



Physics Education Students' Perceptions of Infused Water as a Healthy Beverage Companion to the MBG Program in Schools

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Abstract

The Free Nutritious Food Program (MBG) in Indonesia has primarily focused on solid food provision, leaving the beverage component largely unaddressed. Meanwhile, sugar-sweetened beverage (SSB) consumption among school-age children remains a significant public health concern. Infused water has emerged as a low-cost, low-sugar alternative that may complement MBG implementation. This study investigates the perceptions of Physics Education students ($n=33$) at Universitas Negeri Medan toward the potential of infused water as a healthy beverage companion to MBG, using a descriptive quantitative survey design. A 20-item Likert-scale instrument was developed based on Bloom's Revised Taxonomy across cognitive, affective, and behavioral dimensions, and validated through Pearson correlation (all $r > 0.339$) and Cronbach's Alpha ($\alpha = 0.966$). Results indicate generally positive perceptions: cognitive ($M = 4.06$, High), affective ($M = 4.28$, Very High), and behavioral ($M = 3.91$, High). The affective dimension yielded the highest mean, while the behavioral dimension was comparatively lower, suggesting that students support the concept but may have limited practical experience. These findings suggest that infused water may have potential as a science-based educational tool to promote healthy hydration habits within MBG; however, further studies involving broader samples and field trials are needed before wider implementation.

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INTRODUCTION

Consumption of sugar-sweetened beverages (SSBs) among school-age children and adolescents represents one of the most persistent public health challenges globally, including in Indonesia. Epidemiological evidence consistently demonstrates that excessive SSB intake correlates positively with elevated risks of obesity, insulin resistance, hypertension, metabolic syndrome, and reduced sleep quality among adolescents (Calcaterra et al., 2023; Zhang et al., 2026). A prospective cohort study further reported a significant association between adolescent SSB consumption and elevated risk of early-onset colorectal cancer in women (Hur et al., 2021). These findings have prompted governments worldwide to develop school-based interventions

aimed at cultivating healthier beverage habits from an early age.

Within the Indonesian context, the government's commitment to improving student nutrition is embodied in the Free Nutritious Food Program (*Program Makanan Bergizi Gratis/MBG*), a national policy priority introduced in 2025. MBG aims to systematically improve the nutritional status of school-age children through the provision of nutritious food at no cost. However, current MBG implementation remains predominantly focused on solid food components, while the healthy beverage dimension has received comparatively little attention. In parallel, adequate consumption of plain water and low-sugar drinks constitutes a

critical component of student growth, development, and learning concentration (Kamin et al., 2022; Wang et al., 2022).

In this context, *infused water*—water infused with natural ingredients such as fresh fruit, spices, or herbs through a diffusion process—has emerged as an attractive low-sugar candidate beverage to complement MBG. This study does not claim that *infused water* has been clinically proven to deliver health benefits; rather, it is considered a practical, easily prepared option that avoids the added sugars present in commercial SSBs. From a physics and chemistry perspective, the preparation of *infused water* involves the diffusion of solutes from natural materials into the water solvent—making it a contextually relevant topic for Physics Education students exploring solution and diffusion concepts. Several laboratory studies suggest that natural infusion ingredients may contain bioactive compounds such as polyphenols and flavonoids (Bernacka et al., 2022; Garcia-Montalvo et al., 2022), though further clinical evidence is needed (Purwanti & Indarto, 2021).

Despite the growing body of research on *infused water* from bioactive perspectives, studies integrating the academic viewpoints of Physics Education students in evaluating its potential within school nutrition programs remain scarce. Physics Education students—equipped with foundational knowledge of diffusion, solution concentration, and physical chemistry—possess a unique capacity to assess *infused water* critically and scientifically. Their role as prospective educators makes their perceptions particularly relevant to the development of science-based nutrition education strategies. A closely related study by Ridho, Bunawan, et al. (2025) affirms the value of capturing disciplinary perspectives from future science educators on everyday beverage choices. The novelty of the present study therefore lies not in clinical validation, but in analyzing future science educators' perceptions of *infused water* in relation to MBG—a perspective not previously documented in the literature.

Based on this identified gap, the present study aims to: (1) analyze the perceptions of Physics Education students toward the potential of *infused water* as a companion to MBG across cognitive, affective, and behavioral dimensions; (2) identify the dominant subdimensions in student perceptions; and (3) discuss possible educational

implications for healthy beverage promotion in schools.

METHOD

Research Design and Approach

This study employed a descriptive quantitative method using a survey approach, which enables a systematic and measurable description of respondents' perceptions through a standardized questionnaire (Creswell & Creswell, 2018). Descriptive statistics were used to characterize the central tendency and response distribution of students across each indicator, without testing causal relationships. All data are perception-based and should be interpreted accordingly within these methodological boundaries.

Participants

The study was conducted in April 2026 in the Physics Education Study Program at Universitas Negeri Medan (UNIMED). Participants were second-semester students enrolled in the General Chemistry course. Inclusion criteria required current enrollment in the course during the study period; no exclusion criteria beyond non-enrollment were applied. Sampling employed a *total sampling* technique. Of 34 responses received via Google Form, one duplicate entry was identified based on identical email address and submission timestamp and was eliminated, yielding a final analytic sample of $n=33$ respondents from classes PESP 25 and PSF A 25. The sample comprised predominantly female students, consistent with the gender distribution of this study program; the age range of participants was 18–20 years. Given the single-institution, single-program sample, findings are context-specific and should not be generalized to all Physics Education students in Indonesia.

Participation was voluntary. Respondents were informed of the study's purpose, and anonymity of responses was assured. No personally identifying information beyond email address (used solely for duplicate detection) was retained in the dataset.

Instrument

The instrument was a closed-ended questionnaire using a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree). The 20 items were developed by the authors based on Bloom's Revised Taxonomy, drawing on the item frameworks established in Ridho, Juwitaningsih,

et al. (2025) and adapted to the context of *infused water* and MBG. A draft instrument was reviewed by two subject-matter experts—one in physics education and one in nutrition science—before empirical testing, to ensure content validity and clarity of wording. Items were then piloted with the study sample as the validation cohort.

Items were organized across three dimensions: (1) **Cognitive** (12 items, P1–P12): Remembering (C1, P1–P2, e.g., “I know that *infused water* is made by soaking natural ingredients in water”), Understanding (C2, P3–P4), Applying (C3, P5–P6), Analyzing (C4, P7–P8), Evaluating (C5, P9–P10), and Creating (C6, P11–P12, e.g., “I can design a new *infused water* recipe”); (2) **Affective** (4 items, P13–P16): Interest (P13), Willingness (P14), Support (P15), and Assessment (P16, e.g., “I believe *infused water* can be a healthy option for students”); (3) **Behavioral** (4 items, P17–P20):

Making (P17), Selecting Ingredients (P18), Presenting (P19), and Evaluating Quality (P20, e.g., “I can evaluate whether *infused water* is well-prepared”).

Validity and Reliability

Validity was assessed using Pearson *Product Moment* correlation ($\alpha = 0.05$, r -critical = 0.339, $df = 31$). All 20 items were valid (r -values: 0.507–0.905). Because the validation sample was small ($n = 33$), these results should be interpreted with appropriate caution. Reliability testing using Cronbach's Alpha yielded $\alpha = 0.966$, which substantially exceeds the accepted threshold of 0.70 (Nunnally & Bernstein, 1994). The very high α value may partly reflect item similarity within dimensions, which is a recognized limitation; however, inter-item overlap is expected given the targeted domain structure. A summary of all item-level validity results is provided in Table 1.

Table 1. Instrument Validity and Reliability Summary

Item	r-Value	r-Critical	Sig.	Status	Cronbach's α
P1	0.779	0.339	0.000	Valid	0.966 (Highly Reliable)
P2	0.507	0.339	0.002	Valid	
P3	0.696	0.339	0.000	Valid	
P4	0.539	0.339	0.001	Valid	
P5	0.767	0.339	0.000	Valid	
P6	0.752	0.339	0.000	Valid	
P7	0.874	0.339	0.000	Valid	
P8	0.837	0.339	0.000	Valid	
P9	0.823	0.339	0.000	Valid	
P10	0.872	0.339	0.000	Valid	
P11	0.757	0.339	0.000	Valid	
P12	0.854	0.339	0.000	Valid	
P13	0.760	0.339	0.000	Valid	
P14	0.722	0.339	0.000	Valid	
P15	0.804	0.339	0.000	Valid	
P16	0.738	0.339	0.000	Valid	
P17	0.888	0.339	0.000	Valid	
P18	0.845	0.339	0.000	Valid	
P19	0.905	0.339	0.000	Valid	
P20	0.873	0.339	0.000	Valid	

Data Analysis

Data were analyzed using descriptive statistics, computed as follows: (1) item mean = $\Sigma(\text{item scores})/n$; (2) subdimension mean = $\Sigma(\text{item means within subdimension})/\text{number of items}$; (3) dimension mean = $\Sigma(\text{item means within dimension})/\text{number of items}$; (4) overall mean = $\Sigma(\text{all item means})/20$. Score categories followed mean interval conventions: Very Low (1.00–1.80), Low (1.81–2.60), Moderate (2.61–3.40), High (3.41–4.20), and Very High (4.21–5.00). No missing data were identified in the final dataset. All analyses were conducted using

SPSS version 26 and independently verified using Python (pandas). Frequency distributions for each response category are reported alongside means to strengthen interpretive transparency. Causal language is intentionally avoided, consistent with the descriptive design.

RESULTS AND DISCUSSION

Overall Student Perceptions

Physics Education students at UNIMED demonstrated generally positive perceptions toward the potential of *infused water* as a

companion to the MBG program. Descriptive analysis yielded an overall mean of $M=4.07$

($SD=0.70$), categorized as **High**. Table 2 summarizes results by dimension.

Table 2. Descriptive Analysis Summary by Dimension

Dimension	Mean	SD	Category
Cognitive (P1–P12)	4.06	0.68	High
Affective (P13–P16)	4.28	0.67	Very High
Behavioral (P17–P20)	3.91	0.72	High
Overall	4.07	0.70	High

The distribution of perception categories across respondents showed that 14 students (42.4%) fell in the Very High category, 14 (42.4%) in the High category, 4 (12.1%) in the Moderate category, and 1 (3.0%) in the Low category. No respondents were in the Very Low category. These proportions confirm the predominantly positive perceptual profile of the sample, while

also acknowledging that a minority of students expressed moderate or lower agreement.

Cognitive Dimension

The cognitive dimension yielded an overall mean of $M=4.06$ (High), indicating that students hold substantial factual and conceptual knowledge about *infused water*. Table 3 presents subdimension-level results.

Table 3. Cognitive Dimension Results by Subdimension

Level	Subdimension	Items	Mean	Category
C1	Remembering	P1, P2	4.26	Very High
C2	Understanding	P3, P4	4.15	High
C3	Applying	P5, P6	3.91	High
C4	Analyzing	P7, P8	4.18	High
C5	Evaluating	P9, P10	4.02	High
C6	Creating	P11, P12	3.85	High

The Remembering subdimension (C1) achieved the highest cognitive mean ($M=4.26$, Very High), suggesting that students can readily identify the definition, basic composition, and general characteristics of *infused water*. This is consistent with Hallak et al. (2022), who found that individuals with health-oriented information exposure tend to hold stronger factual knowledge of healthy beverage attributes. The Analyzing subdimension (C4) also scored relatively high ($M=4.18$), reflecting students' capacity to critically examine *infused water* composition—a capacity plausibly linked to their physics and chemistry background in diffusion principles and solution properties.

Conversely, the Creating subdimension (C6)

received the lowest cognitive score ($M=3.85$). Although still categorized as High, this relative gap suggests that higher-order creative tasks, such as designing novel *infused water* formulas, require more intensive practical engagement than this population has thus far encountered. This finding is consistent with the general principle that higher-order knowledge demands experiential reinforcement (Bernacka et al., 2022; Ridho, et al., 2025).

Affective Dimension

The affective dimension yielded the highest mean ($M=4.28$, Very High), reflecting strong emotional endorsement of *infused water* as a potential MBG beverage companion. Table 4 presents subdimension-level results.

Table 4. Affective Dimension Results by Subdimension

Item	Subdimension	Mean	SD	Category
P13	Interest	4.15	0.75	High
P14	Willingness	4.33	0.76	Very High
P15	Support	4.27	0.73	Very High
P16	Assessment	4.36	0.79	Very High

The Assessment subdimension (P16) registered the highest mean ($M=4.36$), followed by Willingness ($M=4.33$), Support ($M=4.27$), and Interest ($M=4.15$). Three of four subdimensions fell in the Very High category. The affective

dimension's dominance over the cognitive and behavioral dimensions is notable: it suggests that students hold stronger emotional and evaluative endorsement of *infused water* than they do practical behavioral capacity. This affective–

behavioral gap—where attitudes outpace action—is well documented in health behavior research and may reflect limited prior hands-on experience with preparing or evaluating *infused water*.

These findings are consistent with Hallak et al. (2022), who found that health-oriented individuals tend to rate healthy beverages more favorably. Hallez et al. (2023) further affirm that health perceptions are shaped not only by product content but by how products are framed and contextualized—suggesting that science-

based framing of *infused water* in an academic setting may reinforce positive affective responses. Drolet-Labelle et al. (2025) additionally establish that social norms and environmental context shape beverage perceptions, which may explain why students in a science education community express particularly strong endorsement.

Behavioral Dimension

The behavioral dimension obtained a mean of $M=3.91$ (High), the lowest among the three dimensions. Table 5 presents subdimension-level results.

Table 5. Affective Dimension Results by Subdimension

Item	Subdimension	Mean	SD	Category
P17	Making	3.97	0.77	High
P18	Selecting Ingredients	3.97	0.82	High
P19	Presenting	3.85	0.83	High
P20	Evaluating Quality	3.85	0.87	High

Making and Selecting Ingredients scored highest within the behavioral dimension ($M=3.97$ each), while Presenting and Evaluating Quality were slightly lower ($M=3.85$ each). All subdimensions remained in the High category. The relative gap between affective ($M=4.28$) and behavioral ($M=3.91$) dimensions indicates that students' willingness and support are not yet fully matched by hands-on practical capacity. This is understandable: the current physics education curriculum does not explicitly include *infused water* preparation activities. Oddo et al. (2022) similarly observed that even when nutritional knowledge improves through educational intervention, practical implementation remains a persistent challenge outside the school context.

Educational Implications and Program Implications

These findings carry two distinct sets of implications, which are discussed separately to maintain analytical clarity. From an *educational perspective*, the affective-behavioral gap identified in this study suggests that practical training programs—such as structured *infused water* preparation workshops integrated into General Chemistry or Physics practicum courses—could help bridge the gap between students' positive attitudes and their practical capability. The topic offers genuine interdisciplinary value: it situates diffusion principles, solute concentration, and bioactive compound extraction within an everyday health context, consistent with the interdisciplinary approach advocated by Ridho,

et al. (2025) and Oddo et al. (2022). Such integration should be piloted and evaluated before broad curriculum adoption.

From an *MBG program perspective*, the present study provides perception-based evidence that Physics Education students regard *infused water* as a potentially suitable low-sugar beverage companion within MBG. This academic endorsement may support initial advocacy discussions. However, program implementation would require consideration of practical factors including hygiene standards, standardized preparation protocols, ingredient safety, cost per serving, and school facility readiness (Kamin et al., 2022; Wang et al., 2024; Zhu et al., 2021). Health benefit claims should be stated cautiously: laboratory evidence suggests that natural infusion ingredients may contain antioxidant compounds (Bernacka et al., 2022; Garcia-Montalvo et al., 2022), and naturally enriched waters may contribute to certain mineral intake (Pop et al., 2023); however, large-scale clinical evidence for direct health outcomes remains limited (Dhillon et al., 2024; Purwanti & Indarto, 2021). *Infused water's* primary advantage over SSBs—the absence of added sugar—is well-established and particularly relevant given the documented urgency of reducing sugar intake in school-age populations (Ra, 2022; Sievenpiper et al., 2025).

CONCLUSION

This study found that Physics Education students at Universitas Negeri Medan held positive perceptions of *infused water* as a possible

healthy beverage companion to the MBG program. The affective dimension was the strongest ($M=4.28$, Very High), indicating that students support the concept strongly. The cognitive dimension was also high ($M=4.06$), while the behavioral dimension was comparatively lower ($M=3.91$), suggesting that practical training is needed before any wider educational implementation. The instrument was valid and highly reliable ($\alpha=0.966$). Given the small sample from a single institution, these findings are perception-based and exploratory; they do not provide a basis for direct policy prescription, but may inform future pilot studies and curriculum development discussions.

RECOMMENDATION

Based on these findings, the following recommendations are offered to different stakeholders:

For *teachers and curriculum developers*: consider piloting *infused water* preparation as a contextual practicum activity within General Chemistry or Physics courses, connecting diffusion and solution concepts to everyday health applications. Pilot activities should include structured evaluation of student outcomes before broader curriculum adoption.

For *MBG program stakeholders*: this study provides initial perception-based support for exploring *infused water* as a low-sugar beverage option. Before implementation, a formal pilot program should assess hygiene feasibility, standardized recipes, cost-effectiveness, ingredient safety verification, and student acceptance in actual school settings.

For *future researchers*: studies should expand sampling to multiple institutions and programs using mixed methods, examine potential demographic moderators of perception, and employ experimental or quasi-experimental designs. Collaboration with nutrition and public health experts is recommended to assess the actual health impact of regular *infused water* consumption among school-age populations.

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