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Teaching climate change adaptation to special education learners in Cebu

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ABSTRACT

The study investigated the SpEd teachers' methods, difficulties, and experiences in teaching children with disabilities in relation to climate change adaptation during the 2023–2024 school year in Cebu. This descriptive correlational research involved 126 purposively selected special education teachers from different school divisions in Cebu who completed a survey tool. Ethical considerations were observed before, during, and after the data collection process. The gathered data were analyzed using descriptive statistics and correlation analysis. Results indicate that the level of implementation of climate change adaptation strategies by special education (SpEd) teachers in their classrooms is moderate. The obstacles faced by SpEd teachers in mainstreaming climate change adaptation are significant, including the lack of SpEd-friendly instructional materials, inadequate funding for climate-related materials, and the absence of standard curricula. The level of adaptive teaching strategies developed by SpEd teachers was found to be low to moderate, with emphasis on visual storytelling, interactive role-playing, and assistive technologies. There is no significant relationship between the level of teaching strategies implemented by SpEd teachers and the challenges they face in integrating climate change adaptation concepts into their curriculum. Teachers recognize the importance of incorporating climate adaptation education into their curriculum, but encounter numerous obstacles. These findings underscore the need for effective organizational support, targeted professional development, and differential resources for special education to adequately address the complexities surrounding climate change mitigation.

Contribution/Originality: This study will provide valuable insights that can assist educators, curriculum developers, and policymakers in the development of inclusive and practicable solutions for teaching climate change adaptation to learners with a variety of needs in the Philippines.

1. INTRODUCTION

It has been rapidly recognized that climate change is a crucial issue, with a worldwide spread, causing selective effects on the more vulnerable ones, such as persons with disabilities (Jodoin, Ananthamoorthy, & Lofts, 2020). The increasing frequency and severity of climate-related disruptions make education focused on climate adaptation critical for preparing people with the tools and skills they need to respond effectively. Despite continued attempts to integrate climate change education into formal curricula, students with disabilities often face significant obstacles to ensure they have access to this essential education (Roderick, 2023). Students in special education (SpEd) confront challenges due to cognitive, sensory, and motor impairments, which indicate a necessity for personalized teaching and flexible learning models (Batool, 2020).

An inclusive climate adaptation education that meets the broad spectrum of student learning needs among those with disabilities is essential and vital (Dupuis & Jacobs, 2021). However, SpEd teachers encounter many barriers, such as limited access to educational resources, inadequate training in environmental instruction, and lack of institutional support (Pocaan, 2022). To meet these challenges, there is a need for an organized and evidence-informed process for incorporating special education into climate change initiatives.

The United Nations Sustainable Development Goals also emphasize the need for inclusive and equitable quality education (Goal 4) as well as climate action (Goal 13). While there is a worldwide movement to integrate climate education within educational curricula, students with disabilities are a segment of children left behind within mainstream models of climate adaptation (King & Gregg, 2022). It is due to: the lack of SpEd-friendly resources, unprepared teachers, and lack of inter-disciplinary articulation (Santaolalla, Urosa, Martín, Verde, & Díaz, 2020). In addition, the existing studies on climate adaptation education mainly concentrate on general education, which ignores how SpEd teachers encounter instructional barriers and overcome obstacles (Pak, Polikoff, Desimone, & Saldívar García, 2020).

This study examines the techniques and challenges faced by SpEd teachers in Cebu regarding climate change adaptation. While there are existing studies on the K to 12 curriculum in Cebu City, gaps remain, particularly in identifying the teaching techniques, strategies, and problems encountered by SpEd teachers in climate change adaptation instruction. This study seeks to answer the following questions: What is the extent of teaching strategies utilized by SpEd teachers in teaching students with disabilities about climate change adaptation in relation to: adaptations in instruction and differentiated instruction design; use of sensory-based and assistive learning materials; community involvement; experiential learning activities; and collaboration with environmental groups, parents, and school administration? Second, what difficulties do SpEd teachers face in incorporating climate change adaptation into their regular curriculum, such as: availability and accessibility of climate change-related instructional materials; teacher preparedness and training in environmental education; student participation and cognitive understanding level; institutional and policy support for climate-focused SpEd programs? Third, what are the adaptive teaching strategies that help SpEd teachers navigate these challenges? Lastly, is there a notable correlation between the level of teaching methods used by SpEd teachers and the difficulties they encounter in incorporating climate change adaptation concepts in their lessons? The results of this study will provide a foundation for policy recommendations, instructional modifications, and partnerships to increase the accessibility of climate education for SpEd learners and contribute to a more inclusive, sustainable future.

2. LITERATURE REVIEW

Inclusion of climate change adaptation in educational curricula helps in nurturing students' environmental consciousness, perception, and adaptability (Iqbal & Khan, 2020). Schools play a critical role in providing students with the knowledge, attitudes, and skills required to reduce the risks of climate change and participate in local adaptation initiatives (Ismail, Ali, & Yasukawa, 2024). Studies that address climate change education (CCE) in general education are numerous (Hung, 2022), but few studies have examined the integration of climate change education practices in special education (SpEd).

A range of pedagogical approaches has been advocated to improve climate change education, such as inquiry-based approaches (Brumann, Ohl, & Schulz, 2022), problem-based methods (Cross & Congreve, 2021), and experiential learning (Siegner & Stapert, 2020). Field-based activities and tangible treatments come alive and captivate students' interests while helping students form a better understanding of climate issues (MacKay, Tran, & Lunstrum, 2021). Interactive media and gamification as effective tools in climate change education are increasingly emerging in formal educational settings (Brannon, Gold, Magee, & Walton, 2024). Nevertheless, these pedagogical approaches are scarcely examined in special education environments where personalized learning, multimodal interaction, and the use of assistive technologies are essential (Nyakoe, 2024).

Pedagogical techniques for special education students must adhere to Universal Design for Learning (UDL) principles that accommodate diverse learner demands (Rao, 2021). However, research on UDL-based interventions in climate education is markedly deficient, consequently disadvantaging SpEd students (Saffar, 2020). The incorporation of assistive learning technologies is a key factor in improving access to education for students with disabilities (Fernández-Batanero, Montenegro-Rueda, Fernández-Cerero, & García-Martínez, 2022). Further, sensory-based instruction has been found to make a substantial difference in the retention as well as engagement of learners with learning disabilities (Bhatnagar, 2023; Skalitzky, 2023). It highlights the relevance of multimodal learning materials, including tactile graphics, auditory tools, and interactive visual models, in promoting cognitive development in special education contexts. While the benefits of assistive technology in special education are well known (Hunt, 2021), there is a dearth of publications concerning the utilization of assistive technology for climate change adaptation education (Devonald, Jones, & Kajumba, 2023).

Community engagement is acknowledged as a crucial element in effective climate change education (Hügel & Davies, 2020). Participation in practical environmental activities among students leads to increased environmental responsibility (Costa, de Lucena, Christoffersen, Piñeiro-Corbeira, & Dolbeth, 2022). Experiences such as restoration projects, ecological interventions, or preparedness programs effectively foster students' adaptive capacities and practical knowledge (Ruiz-Mallén, Satorras, March, & Baró, 2022). Although these approaches have proven effective in mainstream educational practices (Oberle, Domitrovich, Meyers, & Weissberg, 2020), the research regarding their adaptation to special education (SpEd) is limited. Experiential learning from inclusion has a significant impact on engaging students with disabilities (Howell, Yell, & Katsiyannis, 2021).

A crucial problem remains the availability and accessibility of special needs learning materials (Ingavélez-Guerra, Robles-Bykbaev, Perez-Muñoz, Hilera-González, & Oton-Tortosa, 2022). Most climate resources are designed for neurotypical learners, so they may be difficult to modify for SpEd students (Dobie, 2022). Further, preparing teachers even introduces its own obstacles – many special teachers are not professionally prepared in environmental education (Ginsburg & Audley, 2020; Opuni-Frimpong, Essel, Opuni-Frimpong, & Obeng, 2022). Institutional and policy backing is uneven, and programs are therefore not realized in their potential effectiveness, despite the UN Sustainable Development Goals (SDGs) promoting inclusive education in various ways (Hope Sr, 2020; Smith, 2015; Zhao, Bojic, & Kovac-Cerovic, 2015).

Furthermore, some SpEd teachers have developed innovative methods to teach climate adaptation. Pedagogical approaches, such as social storytelling, role-playing, scaffolded learning, individualized education programs, and co-teaching, greatly contribute to enlightening and involving students (Mofield, 2019; Pompei & Cohn-Vargas, 2023; Zaic, 2021; Ziegler, Matthews, Mayberry, Owen-DeSchryver, & Carter, 2020). However, these interventions are still not evenly deployed in terms of institutional support, training, and resources (Zhao, Zhao, & Shi, 2024). Moreover, studies exploring the confluence of climate education and special education seem to lean toward theoretical frameworks rather than classroom practices (Anderson & Putman, 2019; Kosanic, Petzold, Martín-López, & Razanajatovo, 2022; Migliarini & Annamma, 2019).

3. METHODOLOGY

This research used a descriptive correlational design, a methodology aimed at understanding the relationships between variables without any manipulation (Jackson, 2009). There were 126 SpEd teacher respondents who were selected through purposive sampling technique from the division offices of Cebu City, Talisay, and Cebu Province, Department of Education, Cebu, Philippines. Makwana, Singh, Patel, and Patel (2023), explained that purposive sampling is a research technique that involves selecting individuals based on predetermined features or criteria, which in this case are: teachers who are assigned in Cebu and handle special education classes. Ethical guidelines were followed throughout the process. The survey questionnaire was distributed in person and online, through Google

Forms, to the respondents. The data gathered were organized, tallied, summarized, tabulated, and analyzed using descriptive and inferential statistics.

Table 1. Level of the climate change adaptation teaching strategies implemented in SPED classrooms.

S/N	Indicators	WM	Verbal description
1.1 Instructional adaptations and differentiated lesson planning			
1	I integrate climate change adaptation topics into my SPED lessons.	4.74	Very High
2	I modify lesson plans to cater to SPED learners' cognitive and sensory needs when teaching climate change concepts.	3.82	High
3	I use real-life examples and storytelling to help SPED learners understand climate change and its impacts.	3.88	High
4	I adapt hands-on activities to teach environmental concepts to SPED students.	3.65	High
5	I provide alternative assessments (e.g., projects, visual presentations) instead of traditional exams for climate-related lessons.	3.47	High
Weighted mean		3.71	High
1.2 Use of sensory-based and assistive learning materials			
6	I incorporate multisensory learning tools (e.g., tactile objects, videos, simulations) in my climate change lessons.	3.7	High
7	I utilize assistive technologies (e.g., speech-to-text software, adaptive visual aids) for teaching environmental topics.	3.42	High
8	I provide pictorial representations or simplified infographics to explain climate adaptation concepts.	3.55	High
9	I use outdoor learning experiences (e.g., gardening, nature walks) to engage SPED learners in climate adaptation education.	3.33	Moderate
10	I ensure that SPED learners can interact with nature safely to enhance their environmental awareness.	3.25	Moderate
Weighted mean		3.41	Moderate
1.3 Community engagement and experiential learning activities			
11	I facilitate school-based projects such as tree planting and waste segregation for SPED learners.	3.4	Moderate
12	I organize field trips or virtual learning experiences about climate adaptation.	3.15	Moderate
13	I invite environmental experts or community leaders to speak to my SPED learners about climate change.	3.07	Moderate
14	I encourage students to participate in environmental conservation activities (e.g., recycling, composting).	3.22	Moderate
15	I provide opportunities for peer collaboration in climate-related school projects.	3.3	Moderate
Weighted mean		3.23	Moderate
1.4 Collaboration with parents, specialists, and support staff			
16	I communicate regularly with parents about environmental education activities for SPED learners.	3.1	Moderate
17	I collaborate with SPED specialists and environmental advocates to create appropriate teaching strategies.	3.2	Moderate
18	I attend professional development programs related to climate education and SPED.	3.05	Moderate
19	I work with school administrators to advocate for climate education resources in SPED programs.	2.93	Moderate
20	I integrate community-based environmental initiatives into my teaching approach.	2.85	Moderate
Weighted mean		**3.02**	**Moderate**
Aggregate weighted mean		**3.35**	**Moderate**

Note: 4.21-5.00-Very High; 3.41-4.20- High; 2.61-3.40- Moderate; 1.81-2.60- Low ;1.00-1.80- Very Low

4. RESULTS AND DISCUSSION

Table 1 includes the findings on the level of teaching strategies employed by SPED instructors when instructing students with disabilities on climate change adaptation.

Instructional adaptations and differentiated lesson planning, sensory-based and assistive learning materials, community engagement and experiential learning, and collaboration with parents, specialists, and support staff are the four core areas that the table analyzes. The weighted mean (WM = 3.35) indicates a moderate degree of implementation overall, indicating that although SPED teachers are actively incorporating climate education concepts, there are still issues, especially with access to resources, collaborative problem solving, and experiential learning.

Instructional adaptations and differentiated lesson planning (WM = 3.71, High) is the highest-rated dimension, indicating the effective integration of climate change concepts, particularly through direct instruction (WM = 4.74, Very High) via experiential activities, real-life examples, and storytelling. This aligns with the findings of Loomis, Klatzky, and Giudice (2018), who emphasized the importance of employing diverse instructional strategies to meet a wide range of cognitive and sensory needs. However, alternative assessment methods such as visual projects (WM = 3.47) are underutilized, suggesting that educators should diversify assessment strategies to better accommodate individual learner differences.

Sensory-Based and Assistive Learning Materials (WM = 3.41, Moderate) demonstrate inconsistent utilization of multisensory devices and assistive technology. Students' opportunities for experiential environmental learning are restricted by physical access barriers, as evidenced by their lower scores for outdoor learning (WM = 3.33) and secure nature contact (WM = 3.25). The findings reinforce Beery and Jørgensen (2018), who emphasized that nature-based learning improves environmental awareness and sensory development, although it necessitates structured support systems and modified equipment (Bryant, Bryant, & Smith, 2019).

The Community Engagement and Experiential Learning Activities category (WM = 3.23, Moderate) indicates a lack of direct climate adaptation experiences for SPED participants. School-based initiatives (WM = 3.40) are implemented modestly, although field trips (WM = 3.15) and expert presentations (WM = 3.07) are limited, presumably due to logistical and accessibility obstacles. These data corroborate (Bennett et al., 2018), who indicated that experiential learning enhances environmental stewardship and practical skills, while mobility and communication support are crucial for students with impairments.

Educators and stakeholders' engagement was insufficient, as evidenced by the lowest rating for collaboration with parents, specialists, and support staff (WM = 3.02, moderate). A fully integrated approach is impeded by limited participation in professional development (WM = 3.05) and climate advocacy (WM = 2.93), despite some contact between teachers and parents (WM = 3.10) and collaboration with special education professionals (WM = 3.20). These findings align with Hayward (2020), who underscored that inclusive climate education necessitates active engagement from schools, families, and environmental organizations. Similarly, Zickafoose et al. (2024) emphasized that comprehensive implementation is impeded by institutional obstacles, resource limitations, and accessibility issues, even when instructors are motivated. Brown (2024) contended that augmenting teacher preparation, broadening access to assistive resources, and cultivating school-community collaborations are vital ways for promoting climate education outcomes.

The results of this study indicate that, despite the commendable efforts of SPED teachers to incorporate climate change adaptation into their teaching, systemic support, accessible resources, and collaborative structures are still essential for ensuring that learners with disabilities can fully develop climate literacy and participate in sustainability actions.

Table 2 presents the results regarding the level of challenges faced by SpEd teachers in integrating climate change adaptation concepts into their curriculum.

Table 2. Level of the challenges in integrating climate change adaptation for SPED learners.

S/N	Indicators	WM	Verbal Description
2.1 Availability and accessibility of climate change-related instructional materials			
1	There are insufficient SPED-friendly materials on climate adaptation available for classroom use.	4.35	High
2	I struggle to find age-appropriate and disability-inclusive learning resources on climate change.	3.28	High
3	The existing environmental education resources are not designed for diverse learning needs.	4.22	High
4	Funding constraints limit access to assistive technology and climate-related instructional tools.	4.43	High
5	My school does not prioritize climate education materials in SPED programs.	4.07	High
Weighted mean		4.24	High
2.2 Teacher preparedness and training in environmental education			
6	I struggle with adapting environmental education concepts for students with varying cognitive abilities.	4.02	High
7	I lack formal training in integrating climate change education into SPED teaching.	4.32	High
8	My school provides limited professional development on climate change and environmental education.	4.12	High
9	I feel unprepared to implement hands-on climate adaptation activities for SPED learners.	4.2	High
10	There is little institutional support for capacity-building in climate change education for SPED teachers.	4	High
Weighted mean		4.14	High
2.3 Student Engagement and Cognitive Comprehension Levels			
11	Some students have difficulty understanding abstract climate change concepts.	3.96	Moderate
12	Certain climate-related activities pose sensory or motor challenges for SPED learners.	3.74	Moderate
13	I struggle to maintain students' engagement in climate adaptation lessons.	3.83	Moderate
14	Cognitive and attention differences affect how students grasp environmental issues.	3.9	Moderate
15	Limited adaptive teaching strategies make it difficult to engage all students equally.	3.67	Moderate
Weighted mean		3.34	Moderate
2.4 Institutional and policy support for climate-focused SPED programs			
16	My school does not have clear policies supporting climate change education for SPED learners.	4.1	High
17	There are insufficient administrative efforts to integrate climate adaptation education into SPED curricula.	4.2	High
18	Collaboration between environmental agencies and SPED institutions is lacking.	4	High
19	SPED programs are not prioritized in broader school climate adaptation plans.	3.92	Moderate
20	There is little government funding or support for climate change education in special education.	4.3	High
Weighted mean		**4.1**	**High**
Aggregate weighted mean		**4.08**	**High**

Note: 4.21-5.00-Very High; 3.41-4.20- High; 2.61-3.40- Moderate; 1.81-2.60- Low ;1.00-1.80- Very Low

Table 2 explains the different barriers to mainstreaming climate change adaptation in the education of SPED learners along four critical dimensions: availability and accessibility of climate change-related instruction; teacher preparedness and training; student engagement and cognitive understanding; and institutional and policy support. The overall weighted mean of 4.08 (high) demonstrates that major obstacles affect the efficient implementation of climate adaptation education in the SPED setting. These challenges are especially evident in the domains of resources, teacher training, and institutional support. The most highly ranked difficulty, availability and accessibility of climate change-related instructional materials (WM = 4.24, high), underscores the deficiency of SpEd-friendly climate adaptation resources (WM = 4.35) and the insufficiency of funding for assistive technologies (WM = 4.43). Kinshuk, Chen, Cheng, and Chew (2016) suggested that effective environmental education necessitates customized teaching resources that address varied cognitive and sensory requirements in the absence of adequate resources. Mitchell and Sutherland (2020) corroborated that SPED educators find it challenging to provide accessible and impactful climate instruction. The teacher preparedness and training category (WM = 4.14, high) indicates that numerous educators perceive themselves as ill-equipped to incorporate climate change concepts into SPED instruction (WM = 4.32), attributed to insufficient professional development opportunities (WM = 4.12) and inadequate institutional support for capacity-building (WM = 4.00). Jordan, Schwartz, and McGhie-Richmond (2009) emphasized that specialized training improves and enhances teachers' confidence and their capacity to modify environmental concepts for students with disabilities. It is crucial to address this gap through organized professional development programs and interdisciplinary collaboration to promote successful climate adaptation education.

Student engagement and cognitive comprehension (WM = 3.34, moderate) imply the difficulties associated with teaching abstract environmental concepts (WM = 3.96) and adapting activities to accommodate a variety of cognitive and sensory profiles (WM = 3.74). The moderate rating emphasizes the necessity of more inclusive and experiential learning practices to improve learner engagement, which is consistent with Kolb (2014), who emphasized the importance of experiential approaches for cognitive comprehension in complex subjects. Standen et al. (2020) have demonstrated that adaptive instructional strategies, including alternative evaluations, experiential activities, and multimodal learning, enhance comprehension and engagement among students with disabilities, which is consistent with the most recent research.

The Institutional and Policy Support category (WM = 4.10, High) underscores structural barriers to the execution of climate change-focused SPED initiatives. The structural barriers that Gupta and Vegelin (2016) identified as critical for the preservation of inclusive environmental education programs are reflected in the absence of explicit policies endorsing climate education for SPED learners (WM = 4.10), insufficient administrative initiatives (WM = 4.20), and inadequate governmental financing (WM = 4.30). Therefore, it is imperative to enhance collaboration among environmental agencies, SPED institutions, and policymakers to secure the necessary funding and resources for the successful implementation of the curriculum.

These findings indicate that, despite the fact that SPED instructors acknowledge the significance of climate change education, the effective delivery is impeded by insufficient resources, limited professional development, and weak institutional support. Educational institutions must invest in accessible resources, specialized professional training, and stronger policy support to tackle these difficulties. A comprehensive strategy that includes funding for adaptive learning materials, collaboration with environmental organizations, and capacity-building initiatives is essential to guarantee that SPED learners have equitable access to climate education, thereby addressing the inequalities identified in previous literature.

Table 3 presents the results of the level of adaptive teaching strategies developed by SPED teachers to address the challenges in teaching climate change adaptation to students with disabilities.

Table 3. Level of the adaptive teaching strategies developed by special education teachers to address the challenges in teaching climate change adaptation to students with disabilities.

S/N	Indicators	WM	Verbal description
1	I develop and modify climate change lesson plans to align with the cognitive and sensory needs of SPED learners.	3.25	Moderate
2	I integrate hands-on environmental activities (e.g., gardening, waste management, recycling) to enhance experiential learning.	2.9	Moderate
3	I use multimodal teaching strategies (e.g., visual, auditory, tactile learning) to ensure students with different learning styles can grasp climate concepts.	3.3	Moderate
4	I adapt storytelling and interactive role-playing to simplify climate change concepts for students with disabilities.	3.45	High
5	I incorporate assistive technologies (e.g., speech-to-text, audio resources, large print materials) to enhance accessibility to climate education materials.	3.4	Moderate
6	I collaborate with community organizations and environmental groups to provide real-world learning experiences for SPED learners.	2.85	Moderate
7	I engage parents in reinforcing climate adaptation concepts at home through take-home activities and discussions.	3.2	Moderate
8	I integrate sensory-friendly environmental activities (e.g., nature walks, water play, and safe climate experiments) for SPED learners with sensory sensitivities.	3.1	Moderate
9	I advocate for the inclusion of climate change topics in the SPED curriculum and work with administrators to secure necessary resources.	3.35	Moderate
10	I continuously seek professional development opportunities to enhance my ability to teach climate change adaptation to SPED learners effectively.	3.15	Moderate
Weighted mean		3.19	Moderate

Note: 4.21-5.00-Very High; 3.41-4.20- High; 2.61-3.40- Moderate; 1.81-2.60- Low ;1.00-1.80- Very Low

Table 3 explains the adaptive teaching approaches that SpEd teachers created to address the challenges of teaching climate change adaptation to students with disabilities. With a weighted mean (WM) of 3.19, ranked as moderate, this suggests that while teachers use a variety of strategies to ensure that climate education is accessible, there is further space for growth in refining instructional methodologies, expanding experiential learning, and building collaborative relationships, which aligns with previous studies emphasizing continuous professional development (Hein et al., 2018; Johnson, Tilt, Ries, & Shindler, 2019).

Among the strategies, the adaptation of storytelling and role-playing (WM = 3.45, High) is the most effectively implemented approach, indicating that educators leverage narrative-based methods to simplify complex climate concepts for SpEd learners. This is consistent with Stevens (2015), who argued that interactive storytelling combined with role-play increases engagement and understanding in students with heterogeneous learning needs. However, other important strategies such as hands-on environmental activities (WM = 2.90) and partnerships with community organizations (WM = 2.85), are not fully utilized, highlighting a gap in field-based experiential learning, which is critical for developing practical climate adaptation skills.

Multimodal teaching methods (WM = 3.30) and assistive technology (WM = 3.40) are used to a moderate extent, suggesting that efforts have been made to accommodate diverse learning styles. These moderate scores underscore the need for greater access to specialized learning aids and teacher training to integrate ICT effectively, reflecting the literature on the importance of adaptive technologies for SPED learners (Standen et al., 2020).

The emphasis on curriculum access and resource provision (WM = 3.35) highlights that educators recognize the need for institutional support, despite potential bureaucratic obstacles in operationalizing climate change education within special education contexts. The involvement of parents to support and co-teach climate adaptation concepts at home (WM = 3.20) and the integration of sensory-friendly environmental activities (WM = 3.10) also demonstrate moderate implementation. This aligns with Gershwin (2020), who demonstrated that family engagement enhances

continuity of learning and enriches educational experiences for students with disabilities, though the absence of structured take-home assignments may limit effectiveness.

Despite these efforts, professional development in climate change education (WM = 3.15, Moderate) remains an essential area for advancement. Hein et al. (2018) highlighted that limited access to specialized training and interdisciplinary collaboration can impede teachers' ability to implement innovative strategies effectively, while Johnson et al. (2019) argued that enhanced professional development programs focused on inclusive environmental education can equip educators with adaptive pedagogical methods, technologies, and collaborative skills.

Overall, the results imply that SPED teachers are committed to teaching climate change adaptation, but resource limitations, training gaps, and institutional barriers hinder full implementation. Strengthening experiential learning opportunities, fostering partnerships, and expanding teacher training are critical to enhancing inclusive climate education, confirming the recommendations of prior research.

Table 4. Test of significant relationship between the level of teaching strategies that SpEd teachers implement and their level of challenges in integrating climate change adaptation concepts into their curriculum.

Teaching strategies implemented	Challenges faced	Correlation coefficient (r)	p-value	Statistical interpretation
Instructional adaptations and differentiated lesson planning	Availability of materials, teacher preparedness, student engagement, institutional support	-0.07	0.313	No significant relationship
Use of sensory-based and assistive learning materials	Availability of materials, teacher preparedness, student engagement, institutional support	0.09	0.457	No significant relationship
Community engagement and experiential learning activities	Availability of materials, teacher preparedness, student engagement, institutional support	-0.12	0.532	No significant relationship
Collaboration with environmental organizations, parents, and school administrators	Availability of materials, teacher preparedness, student engagement, institutional support.	-0.05	0.618	No significant relationship

Note: Tested at 0.05 level of significance.

Table 4 presents the results of the test for a significant relationship between the level of teaching strategies implemented by SpEd teachers and the challenges they face.

Table 4 reveals no significant correlation between the instructional tactics employed by SPED teachers and the difficulties encountered in incorporating climate change adaptation principles. The correlation coefficients (r) vary from -0.12 to 0.09, with p-values exceeding 0.05, indicating that teaching styles do not directly affect or influence the availability of materials, teacher preparedness, student involvement, or institutional support. In that context, SPED teachers did employ climate adaptation strategies; despite systemic obstacles, showcasing adaptability while also emphasizing that overcoming barriers alone may not necessarily improve implementation. A significant result is that special education teachers are already utilizing self-created adaptation methods, irrespective of external limitations. However, in the absence of institutional support and established policies, these techniques may become inconsistent or unsustainable. These findings indicate that teacher training, resource availability, and collaborative efforts alone do not substantially influence implementation, highlighting the necessity for a more systemic, policy-oriented approach to climate change education (Liu, Roehrig, Bhattacharya, & Varma, 2020). The lack of a substantial connection between experiential learning and problems indicates that current outdoor and hands-on climate education approaches may not be entirely accessible or inclusive for special education learners. Policymakers should enhance institutional policies and funding for special education-friendly climate education resources (Tenzing, 2020). Educational institutions ought to improve collaboration among special education professionals, environmental

scientists, and technology developers to build inclusive pedagogical practices (Mohamed, 2018). Moreover, professional development must be continuous and contextually relevant, enabling educators to proficiently incorporate climate themes into special education curricula (MacKay et al., 2021). Through these, adaptive climate education frameworks can be expanded to incorporate comprehensive sustainability programs within schools and communities to boost both regular and special education students' involvement; uphold curriculum relevance; deliver quality educational services; mitigate the impact of climate change; and ensure a sustainable future.

5. CONCLUSION

Based on the findings of the study, it is concluded that SpEd teachers actively employ climate change adaptation measures, and substantial hurdles impede their complete incorporation into the curriculum. The study indicates an absence of a significant correlation between the implementation of teaching tactics and the problems encountered, suggesting that educators employ these strategies irrespective of resource limits, training deficiencies, and institutional support. However, the absence of SpEd-friendly teaching resources, inadequate professional development, and feeble policy support continue to pose significant challenges. These underscore the imperative of a systematic and inclusive methodology instead of fragmented solutions. Enhancing access to adaptable resources, broadening teacher training, and cultivating robust institutional support are crucial for enduring and equitable climate change education for SpEd students. There is a need for collaboration among educators, policymakers, and environmental organizations to improve instructional delivery and ensure that climate adaptation education is inclusive and effective.

6. POLICY IMPLICATIONS

The conclusions underscore that policymakers must institutionalize SPED-inclusive climate education policies, allocate funding, and provide teacher training.

7. RECOMMENDATIONS

It is recommended that schools develop adaptive instructional materials, strengthen collaborations, and enhance curriculum frameworks for sustainable, inclusive climate education.

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Institutional Review Board Statement: This study was approved by the Ethical Committee of Cebu Technological University, Philippines under reference number (Ref. No. ERCRC 05426), dated (September 6, 2022). Informed verbal consent was obtained from all participants, and all data were anonymized to protect participant confidentiality.
Transparency: The author states that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
Competing Interests: The author declares that there are no conflicts of interests regarding the publication of this paper.
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