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Analysis of Global Competence of Gifted Students in Science in the ASEAN+3 Region*

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〈Abstract〉

The ASEAN Plus Three Junior Science Odyssey (APT JSO) brings together gifted middle school students to tackle global challenges such as climate change. Over one week, participants collaborate in international teams to analyze environmental issues and present their findings. This study evaluates changes in Global Competence and Attitudes Toward Science before and after the program using a mixed-methods approach. Pre- and post-program surveys revealed statistically significant improvements ($p < 0.05$) in Global Competence, particularly in self-efficacy on global issues, perspective-taking, adaptability, intercultural awareness, and environmental awareness. However, the program had a limited effect on participants' attitudes toward science. The findings highlight the importance of integrating cross-cultural collaboration into STEM education and provide recommendations for further enhancing global competency development in gifted science programs.

key words: global competence, attitudes toward science, ASEAN+3, Junior Science Odyssey

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I. Introduction

The ASEAN+3 Center for the Gifted in Science (ACGS) was founded in 2010 as a collaborative platform to nurture young talent in science and technology across ASEAN+3 countries, equipping them for leadership roles in scientific and technological advancement. ACGS aims to foster international cooperation and cultivate global competencies among gifted students in science.

One of its flagship initiatives is the ASEAN Plus Three Junior Science Odyssey (APT JSO), unites scientifically gifted middle school students to address global challenges through collaborative problem-solving.

Providing gifted middle school students with platforms for collaboration and knowledge exchange is crucial. Many of these students experience isolation in their schools due to their intense focus on science and technology, often being perceived as "different" by their peers. APT JSO offers a supportive environment where these students can share their interests while engaging in intellectually stimulating activities.

In 2024, the 10th APT JSO was hosted in Siem Reap, Cambodia, bringing together over 100 middle school students from ASEAN+3 countries. Participants engaged in a week-long program focused on climate change, working in international teams to devise solutions to environmental challenges, and presenting their findings to a panel of experts.

Climate change and sustainability are global challenges that demand international cooperation. These critical issues highlight the interconnected nature of the world and underscore the necessity of global competence among future scientists. APT JSO provides a unique educational setting where young researchers can develop essential scientific and cross-cultural competencies while enhancing their teamwork and communication skills.

This study evaluates the impact of APT JSO on participants' global competence and attitudes toward science. The following research questions guide the investigation:

1. How do participants' global competence and attitudes toward science evolve before and after participating in APT JSO?

2. Are there gender differences in the changes in global competence and attitudes toward science following participation in the program?

II. Literature Review

In today's rapidly evolving world, fostering global competence and a positive attitude toward science among students is essential for preparing them to navigate complex global challenges. Middle school students, at a critical stage in their cognitive and ethical development, benefit significantly from educational approaches that promote interest in science topics, enjoyment of learning science, motivation to learn science, and the development of sophisticated epistemic beliefs about science. Additionally, global competence enables students to critically examine global issues, appreciate diverse perspectives, and take responsible action toward sustainability (OECD, 2018). For gifted students, whose cognitive abilities and critical thinking skills are more advanced, cultivating these attitudes provides an opportunity to engage with scientific and global issues at a deeper level, fostering leadership in scientific and societal endeavors (Ayaydın et al., 2018).

The integration of global competence in science education is crucial for preparing students to solve real-world problems through interdisciplinary and cross-cultural collaboration. For example, a pilot project connecting Australian and U.S. pre-service teachers demonstrated the value of cross-cultural collaboration in science education (Rogers et al., 2003). By engaging in international dialogues, students and teachers developed a broader perspective on scientific and global challenges, highlighting the importance of incorporating global learning initiatives into curricula. Similarly, the OECD's PISA framework emphasizes the role of global competence in understanding scientific literacy and addressing contemporary scientific issues in a globalized context (OECD, 2020).

Students' attitudes toward science encompass their interest in science topics, enjoyment of learning science, motivation to learn science, and epistemic beliefs about science. These attitudes significantly influence their engagement and achievement in science education. A meta-analysis by Lee & Kwon (2021) found a positive and moderate relationship between attitude toward science and learning achievement, indicating that fostering positive attitudes can enhance academic performance. Intrinsic motivation and sophisticated epistemic beliefs have been identified as predictors of higher science achievement, as they encourage deeper engagement with scientific content (Lau & Ho, 2020). Moreover, students' attitudes toward science are positively related to cooperative teaching strategies, such as group work and small-group projects, which can enhance their learning experiences (Wang et al., 2019).

Research indicates that gifted students often exhibit more positive attitudes toward science compared to their non-gifted peers. A study by Köksal (2013) compared academically advanced science students and gifted students, finding that both groups displayed high levels of motivation toward science learning and positive attitudes toward science. This suggests that gifted students possess a strong intrinsic motivation and favorable disposition toward science education. However, a study exploring the science attitudes of urban diverse gifted middle school students revealed a lack of interest in science among 6th and 8th graders, particularly among minority students (Gilson, 2014). This highlights the need for culturally responsive teaching practices that can engage diverse gifted students and foster positive attitudes toward science.

Recent studies have highlighted the positive impact of targeted educational programs on students' environmental attitudes and scientific creativity. Çalışıcı & Benzer (2021) implemented STEM-based activities with 8th-grade students, resulting in enhanced environmental awareness, improved problem-solving skills, and increased science achievement. Similarly, Ceylan (2022) conducted a waste management-themed summer program for gifted students, which led to significant improvements in their environmental attitudes, creative thinking abilities, and critical thinking dispositions. These findings underscore the effectiveness of integrating environmental themes into educational curricula to foster global competence among students.

Participating in global collaborative science inquiry projects offers gifted students unique opportunities to enhance their global competence and attitudes toward science. By working in cross-country teams to address scientific and societal challenges, these students engage in authentic, interdisciplinary problem-solving that transcends cultural and geographical boundaries. Such experiences not only deepen their understanding of scientific concepts but also foster critical thinking, creativity, and collaboration skills essential for future leadership in STEM and sustainability efforts.

Research indicates that gifted students possess advanced cognitive abilities that enable them to approach complex global and scientific problems with innovative solutions. For instance, Akhan et al. (2022) found that gifted students demonstrated critical and creative perspectives when analyzing global climate change issues, highlighting their potential to contribute meaningfully to scientific discourse. Engaging in international collaborative projects further amplifies these capabilities by exposing students to diverse perspectives and problem-solving approaches.

Global collaborative science inquiry projects such as APT JSO can serve as a powerful pedagogical approach for gifted students, enriching their educational experience and preparing them to become proactive leaders in addressing environmental challenges.

III. Methods

1. Research participants

Participants of APT JSO were junior high school students aged 13 to 15. They were selected as national delegates through a domestic selection process.

To address the research questions, pre- and post-program surveys on Global Competence and Attitudes Toward Science were administered to all APT JSO attendees (N = 112). Survey participation was voluntary, and 83 students completed the surveys, resulting in a response rate of 74.1%.

Among the respondents, 39 were male (49.0%), 41 were female (49.4%), and 3 did not disclose their gender (3.6%). The number of participants per country ranged from 5 to 11 students (see Table 1).

Table 1. Characteristics of Study Participants (N = 83)

	n	%
Gender		
Male	39	47.0
Female	41	49.4
No answer	3	3.6
Country		
Brunei Darussalam	6	7.2
Cambodia	11	13.3
China	9	10.8
Indonesia	6	7.2
Korea	8	9.6
Lao PDR	6	7.2
Malaysia	6	7.2
Myanmar	8	9.6
Philippines	6	7.2
Singapore	6	7.2
Thailand	6	7.2
Viet Nam	5	6.0

2. Data collection

Survey questionnaires were administered to assess students' Global Competence and Attitudes Toward Science before and after participating in the program. Both instruments were adapted from the PISA 2018 student questionnaire (OECD PISA 2018 Database).*

(1) Global Competence

Global Competence was assessed using survey instruments adapted from the PISA 2018 student questionnaire, measuring key dimensions such as openness to other cultures, respect for cultural diversity, interest in global issues, perspective-taking, adaptability, and intercultural communication skills, providing insight into students' attitudes and perceptions toward global and intercultural interactions. The reliability of the Global Competence scales was evaluated using Cronbach's alpha, ranging from .774 to .921, indicating acceptable to excellent internal consistency.

Table 2. Reliability of Global Competence Scale

	No of items	Scale	Cronbach's alpha
Self-efficacy regarding global issues	6	4 points	.833
Awareness of global issues	7	4 points	.853
Environmental awareness	7	4 points	.876
Perspective-taking	5	5 points	.787
Adaptability	6	5 points	.877
Awareness of intercultural communication	7	4 points	.921
Interest in learning about other cultures	4	5 points	.901
Respect for people from other cultural backgrounds	5	5 points	.910
Global Mindedness	6	4 points	.774

(2) Attitudes Toward Science

Attitudes Toward Science were assessed using survey instruments adapted from the

* https://www.oecd.org/en/data/datasets/pisa-2018-database.html#questionnaires

PISA 2018 student questionnaire, measuring key dimensions such as interest in broad science topics, enjoyment of learning science, students' instrumental motivation to learn science, and epistemic beliefs about science, providing insight into students' perceptions and engagement with scientific learning. The reliability of the Attitudes Toward Science scales was evaluated using Cronbach's alpha, ranging from .649 to .937, indicating acceptable to excellent internal consistency.

Table 3. Reliability of Attitudes Toward Science Scale

	No of items	Scale	Cronbach's alpha
Interest in broad science topics	5	4 points	.649
Enjoyment of learning science	5	4 points	.919
Students' instrumental motivation to learn science	4	4 points	.937
Epistemic beliefs about science	6	4 points	.856

3. Data analysis

The differences in Global Competence and Attitudes Toward Science before and after participation in APT-JSO program were analyzed to assess the program's effectiveness using a paired-sample *t*-test with a total of 75 respondents who completed both pre- and post-surveys. Additionally, an independent t-test was conducted to examine gender differences in Global Competence and Attitudes Toward Science.

All analyses were conducted using jamovi Desktop application (https://www.jamovi.org/).

IV. Results

1. Changes in Global Competence and Attitudes Toward Science Before and After the Program

The results of the paired-sample *t*-test showed significant improvements in students' Global Competence after participating in the APT-JSO program (see Table 4). Self-efficacy regarding global issues increased from a mean score of M = 3.06 (SD = 0.580) to M = 3.36 (SD = 0.584), and awareness of global issues also improved from M =

3.10 (SD = 0.556) to M = 3.45 (SD = 0.501), both showing statistical significance with $p < 0.001$. Environmental awareness increased from M = 3.25 (SD = 0.619) to M = 3.51 (SD = 0.530), and perspective-taking showed the most notable change, rising from M = 3.93 (SD = 0.705) to M = 4.36 (SD = 0.780). Adaptability increased from M = 3.92 (SD = 0.769) to M = 4.27 (SD = 0.735), and awareness of intercultural communication also improved from M = 3.21 (SD = 0.654) to M = 3.48 (SD = 0.509). The results indicate that students became more confident in addressing global issues, more aware of environmental challenges, and better at understanding different perspectives and adapting to new cultural contexts.

Interest in learning about other cultures increased slightly from M = 4.31 (SD = 0.873) to M = 4.49 (SD = 0.840), but the change was not statistically significant($p = 0.079$). Similarly, respect for people from other cultural backgrounds remained largely unchanged($p = 0.517$), with pre- and post-survey scores of M = 4.65 (SD = 0.609) and M = 4.71 (SD = 0.613), respectively. However, global mindedness showed a small but significant improvement from M = 3.31 (SD = 0.443) to M = 3.45 (SD = 0.574). These results suggest that while students gained a deeper understanding of global and environmental issues, their pre-existing attitudes toward cultural diversity and respect remained stable.

Table 4. *t*-test Results Comparing Pre and Post Global Competence Level

Global Competence	Pre-survey		Pots-survey		*t*	*p*
	M	SD	M	SD		
Self-efficacy regarding global issues	3.06	0.580	3.36	0.584	-4.796***	0.000
Awareness of global issues	3.10	0.556	3.45	0.501	-5.753***	0.000
Environmental awareness	3.25	0.619	3.51	0.530	-4.203***	0.000
Perspective-taking	3.93	0.705	4.36	0.780	-8.000***	0.000
Adaptability	3.92	0.769	4.27	0.735	-4.135***	0.000
Awareness of intercultural communication	3.21	0.654	3.48	0.509	-3.693***	0.000
Interest in learning about other cultures	4.31	0.873	4.49	0.840	-1.779	0.079
Respect for people from other cultural backgrounds	4.65	0.609	4.71	0.613	-0.651	0.517
Global Mindedness	3.31	0.443	3.45	0.574	-2.117*	0.038

****p<.001, **p<.01, *p<.05*

The paired-sample *t*-test results for Attitudes Toward Science showed moderate to minor improvements after the program(see Table 5). Interest in broad science topics increased slightly from M = 3.31 (SD = 0.485) to M = 3.33 (SD = 0.526), but the change was not statistically significant. Enjoyment of learning science increased from M = 3.42 (SD = 0.605) to M = 3.57 (SD = 0.551), with a marginal significance level of p = 0.066. Instrumental motivation to learn science showed almost no change, with pre- and post-survey scores of M = 3.42 (SD = 0.710) and M = 3.39 (SD = 0.800), respectively. However, epistemic beliefs about science improved significantly, increasing from M = 3.45 (SD = 0.510) to M = 3.55 (SD = 0.453), indicating that students developed a stronger understanding of the nature of scientific knowledge.

Table 5. *t*-test Results Comparing Pre and Post Attitudes Toward Science Level

Attitudes Toward Science	Pre-survey		Pots-survey		*t*	*p*
	M	SD	M	SD		
Interest in broad science topics	3.31	0.485	3.33	0.526	-0.338	0.079
Enjoyment of learning science	3.42	0.605	3.57	0.551	-1.869	0.066
Students' instrumental motivation to learn science	3.42	0.710	3.39	0.800	0.264	0.793
Epistemic beliefs about science	3.45	0.510	3.55	0.453	-2.346*	0.022

*$p<.05$

Overall, the findings suggest that the APT-JSO program had a positive impact on students' Global Competence, particularly in increasing self-efficacy, awareness of global and environmental issues, and perspective-taking. However, while some improvements were observed in students' Attitudes Toward Science, the changes were generally smaller, with epistemic beliefs showing the most significant growth. These results indicate that while the program was effective in enhancing global awareness and intercultural understanding, its influence on students' interest and motivation in science was more limited.

2. Gender Differences in Global Competence and Attitudes Toward Science

The results of the independent *t*-test for Global Competence showed significant gender differences in certain sub-dimensions before participating in the APT-JSO program(see Table 6). In the pre-survey, females reported significantly higher self-efficacy regarding global issues (M = 3.17, SD = 0.667) compared to males (M = 2.92, SD = 0.438), $t(73) = -2.000$, p = 0.049. Environmental awareness was also significantly higher among females (M = 3.39, SD = 0.579) than males (M = 3.05, SD = 0.610), $t(73) = -2.527$, $p = 0.014$. However, no significant gender differences were found in awareness of global issues, perspective-taking, adaptability, awareness of intercultural communication, interest in learning about other cultures, respect for people from different backgrounds, or global mindedness ($p > 0.05$).

In the post-survey, no statistically significant gender differences were found across all dimensions of Global Competence ($p > 0.05$). The results suggest that while males showed weaker self-efficacy in global issues and environmental awareness before the program, the APT-JSO program contributed to reducing these differences, leading to comparable levels of Global Competence between male and female participants after the program.

Table 6. *t*-test Results Comparing Males ad Females on Global Competence Level

Global Competence	Males		Females		*t*	*p*
	M	SD	M	SD		
Pre Survey						
Self-efficacy regarding global issues	2.92	0.438	3.17	0.667	-2.000*	0.049
Awareness of global issues	2.98	0.596	3.18	0.524	-1.564	0.122
Environmental awareness	3.05	0.610	3.39	0.579	-2.527*	0.014
Perspective-taking	3.88	0.634	4.00	0.762	-0.782	0.437
Adaptability	3.81	0.789	4.03	0.716	-1.268	0.209
Awareness of intercultural communication	3.11	0.664	3.31	0.612	-1.387	0.169
Interest in learning about other cultures	4.35	0.875	4.28	0.838	0.337	0.737
Respect for people from other cultural backgrounds	4.64	0.727	4.64	0.474	-0.021	0.983
Global Mindedness	3.30	0.399	3.28	0.499	0.197	0.844

Post Survey						
Self-efficacy regarding global issues	3.37	0.569	3.36	0.605	0.077	0.939
Awareness of global issues	3.38	0.566	3.52	0.419	-1.219	0.227
Environmental awareness	3.44	0.614	3.59	0.423	-1.243	0.218
Perspective-taking	4.38	0.736	4.34	0.829	0.222	0.825
Adaptability	4.33	0.587	4.22	0.854	0.631	0.530
Awareness of intercultural communication	3.42	0.594	3.54	0.413	-0.958	0.341
Interest in learning about other cultures	4.66	0.550	4.33	1.020	1.735	0.087
Respect for people from other cultural backgrounds	4.78	0.349	4.65	0.786	0.939	0.351
Global Mindedness	3.53	0.465	3.38	0.659	1.183	0.240

*$p<.05$

The independent t-test results for Attitudes Toward Science indicated no significant gender differences in most sub-dimensions before and after the program. In the pre-survey, interest in broad science topics was slightly higher for females (M = 3.35, SD = 0.517) than males (M = 3.20, SD = 0.456), but this difference was not statistically significant, $t(73) = -1.342$, $p = 0.183$. Enjoyment of learning science, students' instrumental motivation to learn science, and epistemic beliefs about science also showed no significant gender differences before the program ($p > 0.05$).

In the post-survey, gender differences remained statistically non-significant in all measured aspects of Attitudes Toward Science ($p > 0.05$). These findings indicate that both male and female students exhibited similar levels of interest, enjoyment, and motivation toward science learning, and that the APT-JSO program did not lead to any substantial shifts in these gender-related differences (see Table 7).

Overall, the results suggest that while initial gender differences were observed in certain aspects of Global Competence, particularly self-efficacy and environmental awareness, these differences diminished after the program. Meanwhile, no significant gender disparities were found in students' attitudes toward science, both before and after the program, indicating that male and female students shared similar perspectives on science learning throughout their participation.

Table 7. *t*-test Results Comparing Males ad Females on Attitudes Toward Science Level

Attitudes Toward Science	Males		Females		*t*	*p*
	M	SD	M	SD		
Pre Survey						
Interest in broad science topics	3.20	0.456	3.35	0.517	-1.342	0.183
Enjoyment of learning science	3.34	0.490	3.50	0.674	-1.265	0.210
Students' instrumental motivation to learn science	3.28	0.725	3.42	0.799	-0.823	0.413
Epistemic beliefs about science	3.42	0.401	3.48	0.580	-0.469	0.641
Post Survey						
Interest in broad science topics	3.25	0.482	3.41	0.561	-1.313	0.193
Enjoyment of learning science	3.53	0.509	3.61	0.591	-0.645	0.521
Students' instrumental motivation to learn science	3.36	0.823	3.42	0.789	-0.298	0.766
Epistemic beliefs about science	3.50	0.505	3.60	0.401	-0.946	0.347

V. Discussion

The findings of this study indicate that participation in the APT-JSO program significantly improved students' Global Competence, particularly in self-efficacy regarding global issues, awareness of environmental challenges, and perspective-taking. These results align with previous research highlighting the importance of international collaboration in science education (OECD, 2018). The statistically significant increase in adaptability and intercultural communication awareness suggests that engaging in cross-cultural teamwork fosters a more open and flexible mindset among gifted students. The program provided an opportunity for participants to collaborate with peers from diverse cultural backgrounds, which likely enhanced their ability to navigate and appreciate different perspectives. These findings reinforce the idea that global science programs can be effective in developing key competencies necessary for addressing international scientific challenges.

While notable improvements were observed in Global Competence, the program had a more limited impact on students' Attitudes Toward Science. The results showed only minor increases in students' interest in broad science topics and enjoyment of learning science, with no significant change in instrumental motivation to learn science. However, epistemic beliefs about science did show statistically significant growth, suggesting that the program contributed to a deeper understanding of the nature of scientific knowledge. This finding aligns with Ozdeniz and Aktamis (2025), who found a positive relationship between gifted students' scientific epistemological beliefs and their awareness of climate change, indicating that an enhanced understanding of scientific knowledge correlates with greater awareness of global issues. Similarly, exposure to real-world scientific problems has been shown to enhance students' appreciation for the role of science in addressing global challenges (Lau & Ho, 2020). Additionally, Yılmaz and Emir (2024) found that gifted students exhibit higher levels of 21st-century skills and climate literacy compared to their undiagnosed peers, suggesting that programs like APT-JSO, which emphasize international collaboration and scientific inquiry, may enhance these competencies. Despite this, the relatively modest changes in science attitudes suggest that short-term programs like APT-JSO may not be sufficient to significantly influence students' long-term motivation and interest in science.

Gender differences in Global Competence were evident in some of the pre-survey results, with female students reporting higher self-efficacy in global issues and greater environmental awareness than their male counterparts. This finding is consistent with existing literature that suggests female students tend to exhibit greater concern for environmental issues and stronger global awareness (Ayaydin et al., 2023. Aydın et al., 2011). However, these gender differences were no longer significant in the post-survey, indicating that male students closed the gap after participating in the program. This suggests that structured international science experiences can help reduce initial disparities in global competence, equipping all students—regardless of gender—with a more balanced perspective on global issues.

In contrast, no significant gender differences were found in Attitudes Toward Science, both before and after the program. Male and female students reported similar levels of interest, enjoyment, and epistemic beliefs about science, reinforcing previous studies that found gifted students generally share positive attitudes toward science regardless of gender (Köksal, 2013). The lack of gender disparities in this area suggests that factors beyond short-term program participation—such as prior educational experiences and long-term exposure to science engagement opportunities—may play a larger role in shaping students' attitudes toward science. These findings highlight the need for longitudinal or follow-up studies to examine how sustained participation in international science programs influences students' long-term engagement with science education and careers.

Overall, the results underscore the importance of integrating global science programs into gifted education, as they can significantly enhance students' global competence while also contributing to their understanding of science as a global discipline. While the APT-JSO program effectively improved students' awareness and adaptability in cross-cultural contexts, its impact on science attitude and motivation remained limited. Future programs could incorporate longer-term interventions, mentorship opportunities, and hands-on science projects to foster deeper engagement with science learning. Additionally, expanding these initiatives to a broader range of students beyond those identified as gifted could help cultivate a larger cohort of scientifically literate global citizens equipped to tackle pressing environmental and scientific challenges.

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