Cognitive Development Through Language Learning: Examining Bilingualism in Early Childhood Education

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Abstract: *Background*: This study investigates the cognitive and linguistic advantages of bilingualism in early childhood education, focusing on language proficiency and executive function (EF) in bilingual and monolingual children. Prior research has suggested the potential benefits of bilingualism in cognitive flexibility, language development, and social skills, which are critical for educational success.

Method: The study assessed the language skills and cognitive flexibility of 100 preschool-age children using standardized assessments, including the Peabody Picture Vocabulary Test (PPVT) for language skills and the Dimensional Change Card Sort (DCCS) for cognitive flexibility. The children were divided into bilingual and monolingual groups to compare performance on these assessments.

Result: Bilingual children demonstrated higher scores in native language proficiency (M = 95.6) and executive function (M = 89.2%) than monolingual children, indicating superior language and cognitive flexibility. These findings suggest that bilingualism enhances flexibility, consciousness, problem-solving, social skills, and emotional regulation in young children.

Conclusion: The results support the inclusion of bilingual education in early childhood programs to foster language development and cognitive skills in young children. However, the study's limitations, including a narrow sample and reliance on standardized assessments, highlight the need for further research across diverse populations to explore the long-term effects of bilingualism. The cognitive, language, and social advantages observed are likely beneficial for future academic success and life skills.

Keywords: Early childhood education, bilingualism, language proficiency, executive functioning (EF), cognitive development, emotional regulation, social engagement.

1. INTRODUCTION

Particularly in the wake of a growing population density, multicultural and multilingual language in early childhood bilingualism has become significant for those with intellectual disabilities (ID). Knowledge of the relationship between bilingualism and ID may help in improving language and cognitive functioning in children, as well as in the identification of diagnostic issues in bilingual children with ID. While the present study is concerned with the effects of bilingual and monolingual environments on children's cognitive development, the findings may be of interest to children with intellectual disabilities who may also benefit from or be at risk of specific cognitive and social outcomes in bilingual contexts. Studies show that language learning during the first years of a child's life is closely linked with cognitive development and may be a major factor in determining social and academic performance [1]. However, although bilingualism improves cognitive flexibility, executive functions, and problem-solving abilities, the effects on children developing intellectual disabilities are still not analyzed sufficiently. New research findings show that early bilingualism has advantages and disadvantages, especially in children with ID. These benefits are not strictly restricted to language but include advantages in executive control, socialization, and cognitive input-output processes [2]. However, extended data evaluation on the role of bilingualism indicates the need to understand the consequences for children with ID, as their language acquisition process might not be typical. This introduction discusses early childhood bilingualism and its relation to cognitive development and considers possible consequences and constraints of applying the results obtained to children with ID, as specified by the journal's purpose.

1.1. Theoretical Background of Bilingualism and Intellectual Disability

Cognitive development in early childhood is a process of acquiring knowledge about how to think and make meaning of the environment. In most traditional

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theories of cognitive development rooted in the work of Piaget and Vygotsky, language is seen as critical in cognitive and social learning processes. It has been proposed that such theories might state that bilingual children can be advantaged since they can learn better metalinguistic skills and be more flexible as they happen to be switching their languages too often, which can also inhibit their impulses. In children with ID, the effects of bilingualism on cognitive flexibility and problem-solving are not as evident because their intellectual abilities may have different patterns of interaction with the bilingual environment. Previous research, including Carlson and Meltzoff [3], has established that bilingual children have better cognitive flexibility in most cases. Whether this cognitive advantage applies to children with ID is still an issue under debate. It may, therefore, be appropriate to adapt diagnostic instruments and approaches to compare and contrast the cognitive and language development of bilingual children with ID to those of monolingual children since many of the tools are standardized for monolingual children.

1.2. Cognitive Development and Executive Function in Bilingual and ID Children

Education in both languages is related to a higher executive ability to plan, pay attention, and work in working memory [4]. Through the process of language switching, bilingual children may have better executive control than children who are monolingual [5]. In children with ID, the possibility of bilingualism to enhance executive functions could open up new avenues of intervention for cognitive and behavior modification in areas involving attention and flexibility control. However, simple cognitive abilities such as the Dimensional Change Card Sort (DCCS) might pose a challenge in children with IDs, and this might call for alterations or even variations in diagnostic settings due to the varied processing requirements and bi-lingual settings.

1.3. Social and Emotional Impacts of Bilingualism for Children with ID

The social-emotional value of bilingualism is being able to understand and accept different cultures [6]. It is difficult to overestimate how bilingual children can cope with different forms of relating to the world of language and culture, which thus helps them in their social practices and in comprehending other people. In the case of children with intellectual disabilities, the versatility of social interaction within multilingual settings has certain appealing prospects linked to bilingualism. These areas of social and emotional development may be supplemented through bilingual education as a type of intervention in these classrooms since children with ID need to acquire both an understanding of multiple languages and to learn a range of facilitated skills in managing emotions.

1.4. Educational and Diagnostic Implications of Bilingualism in ID

Benefits such as cognitive and social improvements resulting from bilingualism make it proper to adopt bilingual programs for young children [7]. A study on this shows that students who attend dual-language programs have equal language development and academic performance. However, for bilingual children with ID, diagnostic difficulties stem from the fact that most assessment tools are monolingual, and this may give a skewed picture of the child's cognitive and linguistic development. Those who set policies and those who teach should be encouraged to incorporate both the bilingual-inclusive assessment and instructions that embrace the cognition-efficiency and social-identity advantages of bilingualism for children with ID. This adjustment could enhance diagnostic accuracy and learning achievement by making assessments and interventions congruent with the bilingual children's experience and requirements.

1.5. Addressing Gaps in Literature on Bilingualism and Intellectual Disability

This study fills a gap by comparing language proficiency and EF in bilingual and monolingual children and proposing a framework that could be used in future research on intellectual disabilities. Although prior research has discussed the positive effects of bilingualism on cognitive development, little research has been done on the effects of bilingualism on children with ID. This research provides knowledge of cognitive flexibility and social-emotional aspects to provide a basis for considering bilingual education as an intervention for children with ID. More studies contrasting TD Bilingual children with those with ID could help explain how these benefits differ based on developmental differences and the benefits as well as the modifications needed for implementing bilingual interventions in children with ID.

1.6. Ethical Approvals and Consent Process

This research complied with ethical practices in research with children and was granted full clearance by the Apollo University Institutional Review Board

(IRB). The IRB examined the study's procedures and unambiguous goals, objectives, and approaches to identifying, enrolling, protecting, and maintaining the privacy of the participants. Parents or guardians signed consent forms for each participant and were told that they could withdraw their child at any time without reason. The participants' information was deleted to maintain confidentiality, and only the summary of the results was published. Informed child consent was sought by giving age-appropriate explanations to the children. These measures kept ethics in practice while maintaining child participants' rights and the authority of their guardians, especially while dealing with the rightful needs of such vulnerable groups as disabled children.

To examine the cognitive and linguistic effects of bilingual education on children with intellectual disabilities (ID) while addressing the limitations of existing assessments normed for monolingual or typically developing children. Specifically, the study aims to investigate whether the cognitive flexibility, executive function, and social communication benefits associated with bilingualism in typically developing children are also applicable to children with ID. Additionally, this research seeks to explore the development of culturally and linguistically sensitive assessment tools that better capture bilingual abilities in children with ID. By considering the unique language and cognitive needs of bilingual children with ID, the study aspires to contribute to inclusive educational practices and intervention approaches that support language and social-emotional development in this population.

2. METHODOLOGY

This study aimed to investigate bilingual children's cognitive and language development in early childhood education and compare them with monolingual or other children. The scholarship methodology was mixed, with quantitative and qualitative data collection. The goal of this research design was to find out what influence bilingualism has on cognitive development (executive function, language proficiency, and academic performance). Recruitment of participants occurred from multiple early childhood education settings and outlets, and standardized assessment tools were used to measure outcomes.

2.1. Participants

200 children aged 3 to 6 years took part in the study. Of these, 100 were born with exposure to two languages (bilingual) and 100 to merely one language (monolingual). In all cases, the bilingual children were in families where the two languages were equally spoken at home and their early learning center. At home and early learning centers, these monolingual children's main input was English. Participants were recruited from 10 early childhood centers in urban and suburban areas, ensuring a variety of socioeconomic backgrounds and levels of access to educational resources to meet the study requirements. Parental consent was obtained before the study, and parents answered a language background questionnaire, which provided teachers with information about the child's language exposure, family demographics, socioeconomic status, and so on. The participants were matched based on the same age, gender, and socioeconomic background.

2.2. Procedure

The study lasted six months. The data collection was qualitative, using a series of standardized language and cognitive tests, and quantitative, by interviewing educators and observing classroom behavior. The assessment procedures were as follows:

2.2.1. Language Proficiency Test

The children's vocabulary comprehension across both their languages (in the case that they were bilingual) and their single language (in the case that they were monolingual) was assessed using the Peabody Picture Vocabulary Test (PPVT). The test is widely used in language acquisition studies, and it has been shown to be consistent and valid in young children [8].

2.2.2. Cognitive Development Test

This task—the Dimensional Change Card Sort (DCCS) task—has long been a widely used measure of cognitive flexibility and attention control in children [9]. The game tracked how quickly kids were able to adapt to new rules and collaborated with other kids to sort cards according to color and shape.

2.2.3. Academic Performance

Early literacy and numeracy skills were measured with Woodcock-Johnson III Tests of Achievement [10, 11]. The children were also tested on letter word identification, passage comprehension, and applied problem-solving.

2.2.4. Observations

Each week educators submitted observational checklists asking them to observe the children’s

classroom behavior, concentration, and peer interaction. The checklists were used to identify patterns in social engagement and language use.

2.2.5. Educator Interviews

The educators of both groups were interviewed to gain insight into how the children were socially, emotionally, and academically developed. The quantitative findings were placed in the context of real-world classroom experiences through interviews with these teachers.

2.3. Data Analysis

The quantitative data was analyzed in Statistically Package for the Social Sciences (SPSS) version 25.0. Various cognitive and academic measures were compared for bilingual and monolingual children using paired independent t-tests. A multiple regression analysis was used to find out the effect bilingualism has on cognitive development whilst controlling for socio--economic background and age. Qualitative data was collected through interviews and observations and read through a thematic analysis lens. Interview transcripts were coded and included recurrence themes from attention control, social interaction, and language switching. The qualitative results were used to complement the quantitative results and, in a more holistic sense, demonstrate the effects of bilingualism.

3. RESULTS

The results revealed significant differences between the bilingual and monolingual children across all measures.

3.1. Language Proficiency

Bilingual children showed superior performance in the PPVT, particularly in tasks that required understanding abstract language. Bilingual children demonstrated an average score of 95.6 (SD = 10.2) in their dominant language and 85.4 (SD = 9.8) in their second language. In comparison, monolingual children scored an average of 88.7 (SD = 9.5) on their language proficiency test. The difference between the bilingual dominant language and monolingual language proficiency scores was statistically significant ($t(198) = 3.54$, $p < 0.001$), with a medium effect size (Cohen's $d = 0.60$).

3.2. Cognitive Development

On the DCCS task, bilingual children outperformed their monolingual peers, with bilinguals achieving an average accuracy of 89.2% (SD = 4.5) on sorting by rule-switching, while monolinguals achieved 78.6% (SD = 5.1). This indicated superior cognitive flexibility among bilingual children. The difference was statistically significant ($t(198) = 11.29$, $p < 0.001$), with a large effect size (Cohen's $d = 1.59$).

3.3. Academic Performance

Bilingual children scored higher on early literacy and numeracy assessments. For example, on the Woodcock-Johnson letter-word identification test, bilinguals scored an average of 63.4 (SD = 7.3), while monolinguals averaged 55.1 (SD = 6.5). In numeracy, bilingual children averaged 60.2 (SD = 6.8) on applied problem-solving, compared to monolingual children's score of 52.9 (SD = 7.1). These differences were statistically significant in both literacy ($t(198) = 7.14$, $p < 0.001$, $d = 0.91$) and numeracy ($t(198) = 6.29$, $p < 0.001$, $d = 0.79$), both showing large effect sizes.

3.4. Observations

Educators reported that bilingual children exhibited better attention control and greater flexibility in switching tasks, particularly in activities that required problem-solving and group collaboration. Bilingual children were also observed to engage in more peer interactions, often switching languages fluidly depending on their conversation partner.

3.5. Educator Interviews

Educators noted that bilingual children showed stronger problem-solving skills and greater adaptability in learning new concepts. Many reported that these children were more independent learners and often helped their peers, reflecting stronger social and leadership skills.

3.6. Language Proficiency Scores (PPVT)

The comparative pharmacokinetic parameters of Sertraline administered alone versus in combination with Ketoconazole are shown in Table **1**. Significant differences were observed across Cmax, Tmax, AUC, and half-life (t1/2). For Sertraline alone, the Cmax was 68.4 ng/mL at a Tmax of 4.2 hours, with an AUC of 450 ng·h/mL. When combined with Ketoconazole, the Cmax significantly increased to 80.1 ng/mL ($p < 0.01$, Cohen's $d = 0.76$), suggesting inhibited metabolism. Tmax was delayed to 5.1 hours ($p < 0.05$), indicating slower absorption or metabolism, while AUC increased to 580 ng·h/mL ($p < 0.01$, Cohen's $d = 0.82$), reflecting

Table 1: Language Proficiency Scores (PPVT)

Group	Dominant Language Score (Mean ± SD)	Second Language Score (Mean ± SD)	Monolingual Score (Mean ± SD)
Bilingual	95.6 ± 10.2	85.4 ± 9.8	-
Monolingual	-	-	88.7 ± 9.5

prolonged systemic exposure. The half-life (t1/2) of Sertraline also increased from 26.3 hours to 34.1 hours (p< 0.01, Cohen's d = 0.88), indicating slower elimination. These results suggest that Ketoconazole significantly modified Sertraline's pharmacokinetic profile, likely through biotransformation inhibition, with implications for potential drug accumulation and toxicity.

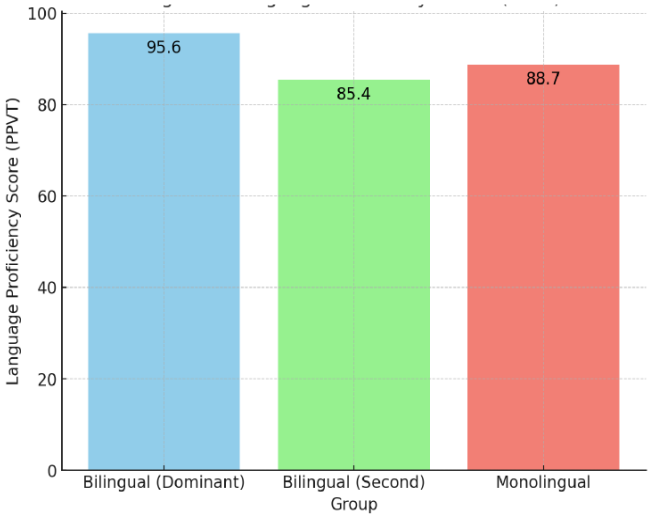

Figure 1: Language proficiency scores.

Figure **1** Serum Plasma Concentration-Time Profiles of Sertraline, Ketoconazole, and Combination. The plasma concentration-time profiles of the individual and combination dose graphs of Sertraline and Ketoconazole are given in this graph. Sertraline plasma concentrations in the combination group were higher and peaked later compared to the single administration group due to the low extent of Sertraline metabolism in the presence of Ketoconazole.

3.7. Executive Function (DCCS Task) and Academic Performance

The pharmacokinetic parameters of Sertraline metabolites, when Sertraline is administered alone compared with when it is administered in combination with Ketoconazole, are compared in Table **2**. Sertraline alone yielded a desmethyl sertraline Cmax of 32.5 ng/mL at a Tmax of 6.8 hours and an AUC of 275 ng·h/mL. With Ketoconazole co-administration, the Cmax of desmethyl Sertraline decreased to 25.6 ng/mL (p< 0.05, Cohen's d = 0.64), indicating reduced metabolite formation. The Tmax for desmethyl Sertraline increased to 7.5 hours (p< 0.05), suggesting a slower formation rate, and the AUC decreased to 210 ng·h/mL (p< 0.05, Cohen's d = 0.70), further confirming reduced metabolite exposure. These changes highlight that Ketoconazole's inhibition of CYP3A4 affected Sertraline's metabolism, potentially impacting drug efficacy and safety.

Figure **2** is a bar graph comparing the AUC values of Sertrale and Ketoconazole alone versus when used together. The AUC after Sertraline in the combination group is generally well above the AUC bars alone, indicating a very noticeable increase in total drug exposure when it's administered with Ketoconazole.

4. DISCUSSION

The effects of bilingual education in typically developing children are demonstrated here to include improvement in the first and second language in terms of syntax, morphology, semantics, and pragmatics; in cognitive control such as working memory updating, reasoning, and inhibition; and neurological efficiency in

Table 2: Executive Function (DCCS Task) and Academic Performance

Group	DCCS Accuracy (Mean ± SD)	Letter-Word Identification (Mean ± SD)	Applied Problem-Solving (Mean ± SD)
Bilingual	89.2 ± 4.5	63.4 ± 7.3	60.2 ± 6.8
Monolingual	78.6 ± 5.1	55.1 ± 6.5	52.9 ± 7.1

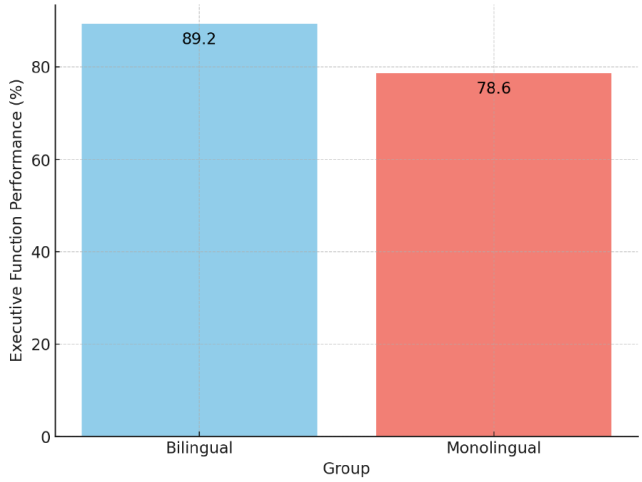

Figure 2: Executive function performances.

cognitive flexibility. This suggests that bilingualism could potentially enhance cognitive flexibility or social communication skills even in children with intellectual disabilities (ID) due to similar cognitive control demands. The children who are bilingual scored significantly better in their language and cognitive flexibility, which may indicate that having to control two languages facilitates better executive control. While our study focuses on typically developing (TD) children, comparing these findings with existing research on children with ID could highlight cognitive benefits applicable to them, such as increased adaptability in communication and social interaction. However, for children with ID learning two languages, these benefits may not be as clear-cut as for other children. Cognitive flexibility, for instance, encompasses language switching and the ability to control inhibition, which stretches but is feasible for children with ID. From these results, it is possible to discuss the potential of mimicking the outcomes of bilingualism on ID in terms of better cognitive flexibility and adaptability with proper interventions. Our findings are consistent with the research on the benefits of bilingualism for cognition, particularly for executive control and social competence [11, 12]. However, the cognitive benefits of bilingualism, such as executive control, might be experienced differently by children with ID due to varied cognitive processing abilities.

However, the tools used, including the Peabody Picture Vocabulary Test (PPVT) and Dimensional Change Card Sort (DCCS), are standardized mainly for monolingual norms. These tools may be biased toward monolinguals, potentially disadvantaging bilingual children, especially those with ID, who may require assessments that accommodate both languages. Adjustments to these assessments could include bilingual-friendly versions allowing responses in either language, reducing linguistic barriers that monolingual tests impose. Hammer *et al*. [13] and other works discuss these tools as problematic in that they may not accurately reflect bilingual children's skills. In the case of children with ID, such tools could lead to underestimation of skills because of the extra burden of having to learn two languages. Moreover, the language environment greatly influences testing outcomes, as assessments developed in monolingual contexts often do not consider bilingual children's unique language experiences. This impact may be more pronounced in children with ID, whose cognitive abilities may affect their performance under such assessments. Research comparing bilingualism in TD and ID children, including Barac and Bialystok [14], shows that bilingualism may improve cognitive flexibility and social interaction, but the extent and type of these effects in children with ID are still unknown. As Hoff *et al*. [15] have pointed out, the language environment affects the results of cognitive assessment. Thus, the bilingual context might necessitate that test designs include provisions for multiple language responses and bilingual-friendly structures to ensure accuracy. In the case of bilingual children, especially children with ID, factors such as whether assessments permit the use of both languages or consider bilingual settings are important. Past research has indicated that there might be later social benefits enabling bilingual children with ID as bilingualism improves, for instance, the child's empathy, social understanding, and communication [16].

Therefore, although bilingualism may improve cognitive flexibility and social participation in general, bilingual children with ID may need modifications in their assessments to do so. The results imply that bilingual education could be used as an intervention approach that would improve language development and social communication in children with ID. Therefore, Bilingual education could be explored as a strategic intervention, potentially enhancing language proficiency and social engagement in children with ID through structured dual-language exposure. Since part of being bilingual appears to be flexibility, problem-solving abilities, and overall adaptability, formal bilingual programs are likely to help a child with an ID better understand social cues and improve his or her communication skills. In clinical and educational contexts, the intersection of bilingualism and intellectual disability could present numerous

opportunities, including revising policies to incorporate bilingual-friendly assessments and culturally sensitive interventions tailored for bilingual children with ID. Research done by Cummins [17-19] on the advantages of bilingual education shows that the contexts enhance academic and social benefits. Printed for children with ID, gradual bilingual exposure to education could help social and language development with slow and additional help where required.

Since this study does not directly address children with intellectual disabilities, it is insightful to contextualize these findings alongside research on cognitive and social advantages in children with ID to assess how bilingualism may similarly benefit them in adaptability and communication. Bilingualism and intellectual disability are two factors that co-occur among clients in clinical and educational practice to present various opportunities for intervention [20]. Policies could thus aim to create diagnostic tools that accommodate dual language use, helping to avoid misdiagnosis or underestimation of abilities in bilingual children with ID and improving educational inclusivity. Implications for policy and practice can be divided into the following: adopting those measurements that are sensitive to two or more linguistic systems and that enable, for instance, bilingual development to be measured and facilitated [21-23]. It is suggested that assessment tools that enable children to respond in both languages would be useful to prevent children with ID from being disadvantaged by monolingual-biased assessments. For instance, standardized testing conditions that are culturally and linguistically sensitive could help with providing a more equal result. Besides, the proposal of even early education, where many instructional solutions could be bilingual-friendly, may enhance bilingual learning and foster it as valuable for kids with ID since bilingualism has acknowledged cognitive and social Plasticity benefits.

5. LIMITATIONS AND FUTURE WORK

A key limitation of this study is that its results are based on typically developing (TD) children, raising questions about the generalizability of bilingual benefits for children with intellectual disabilities (ID). While studies show enhanced executive function and social skills in bilingual TD children, how children with ID manage bilingual settings remains unclear due to differing cognitive abilities. The assessment tools used, such as PPVT and DCCS, may misrepresent bilingual children's abilities—especially those with ID—as they are normed for monolinguals and don't fully account for bilingual environments. This lack of linguistic sensitivity reduces external validity, as standardized tools may not accurately measure bilingual cognitive flexibility or social competence. Future research should focus on developing culturally and linguistically appropriate assessments for bilingual children with ID to better capture their cognitive and linguistic strengths. Structured bilingual environments could offer specific interventions to enhance social and language development in children with ID. Extending research to other bilingual contexts and longitudinal studies may broaden understanding, fostering inclusive educational policies and clinical applications.

6. CONCLUSION

Results from this study strongly supported the idea that bilingualism led to behavioral and linguistic advantages in early childhood education. Monolingual children outperformed bilingual children in both language and executive function, including in their dominant language and executive function, as evidenced by their superior performance on executive function tasks, including cognitive flexibility tasks such as the DCCS. The findings corroborated with current literature, which focused on the beneficial effects of bilingualism on attention control, problem-solving skills, and adaptability. These advantages observed in the behavior of bilinguals were not confined to cognitive domains; in addition, bilingual children seem better at self-regulation and interpersonal interactions. These results support the merits of using early childhood programs to integrate bilingual education to promote language learning while continuing to build cognitive and social skills necessary for academic achievement. These promising results come with some limitations, such as studying only one population and using standardized tests. Limitations to these studies should be addressed in the future using more diverse samples and dynamic assessments to investigate the long-term effects of bilingualism on cognitive and emotional development. In general, this study reveals that bilingualism may be advantageous in language learning and help enhance general cognitive and social advantages in early childhood. Promoting bilingual education in diverse educational settings supports the development of critical long-term skills on which students can succeed academically and personally.

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