responsibility (Haessler, 2020), can discourage students from applying their sustainability knowledge in practice. Even when they acknowledge the importance of protecting the environment, they may be reluctant to prioritize it, reinforcing the idea that financial and environmental goals are fundamentally incompatible in the tourism industry (Baloch et al., 2023).

Greenwashing — a prevalent issue in the tourism sector - intensifies the challenges students face when attempting to engage with sustainability, further contributing to an "eco-deficit culture" (Mangini et al., 2020). Greenwashing occurs when companies make misleading claims about their environmental efforts while continuing practices that are detrimental to the environment. This weakens genuine sustainability initiatives and fosters skepticism among both consumers and students (Papagiannakis et al., 2024). For students trying to navigate an industry that prioritizes profit over sustainability, these deceptive claims make it difficult to align their academic learning with real-world practices.

In the hotel industry, a common manifestation of greenwashing involves branding establishments as "eco-friendly" through superficial or symbolic actions. For example, hotels may promote towel reuse as a sustainability initiative yet continue to rely on energy-intensive practices like inefficient lighting, excessive air conditioning, or unsustainable sourcing of materials. These surface-level actions obscure more significant, harmful practices (Majeed & Kim, 2022). This disconnect between the marketed image of sustainability and the actual operations of these hotels creates confusion for students, who are taught rigorous sustainability standards in their academic programs but encounter misleading examples in practice (de Freitas Netto et al., 2020).

This disconnect is particularly evident in wildlife tourism, where operators often market their tours as conservation-focused, using terms like "sustainable safaris" or "eco-tours." While these tours are promoted as contributing to ecological preservation, they may actually engage in practices that harm wildlife and ecosystems. For instance, elephant tourism operations in Thailand frequently position themselves as advocates for animal welfare, emphasizing educational experiences. However, concerns have been raised

about the treatment of elephants, including practices such as chaining, using bullhooks, and overworking them for rides and performances (Bansiddhi et al., 2020). Such instances of greenwashing may create mixed signals for students, who are taught that responsible tourism involves protecting natural resources but may also observe companies presenting themselves as sustainable while still exploiting these resources (Nguyen & Jones, 2022b; Vangeli et al., 2023).

These inconsistencies can weaken students' confidence in sustainability initiatives, reinforcing an "eco-deficit culture" in which short-term profits often take precedence over long-term environmental goals. As they witness industry practices that prioritize profitability over genuine sustainability, students may feel uncertain about the impact of their education on real-world issues. This uncertainty not only affects their motivation but also compromises the objectives of sustainability education (Torelli et al., 2020). Although tourism education emphasizes the importance of sustainability, the disconnect between theoretical knowledge and the unsustainable practices observed in the industry can hinder students' potential to drive positive change.

4.2. Promoting long-term engagement through motivation and practical application in tourism education

To encourage long-term engagement with sustainable practices among tourism students, education needs to incorporate practical applications that align with their values, interests, and career goals. By combining theoretical learning with real-world experiences, educational institutions can effectively shape students' commitment to sustainability (Abo-Khalil, 2024; Nguyen, Le, et al., 2023). This integrated approach fosters continuous engagement with sustainable behaviors through experiential learning (Bowser et al., 2024).

Tourism education programs should, therefore, prioritize experiential learning opportunities, such as sustainability-focused internships, field trips, and service-learning projects. These initiatives not only equip students with practical skills but also foster the ethical and humanistic perspectives necessary for navigating the complexities of the tourism industry (Jamal et al., 2011; Nguyen, 2024; Vuong & Nguyen, 2023). For instance, a tourism student in Thailand could intern at an eco-friendly destination in Phuket, gaining direct insights into sustainable practices like waste management, water conservation, and community involvement (Ruhanen et al., 2021). Encouraging students to engage actively in sustainability initiatives, particularly through student-led projects,

is crucial for cultivating a sense of ownership and responsibility for sustainable practices (Farsari, 2022; Vare, 2021). For example, students at a Thai university might develop a project aimed at promoting eco-friendly practices among local guesthouses. These opportunities allow students to apply their theoretical knowledge, deepening their understanding of sustainability in practice and ultimately preparing them for future careers in the tourism sector (Vangeli et al., 2023). Such engagement not only strengthens their connection to sustainability principles but also empowers them to effect meaningful change.

Field trips to cultural and natural heritage sites significantly enhance the learning experience by allowing students to observe sustainable tourism practices in action (Ruhanen et al., 2021). Additionally, service-learning projects, such as participating in coastal clean-ups or assisting local businesses in adopting responsible tourism practices, further reinforce this experiential learning. Workshops can also be organized to provide guidance on sustainable practices to students, including waste reduction, energy efficiency, and responsible resource management (Filho et al., 2024). By engaging directly with businesses, students tackle complex sustainability issues while gaining valuable hands-on experience. This active involvement not only deepens their understanding but also fosters essential problem-solving skills that future professionals will need in their careers (Chen et al., 2022).

Building on these experiential opportunities, educational institutions need to collaborate with industry stakeholders from both the tourism and environmental sectors to effectively prepare students for the challenges of integrating sustainability into their careers. Such partnerships are crucial for addressing the complexities of aligning economic, social, and environmental goals. By working together, they provide students with practical insights into how sustainable practices can benefit both the economy and the environment, thereby enhancing their commitment to sustainability (Bowser et al., 2024). When students engage in recognized projects involving industry collaboration, they can apply their theoretical knowledge while understanding the real-world implications of sustainable practices in a business context (Moeller et al., 2011). To support this, the curriculum should emphasize ethical and ecological awareness, highlighting responsible practices in tourism (Hales & Jennings, 2017). This understanding is essential, as initiatives promoting responsible tourism aim to alleviate the perceived conflict between economic success and environmental protection (Mihalic,

2016). Students must learn to balance economic growth with environmental care (Arrobas et al., 2020).

Moreover, a transformative educational approach is needed to challenge the widespread "eco-deficit culture," where higher education may unintentionally support unsustainable behaviors (Chen et al., 2022). Traditional teaching methods often emphasize memorization and theoretical knowledge, which may not effectively build a strong understanding of tourism's effects on the environment and local communities. By shifting towards educational strategies that emphasize ethical reflection and critical thinking, educators can better equip students to make informed, sustainability-focused decisions in their future careers (Chen et al., 2022).

Incorporating the concept of "eco-surplus" — which encourages practices that not only comply with environmental regulations but also actively benefit the environment — can serve as a guiding principle in sustainable tourism education (Nguyen & Jones, 2022a). This approach enables students to understand how tourism operations can positively affect local ecosystems through initiatives centered on conservation and biodiversity (Baloch et al., 2023).

Recognizing students' contributions to sustainability initiatives is also vital in this educational process. When students are acknowledged for their efforts, they gain practical insights into how sustainability practices can be economically viable, reinforcing the idea that environmental stewardship and profitability can coexist (Moeller et al., 2011). Public acknowledgment through awards or recognition can enhance their motivation and foster a culture of sustainability within tourism education (Chen et al., 2022). By creating an environment where sustainability efforts are valued, educational institutions can help prepare students for leadership roles in addressing environmental challenges in their future careers (Vuong & Nguyen, 2024b; Wilson & von der Heidt, 2013).

5. Limitation and future research directions

This study has several limitations, so we present them here for transparency (Vuong, 2020). First, the sample consists solely of undergraduate students from Prince of Songkla University, which may limit the extent to which the results apply to a broader population of university students in Thailand or other regions. Future research could benefit from including a more diverse and representative sample from multiple universities to improve the relevance of the findings. Additionally, while this study emphasizes

knowledge, attitudes, and intentions related to sustainability, other factors such as institutional support, peer influences, and external environmental conditions might also influence students' sustainability practices. Exploring these additional factors in future research could provide a better understanding of the influences on sustainability behavior among students.

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