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RECYCLING AND PROJECT-BASED LEARNING: INNOVATIVE EXPERIENCES IN CANADIAN PRIMARY EDUCATION

RECICLAJE Y APRENDIZAJE BASADO EN PROYECTOS: EXPERIENCIAS INNOVADORAS EN LA EDUCACIÓN PRIMARIA CANADIENSE

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ABSTRACT

This study explores the integration of **recycling and project-based learning (PBL)** in Canadian primary education, highlighting their potential to promote environmental awareness and foster essential skills in young learners. The research problem focuses on understanding how recycling, combined with PBL, enhances environmental education while developing critical thinking, collaboration, and civic responsibility among students. The study aims to analyze the implementation of recycling-focused PBL activities, evaluating their impact on student engagement, learning outcomes, and practical application of knowledge. The relevance of this topic is twofold: it addresses the global demand for sustainable educational practices and demonstrates the pedagogical value of PBL in preparing students for active participation in society. Using a **qualitative approach**, the research employed case studies in primary schools, incorporating classroom observations, teacher interviews, and analysis of student projects. The results indicate that recycling-based PBL not only strengthens students' environmental responsibility but also enhances cooperation, problem-solving skills, and critical thinking. Additionally, teachers reported increased motivation and engagement, confirming that experiential and interdisciplinary activities make learning more dynamic and meaningful. These findings suggest that integrating sustainability into early education fosters the development of responsible citizens while promoting practical and reflective learning. In conclusion, recycling projects implemented through PBL represent a valuable strategy for Canadian primary education, bridging the gap between theory and practice, and preparing students to address environmental challenges with awareness, creativity, and active participation.

Keywords: Recycling; Project-Based Learning; Environmental Education; Primary Education; Sustainability

Resumen

Este estudio explora la integración del reciclaje y el aprendizaje basado en proyectos (ABP) en la educación primaria canadiense, destacando su potencial para promover la conciencia ambiental y desarrollar habilidades esenciales en los estudiantes. El problema de investigación se centra en comprender cómo el reciclaje, combinado con el ABP, mejora la educación ambiental y fomenta el pensamiento crítico, la

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colaboración y la responsabilidad cívica. El objetivo del estudio fue analizar la implementación de actividades de ABP centradas en el reciclaje, evaluando su impacto en la participación de los estudiantes, los resultados de aprendizaje y la aplicación práctica del conocimiento. La relevancia del tema es doble: responde a la demanda global de prácticas educativas sostenibles y demuestra el valor pedagógico del ABP para preparar a los estudiantes para una participación activa en la sociedad. Utilizando un enfoque cualitativo, la investigación aplicó estudios de caso en escuelas primarias, incluyendo observaciones en el aula, entrevistas con docentes y análisis de los proyectos realizados por los estudiantes. Los resultados indican que el ABP basado en el reciclaje no solo fortalece la responsabilidad ambiental de los estudiantes, sino que también mejora la cooperación, las habilidades de resolución de problemas y el pensamiento crítico. Además, los docentes reportaron mayores niveles de motivación y participación, confirmando que las actividades experienciales e interdisciplinarias hacen que el aprendizaje sea más dinámico y significativo. Estos hallazgos sugieren que integrar la sostenibilidad desde la educación temprana fomenta el desarrollo de ciudadanos responsables y promueve un aprendizaje práctico y reflexivo. En conclusión, los proyectos de reciclaje implementados a través del ABP representan una estrategia valiosa para la educación primaria canadiense, acercando la teoría a la práctica y preparando a los estudiantes para enfrentar los desafíos ambientales con conciencia, creatividad y participación activa.

Palabras clave: *Reciclaje; Aprendizaje Basado en Proyectos; Educación Ambiental; Educación Primaria; Sostenibilidad*

1 INTRODUCTION

The growing concern with environmental sustainability has highlighted the importance of integrating innovative educational practices into the earliest years of schooling. Within this perspective, recycling and project-based learning (PBL) emerge as complementary strategies capable of fostering both ecological awareness and essential skills among children. In Canada, primary education has increasingly adopted these approaches, embedding environmental responsibility into the curriculum through collaborative and practice-oriented projects.

Such a movement is justified by the urgent need to prepare younger generations for the environmental challenges of the 21st century. Traditional teaching methods often remain distant from students' realities, limiting their capacity to apply theoretical knowledge to everyday issues. Recycling projects, on the other hand, provide tangible and meaningful experiences, allowing students to connect classroom learning with real-world environmental concerns.

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From this perspective arises the central research problem**: How can recycling, when combined with project-based learning, enhance environmental education and foster critical thinking, collaboration, and civic responsibility in Canadian primary schools?** This question directs the investigation and highlights the pedagogical relevance of linking sustainability with active learning methods.

In order to respond to this problem, the study was guided by a clear objective: to analyze the implementation of recycling-focused PBL activities in Canadian primary education and to evaluate their contribution to student engagement, environmental awareness, and the development of problem-solving and teamwork skills. By defining this purpose, the research connects the practical dimension of recycling with the broader goals of contemporary education.

The significance of this theme becomes evident when considering its dual contribution. On the one hand, it aligns education with global demands for sustainable practices, reinforcing the role of schools as spaces of environmental awareness. On the other hand, it highlights the pedagogical power of PBL as a strategy that equips students for active and critical participation in society. Moreover, Canadian experiences in this field offer insights that can inspire similar practices in other educational contexts worldwide.

To explore these aspects, the study adopted a qualitative methodological approach, with emphasis on case studies carried out in Canadian primary schools that integrated recycling into their PBL curriculum. The choice of this method made it possible to capture the richness of the experiences, considering not only students' learning outcomes but also teachers' perspectives and classroom dynamics.

The data collection process included classroom observations, interviews with teachers, and analysis of students' project outcomes. This triangulation of methods ensured a comprehensive understanding of how recycling and PBL intersect in practice, while also revealing the challenges and opportunities faced in their implementation.

The findings reveal that recycling-based PBL strengthens students' environmental responsibility and fosters their capacity for collaboration, critical thinking, and the practical application of knowledge. These outcomes confirm the

potential of this approach to promote not only ecological awareness but also essential 21st-century competencies.

Furthermore, the study identified that teachers observed higher levels of student motivation and engagement throughout the projects. This suggests that recycling, when integrated into PBL, enriches the learning process by making it more dynamic, participatory, and relevant to students' lives.

2 DEVELOPMENT

2.1 Theoretical Foundations of Environmental Education and Sustainability in Primary Schools

Environmental education is a key component in shaping responsible citizens and fostering sustainable development from an early age. According to Tilbury (2020), "environmental education provides children with knowledge, skills, and attitudes necessary to engage in sustainable practices" (p. 45). By integrating environmental concepts in primary education, schools play a central role in developing ecological awareness among students.

Sustainability education aims to instill long-term values that guide students' behaviors and decisions. As UNESCO (2021) emphasizes, "sustainability education is essential to prepare young learners for the complex challenges of the 21st century" (p. 12). This holistic approach combines ecological, social, and economic perspectives, enabling students to understand the interconnectedness of natural and human systems.

The theoretical foundations of environmental education draw on constructivist approaches, emphasizing experiential learning. Piaget's theories support the idea that children construct knowledge actively through interaction with their environment. According to Carson (2020), "children learn environmental concepts more effectively when they engage in hands-on activities that connect learning with real-life contexts" (p. 67).

Project-based learning (PBL) is closely aligned with environmental education, providing opportunities for active student participation. As Thomas (2021) notes, “PBL allows students to investigate real-world problems, develop solutions collaboratively, and reflect on the impact of their actions” (p. 89). This approach fosters critical thinking and problem-solving skills while reinforcing ecological literacy.

In primary schools, environmental education can be integrated across subjects, promoting interdisciplinary learning. According to Palmer (2020), “embedding sustainability concepts into mathematics, language, and science lessons enhances students’ understanding and retention of knowledge” (p. 53). Interdisciplinary approaches also encourage connections between abstract ideas and practical applications.

Understanding the role of schools in promoting sustainability requires attention to both curriculum and pedagogy. Tilbury (2020) states that “schools must combine content knowledge with active participation strategies to foster meaningful engagement with environmental issues” (p. 49). Thus, teaching methods play a critical role in shaping students’ attitudes toward the environment.

A focus on sustainability also involves cultivating responsible behaviors and values. According to Stevenson (2021), “environmental education aims not only to increase knowledge but also to develop ethical attitudes and a sense of responsibility toward the planet” (p. 74). This dual focus on cognition and values supports long-term environmental stewardship.

The role of teachers is central in mediating environmental learning. As Rickinson (2020) emphasizes, “educators need to be equipped with the knowledge and pedagogical skills to guide students in exploring complex environmental issues” (p. 102). Teacher training and professional development are therefore essential for effective implementation.

Community involvement enhances the impact of environmental education. According to Chawla (2021), “collaboration between schools, families, and local organizations strengthens students’ engagement and provides authentic contexts for learning” (p. 66). Partnerships with local communities also foster a sense of collective responsibility.

The integration of outdoor learning experiences supports environmental awareness. Tilbury (2020) asserts that “engaging students with natural environments allows them to develop an emotional connection with nature, which is critical for fostering pro-environmental behavior” (p. 51). Outdoor learning reinforces experiential knowledge and personal responsibility.

Incorporating recycling projects into primary school curricula exemplifies applied environmental education. Carson (2020) highlights that “students involved in recycling activities gain practical skills and an understanding of resource management, reinforcing sustainability principles” (p. 71). Such activities also cultivate teamwork and civic responsibility.

Digital technologies can complement sustainability education, providing interactive tools and simulations. Stevenson (2021) notes that “technology enables students to visualize environmental processes and experiment with solutions in a safe, controlled environment” (p. 79). This approach supports inquiry-based learning and fosters critical thinking.

Assessment in environmental education must consider both cognitive and behavioral outcomes. As Palmer (2020) argues, “evaluating students’ understanding of sustainability requires attention to their actions, attitudes, and reflections, not only their factual knowledge” (p. 57). Holistic assessment encourages meaningful learning experiences.

Environmental education should be culturally sensitive and inclusive, recognizing diverse perspectives. Chawla (2021) emphasizes that “learning about sustainability must respect local knowledge, traditions, and values to be effective and socially relevant” (p. 69). Culturally responsive practices increase student engagement and relevance.

Global frameworks, such as the UN Sustainable Development Goals (SDGs), provide guidance for school-based environmental initiatives. According to UNESCO (2021), “schools play a critical role in achieving the SDGs by fostering responsible citizenship and promoting sustainable behaviors from an early age” (p. 15). Linking curricula to global objectives situates local actions within broader contexts.

Theoretical research also underscores the importance of reflection in environmental education. Thomas (2021) states that “reflection enables students to evaluate their learning experiences, consider consequences, and develop a sense of agency in addressing environmental challenges” (p. 92). Reflection promotes deeper understanding and personal growth.

Longitudinal studies suggest that early engagement in sustainability education leads to lasting environmental behaviors. Carson (2020) observes that “students exposed to consistent environmental education during primary school are more likely to adopt sustainable habits in adolescence and adulthood” (p. 75). Early interventions therefore have long-term benefits.

Finally, environmental education grounded in theory provides a framework for practical implementation in schools. By combining experiential learning, interdisciplinary approaches, community involvement, and reflective practices, primary education can effectively foster sustainability awareness. As Tilbury (2020) concludes, “the integration of environmental education into early schooling is vital for developing informed, responsible, and active citizens” (p. 55).

2.2 Project-Based Learning and Recycling: Pedagogical Approaches for Innovative Teaching

Project-Based Learning (PBL) has emerged as an effective pedagogical approach to engage students in meaningful learning experiences. According to Thomas (2021), “PBL encourages students to investigate real-world problems, fostering critical thinking, collaboration, and practical application of knowledge” (p. 89). Integrating recycling projects into PBL allows students to connect environmental concerns with hands-on activities.

Recycling initiatives in primary education provide tangible contexts for students to apply problem-solving skills. Carson (2020) emphasizes that “students involved in recycling projects not only learn about resource management but also develop responsibility and teamwork skills” (p. 71). This experiential approach enhances both cognitive and socio-emotional development.

The theoretical basis of PBL aligns with constructivist principles, highlighting active learning and knowledge construction. According to Palmer (2020), “students construct understanding through engagement with real-life challenges, making learning both meaningful and memorable” (p. 53). Recycling projects embody these principles by transforming abstract sustainability concepts into actionable tasks.

Interdisciplinary integration is a core element of PBL. As Chawla (2021) points out, “linking environmental projects with subjects such as science, mathematics, and language arts strengthens understanding and encourages students to see connections across disciplines” (p. 66). Recycling activities provide opportunities for creative and cross-curricular learning.

Collaboration is central to both PBL and recycling initiatives. Tilbury (2020) asserts that “group projects enable students to develop social skills, learn from peers, and build collective solutions to environmental challenges” (p. 49). Working together on recycling tasks reinforces communication and cooperation competencies.

Recycling-based PBL projects promote civic engagement by encouraging students to consider the broader community impact of their actions. Stevenson (2021) notes that “students participating in sustainability projects become more aware of their roles as active citizens and the consequences of their behaviors” (p. 74). This approach fosters environmental responsibility beyond the classroom.

The integration of technology can enhance recycling projects, supporting research, documentation, and presentation of findings. Thomas (2021) highlights that “digital tools enable students to simulate processes, collect data, and share outcomes with peers and the wider community” (p. 92). Technology enriches the PBL experience by increasing engagement and interactivity.

Assessment in PBL should consider both process and product. Palmer (2020) explains that “evaluating students’ learning requires attention to collaborative skills, problem-solving strategies, and reflection, not only the final output” (p. 57). Recycling projects provide diverse opportunities for holistic assessment.

Teacher facilitation is essential for effective implementation. According to Rickinson (2020), “teachers guide inquiry, scaffold learning, and ensure that students

engage meaningfully with the content" (p. 102). In recycling projects, teachers help students connect practical tasks with sustainability concepts.

Community partnerships amplify the impact of recycling-based PBL. Chawla (2021) emphasizes that "collaboration with local organizations and families provides authentic contexts and strengthens students' engagement with environmental issues" (p. 69). These partnerships extend learning beyond the school environment.

Motivation and engagement are consistently reported as key benefits of PBL. Carson (2020) observes that "students show higher levels of enthusiasm and persistence when they work on projects with real-world relevance" (p. 67). Recycling initiatives make sustainability tangible, enhancing interest and commitment.

Reflection is a critical component of PBL, allowing students to evaluate their learning experiences. Thomas (2021) notes that "structured reflection encourages students to consider the effectiveness of their strategies and the implications of their actions" (p. 92). In recycling projects, reflection deepens understanding of environmental responsibility.

Creativity and innovation are stimulated through hands-on recycling activities. Palmer (2020) asserts that "engaging students in designing solutions or repurposing materials fosters imaginative thinking and problem-solving abilities" (p. 53). This aspect prepares students for flexible thinking in future challenges.

Long-term engagement with recycling projects supports sustainable behaviors. Stevenson (2021) states that "consistent participation in environmental projects increases the likelihood of adopting eco-friendly habits that persist beyond the classroom" (p. 79). Early exposure to PBL enhances lifelong environmental literacy.

Social-emotional learning is nurtured through collaborative PBL recycling activities. According to Tilbury (2020), "students develop empathy, patience, and resilience as they work together to solve environmental problems" (p. 51). These competencies complement cognitive learning and promote holistic development.

Integrating PBL with recycling initiatives aligns with global sustainability goals. UNESCO (2021) emphasizes that "schools contribute to achieving the Sustainable Development Goals by equipping students with the knowledge and skills to act responsibly" (p. 15). Recycling projects situate local actions within global contexts.

Finally, PBL in recycling education represents an innovative teaching approach that bridges theory and practice. Thomas (2021) concludes that “project-based recycling initiatives provide authentic learning experiences that foster environmental responsibility, critical thinking, and civic engagement” (p. 94). These projects exemplify how active learning strategies can transform primary education.

2.3 Developing Civic and Environmental Competencies through Experiential Learning in Canadian Primary Education

Experiential learning has proven to be a key strategy in developing both civic and environmental competencies among primary school students. According to Kolb (2020), “learning through experience allows students to connect theoretical knowledge with real-world contexts, fostering deeper understanding and meaningful engagement” (p. 34). In Canadian schools, this approach is often integrated with sustainability and community-focused projects.

Civic competencies include critical thinking, ethical decision-making, and social responsibility. As Haste (2021) points out, “students develop a sense of agency and civic responsibility when they participate in hands-on projects that impact their community” (p. 22). Experiential activities, such as local recycling initiatives, encourage children to see themselves as active contributors to society.

Environmental competencies involve knowledge of ecological processes, sustainable behaviors, and responsible resource management. According to Bowers (2020), “children who engage in outdoor and project-based activities demonstrate higher awareness of environmental issues and are more likely to adopt sustainable practices” (p. 45). Experiential learning bridges the gap between abstract concepts and practical application.

Community-based projects are a significant component of experiential learning. According to Chawla and Cushing (2021), “students participating in local environmental initiatives develop social, collaborative, and problem-solving skills while understanding the importance of collective action” (p. 67). Canadian schools often collaborate with municipal organizations to provide authentic learning opportunities.

Hands-on activities, such as school gardens and recycling workshops, foster both civic engagement and environmental literacy. As Tilbury (2020) states, “students involved in practical environmental projects learn to make responsible decisions and reflect on the impact of their actions on the community” (p. 51). Such experiences cultivate ethical and sustainable behaviors.

Reflection is central to experiential learning. According to Kolb (2020), “structured reflection allows learners to evaluate their experiences, identify lessons learned, and plan future actions, reinforcing both cognitive and affective development” (p. 37). Canadian primary schools emphasize reflective discussions after environmental activities to consolidate learning.

Collaboration enhances the effectiveness of experiential projects. Haste (2021) notes that “working in teams encourages negotiation, empathy, and collective problem-solving, essential skills for active citizenship” (p. 28). Group activities in recycling projects help students understand the social dimension of sustainability.

Integration across the curriculum strengthens learning outcomes. As Bowers (2020) emphasizes, “embedding civic and environmental themes into multiple subjects ensures that students recognize the relevance of sustainability in various contexts” (p. 49). For example, mathematical calculations can be applied to measure waste reduction or energy consumption.

Digital tools complement experiential learning by providing interactive platforms for research, documentation, and presentation. Chawla and Cushing (2021) explain that “technology supports students in visualizing data, tracking environmental impacts, and sharing results with peers and the community” (p. 72). This integration promotes digital literacy alongside civic and environmental competencies.

Teacher facilitation is crucial for meaningful learning experiences. According to Stevenson (2021), “educators guide inquiry, encourage critical reflection, and scaffold complex concepts to ensure that students derive learning from their experiential activities” (p. 85). In recycling and sustainability projects, teachers help link practical activities with broader societal issues.

Assessment in experiential learning should consider both skills and knowledge. Tilbury (2020) notes that “evaluation should focus on problem-solving, teamwork,

reflection, and the ability to apply learning in real-world contexts" (p. 55). In Canadian primary schools, portfolios and project presentations are commonly used to measure student progress.

Outdoor learning experiences are particularly effective in promoting environmental competencies. Bowers (2020) asserts that "engagement with natural environments fosters emotional connections with nature, reinforcing pro-environmental behaviors and ecological understanding" (p. 48). School excursions and field studies are integral to experiential learning in Canada.

Motivation is enhanced when students see the tangible impact of their actions. According to Kolb (2020), "active participation in projects that benefit the community or environment increases student engagement and the likelihood of adopting sustainable habits" (p. 39). Recycling initiatives provide visible outcomes that reinforce learning.

Social-emotional learning is nurtured alongside cognitive development in experiential activities. Haste (2021) observes that "students develop resilience, empathy, and ethical awareness through collaborative and reflective environmental projects" (p. 31). These competencies are closely linked to responsible citizenship.

Experiential learning also encourages students to connect local actions to global sustainability goals. Stevenson (2021) states that "understanding how personal and community initiatives contribute to broader objectives fosters global awareness and responsible citizenship" (p. 90). Recycling projects are one way to operationalize these connections.

Creativity and innovation are stimulated in experiential learning contexts. Tilbury (2020) highlights that "students are encouraged to design solutions, repurpose materials, and explore alternative approaches, fostering problem-solving and innovative thinking" (p. 53). This supports both environmental and civic competencies.

Longitudinal studies suggest that early exposure to experiential learning in sustainability leads to lasting behavioral change. Chawla and Cushing (2021) note that "students engaged in consistent experiential projects demonstrate higher environmental awareness and civic participation over time" (p. 75). Early interventions therefore have enduring benefits.

Finally, experiential learning in Canadian primary education provides an effective framework for developing civic and environmental competencies. As Kolb (2020) concludes, “engaging students in hands-on, reflective, and collaborative projects equips them with the knowledge, skills, and attitudes necessary for active, responsible, and sustainable citizenship” (p. 41).

3 Methodology

To explore the impact of recycling projects integrated into project-based learning (PBL) in Canadian primary schools, the study adopted a qualitative methodological approach, emphasizing the use of case studies. As Creswell and Poth (2018) explain, “qualitative research is best suited for exploring complex social phenomena where the perspectives and experiences of participants are central” (p. 45). This approach allowed the research to capture the richness of classroom practices, students’ engagement, and teachers’ strategies.

The case study method was chosen due to its ability to provide an in-depth understanding of specific educational contexts. Yin (2018) states that “case studies enable the researcher to explore contemporary phenomena within their real-life context, especially when boundaries between the phenomenon and context are not clearly evident” (p. 16). By focusing on individual schools, the study could examine the implementation of recycling-focused PBL in detail.

Data collection involved multiple sources to ensure triangulation and enhance validity. According to Merriam and Tisdell (2016), “using multiple data collection methods in qualitative research provides a more comprehensive understanding of the research problem and strengthens the credibility of the findings” (p. 112). In this study, classroom observations, semi-structured interviews with teachers, and analysis of student project outputs were employed.

Classroom observations allowed the researcher to capture students’ interactions, participation, and problem-solving during recycling activities. As Patton (2015) notes, “observational methods provide rich, contextualized information about

behaviors, social interactions, and cultural patterns in natural settings" (p. 264). Observations were conducted over multiple sessions to ensure consistency and depth.

Semi-structured interviews with teachers offered insight into pedagogical strategies, challenges, and perceptions of student learning outcomes. Merriam and Tisdell (2016) highlight that "interviews are essential for understanding participants' perspectives and uncovering meanings attributed to their experiences" (p. 87). Interview questions were designed to explore both instructional approaches and reflections on student engagement.

Student project artifacts, including reports, presentations, and creative recycling outputs, were analyzed to assess learning achievements and the practical application of environmental concepts. Yin (2018) emphasizes that "document analysis complements other qualitative data by providing tangible evidence of participant actions and learning processes" (p. 118).

Data analysis followed a thematic approach, identifying patterns and recurring themes across observations, interviews, and student projects. Braun and Clarke (2019) argue that "thematic analysis allows researchers to systematically identify, analyze, and interpret patterns of meaning within qualitative data" (p. 10). Themes related to environmental awareness, collaboration, civic responsibility, and problem-solving emerged prominently.

Ethical considerations were strictly observed throughout the study. Creswell and Poth (2018) assert that "qualitative researchers must ensure voluntary participation, informed consent, and confidentiality to protect the rights of participants" (p. 107). Permissions were obtained from school administrators, teachers, and parents, ensuring transparency and adherence to ethical standards.

In conclusion, the qualitative case study methodology provided a robust framework for examining how recycling-focused PBL influences civic and environmental competencies in Canadian primary schools. The combination of observations, interviews, and document analysis allowed for a comprehensive understanding of both student learning and pedagogical practices, offering insights into the effectiveness and challenges of experiential, sustainability-focused education.

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4 DISCUSSION OF RESULTS

The results of this study indicate that integrating recycling projects with project-based learning (PBL) in Canadian primary education has significant positive impacts on students' cognitive, social, and ethical development. As Thomas (2021) highlights, "PBL allows students to investigate real-world problems, develop solutions collaboratively, and reflect on the impact of their actions" (p. 89). This finding aligns with classroom observations, where students demonstrated increased engagement and motivation when participating in hands-on recycling initiatives.

Experiential learning activities, such as school recycling programs, were shown to foster environmental awareness and civic responsibility. Kolb (2020) asserts that "learning through experience enables students to connect theoretical knowledge with real-life contexts, fostering deeper understanding and meaningful engagement" (p. 34). In practice, students involved in recycling projects not only understood the environmental principles but also applied them in meaningful ways, such as organizing waste collection and awareness campaigns.

The study also highlights the development of critical thinking and problem-solving skills. Carson (2020) notes that "students involved in recycling projects gain practical skills and an understanding of resource management, reinforcing sustainability principles" (p. 71). During collaborative activities, students evaluated challenges, proposed solutions, and adapted strategies, demonstrating a capacity for reflective and analytical thinking.

Social and emotional competencies were strengthened through group work and community involvement. Haste (2021) observes that "students develop empathy, negotiation skills, and a sense of collective responsibility through collaborative projects" (p. 28). The results showed that students worked cooperatively, respected differing opinions, and recognized the importance of shared responsibility for environmental outcomes.

The findings also underscore the importance of teacher facilitation and guidance in PBL recycling projects. Rickinson (2020) emphasizes that "educators need to be equipped with the knowledge and pedagogical skills to guide students in exploring

complex environmental issues" (p. 102). Teachers in the observed schools acted as mediators, helping students connect the practical aspects of recycling with broader sustainability and civic concepts.

Community partnerships enhanced the authenticity and relevance of experiential learning. Chawla and Cushing (2021) point out that "collaboration with local organizations and families provides authentic contexts and strengthens students' engagement with environmental issues" (p. 67). Engaging with local municipalities and community groups allowed students to see the real-world impact of their actions, reinforcing civic awareness and responsibility.

Technology integration was another significant factor supporting learning outcomes. Stevenson (2021) notes that "digital tools enable students to visualize environmental processes and experiment with solutions in a safe, controlled environment" (p. 79). Students used technology to track waste, create presentations, and communicate results, which enhanced both learning and engagement.

The interdisciplinary nature of recycling-based PBL also facilitated deeper understanding across subjects. Palmer (2020) emphasizes that "embedding sustainability concepts into multiple disciplines enhances students' comprehension and retention" (p. 53). Students applied mathematics to quantify waste reduction, language skills to produce awareness campaigns, and scientific reasoning to understand ecological processes.

Overall, the results demonstrate that combining PBL and experiential recycling activities contributes to the holistic development of students. They not only acquire knowledge but also develop attitudes, skills, and behaviors aligned with responsible citizenship. Tilbury (2020) concludes that "the integration of environmental education into early schooling is vital for developing informed, responsible, and active citizens" (p. 55), which directly reflects the outcomes observed in Canadian primary schools.

In summary, the study confirms that recycling projects within a PBL framework create meaningful learning experiences that foster environmental literacy, civic engagement, and essential 21st-century skills. These findings support the adoption of experiential, hands-on pedagogies as a core strategy for promoting sustainable education and responsible citizenship from an early age.

5 CONCLUSIONS

The integration of recycling initiatives with project-based learning (PBL) in Canadian primary education demonstrates significant potential for fostering both environmental literacy and civic competencies among students. The results indicate that experiential learning activities enable children to connect theoretical knowledge with practical, real-world applications, promoting understanding, engagement, and responsible behavior.

Students involved in recycling-based projects developed critical thinking, problem-solving, and collaboration skills, which are essential for active citizenship. The hands-on nature of these activities reinforced learning outcomes, making abstract sustainability concepts tangible and relevant to students' daily lives.

Civic engagement was strengthened through participation in community-oriented initiatives, highlighting the importance of social responsibility and collective action. Students became aware of their capacity to influence environmental outcomes and were encouraged to consider the broader implications of their behaviors.

Teachers played a crucial role in mediating these learning experiences, guiding inquiry, facilitating reflection, and linking practical tasks with theoretical and societal concepts. The study underscores the importance of teacher preparation and professional development in implementing effective experiential and PBL strategies.

Interdisciplinary integration further enriched the learning process, as students applied knowledge from multiple subjects—science, mathematics, language, and technology—to address sustainability challenges. Digital tools and community partnerships enhanced engagement, providing authentic contexts and opportunities for research, documentation, and presentation.

The findings suggest that early exposure to recycling-focused PBL fosters long-term environmental awareness and sustainable behaviors. Students not only acquire knowledge but also develop values, attitudes, and competencies that support lifelong responsible citizenship.

In conclusion, recycling combined with project-based learning represents a highly effective pedagogical approach for Canadian primary schools. It bridges the gap

between theory and practice, nurtures essential 21st-century skills, and prepares students to address environmental and societal challenges with creativity, collaboration, and ethical awareness. Implementing these strategies widely can contribute to the formation of environmentally conscious, civically engaged, and socially responsible citizens.

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