

Asian Journal of Human Services

Journal homepage: <https://www.ashs-human.net/international-journal/ajhs/>

Online ISSN: 2188-059X / Print ISSN: 2186-3350

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ORIGINAL ARTICLE

Verification of the Reliability and Construct Validity of the CRAYON BOOK

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ABSTRACT

This study aimed to verify the reliability and construct validity of the CRAYON BOOK, a comprehensive assessment tool designed for early childhood education settings. The CRAYON BOOK assesses five domains: environment and daily life, comprehension, concept formation, consent, and self-expression. Data was collected from 96 children attending four nursery schools in Japan, whose parents consented to their participation. The children's behaviors were observed and evaluated by nursery staff using the CRAYON BOOK. To assess reliability, Cronbach's α was used, confirming high internal consistency across all domains ($\alpha = .844$ to $.982$), with an overall scale reliability of $.989$. Construct validity was analyzed using structural equation modeling, and the results indicated a high goodness-of-fit across all indices. The findings suggest that the CRAYON BOOK is a reliable and valid tool for assessing children's development in early childhood education settings. It allows for the collection of quantitative data, which can help clarify the relationship between educational practices and children's growth. The CRAYON BOOK fills a significant gap in Japan's early childhood education by providing a standardized, practical tool for daily use by teachers, offering insight into both immediate developmental outcomes and potential long-term social and economic effects of early education. Future research should focus on expanding data collection to kindergartens and certified nursery schools to further validate its applicability across different educational settings.

Keywords: reliability, construct validity, structural equation modeling, early childhood education, CRAYON BOOK

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Received: 2024/08/31 ; *Revised:* 2024/10/18 ; *Accepted:* 2024/10/20 ; *Published:* 2024/10/30



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1. Introduction

In recent years, early childhood education has been regarded as important worldwide. A growing literature establishes that early childhood environments substantially impact later life outcomes¹⁻³). Heckman et al. (2010)⁴) show that the Perry program significantly enhanced adult outcomes including, education, employment, earnings, marriage, and participation in healthy behaviors, and reduced participation in crime. All treatment effects displayed there are statistically significant and survive adjustments for multiple hypothesis testing.

In Japan, there are three types of early childhood education: Yochien (kindergartens), Hoikusyo/Hoikuen (nursing schools), and Nintei-Kodomoen (certified children centers). In 2017, the content of these three guidelines was consistent (Table 1).

Table 1. Facilities for Early Childhood Education in Japan

Yochien (kindergartens)
Yochien (kindergartens) falls under the umbrella of the Ministry of Education (MEXT) and its purpose is to prepare children for first grade and beyond. This is done through through academics by MEXT. “Course of study for Kindergarten” is used.
Hoikusho/Hoikuen (nursing schools)
Hoikusho/hoikuen (nursing schools) are facilities that care for infants and young children in place of parents or guardians who are unable to look after their children due to work or other circumstances. The Hoikusho/hoikuen (nursing schools) is under the jurisdiction of the Ministry of Health, Labor and Welfare. “Hoikusho Hoiku Shishin (Guidelines for Nursery Care and Education at Day Nurseries)” is used.
Nintei-Kodomoen (certified children centers)
Nintei-kodomoen (certified children centers) are facilities that combine certain functions and characteristics of Yochien (kindergartens) and hoikusho/hoikuen, and provide childrearing assistance in the community. Nintei-Kodomoen (certified children centers) is under the jurisdiction of the Cabinet Office. “Nintei Kodomo-En Kyoiku Hoiku Yoryo (Guidelines for Education and Childcare Integrated ECEC Centers)” is used

It is not easy to ensure the quality of education by revising the three guidelines for early childhood education in Japan^{5,6}). In addition, the quality of education must be guaranteed regardless of whether a child chooses to attend a kindergarten, nursing schools, or certified children centers. To achieve this, it is necessary to provide infant education according to the characteristics of each child. However, evaluation scales are needed to measure children's characteristics, but many Japanese infant education sites are measured by medical, psychological, and other specialists; for example, intelligence tests⁷). In Japan, nursing school teachers and kindergarten teachers rarely use objective measures to assess children's actual conditions daily. The issue is that the understanding of the actual conditions of children relies solely on the experience of nursing school teachers and kindergarten teachers⁸), and little early childhood education is based on objective data. Scales that can be easily used by childcare workers and kindergarten teachers are needed.

Okada, Kohara & Han (2017)⁹) conducted basic research to develop a comprehensive tool for grasping the actual conditions of early childhood that can be used daily by nursing school teachers and kindergarten teachers. The results

showed the need to incorporate the perspectives of “concept formation,” “talent discovery,” and “parenting support” in understanding the actual conditions of infants and toddlers.

Based on those previous studies, Han (2019)⁵⁾ developed the CRAYON BOOK (Child Rearing Assist for Your Needs book), which is a tool that can be used in early childhood education settings and parenting situations. The CRAYON BOOK has been validated for its content validity¹⁰⁾. The CRAYON BOOK consists of five domains: “Environment and daily life”, “Comprehension”, “Concept formation”, “Consent (Nattoku)” and “Self-expression”. The scale also consists of a total of 206 items, and the total score in each domain allows the scale to measure the state of the educational field. Practical research has been conducted in early childhood education using the CRAYON BOOK; educational practices related to number concepts^{11,12)} and analysis of the developmental process of language concepts and linguistic expressions¹³⁾.

Although the CRAYON BOOK has been theoretically developed and validated for content validity, its reliability and construct validity have not been tested using data. The purpose of this study was to test the reliability and construct validity of the CRAYON BOOK using data accumulated to date.

2. Methods

2.1. Period

From March 2020 to June 2023

2.2. Subjects

Children attending four nurseries whose parents consented to their participation in the study.

2.3. Evaluation

The children's behavior was observed by daycare staff and assessed using the CRAYON BOOK.

2.4. Statistical Analysis

Cronbach's α was used to verify the reliability of the scale, and structural equation modeling was used to verify the construct validity of the scale. The SEM uses GFI (Goodness-of-fit index), CFI (Comparative Fit Index), and RMSEA (Root Mean Square Error of Approximation) as goodness-of-fit indices for validation. The conditions for goodness-of-fit indices are as follows: $GFI > 0.9$, $CFI > 0.9$, $RMSEA < 0.05$.¹⁴⁾ IBM SPSS ver.28 was used for the reliability analysis, and IBM Amos ver.28 was used for the validity analysis.

2.5. Ethical Considerations

At the nurseries where the study was conducted, the research content was explained in writing to all parents of the children. Additionally, nursery teachers provided direct explanations to parents through interviews and obtained their consent for the children's participation in the study. The author received the evaluation data anonymously, ensuring that individual children could not be identified.

3. Results

Evaluation data were obtained from 96 children at four nurseries, whose parents consented to their participation in the study. The characteristics of the children are shown in Table 2.

Table 2. Characteristic of children

		Mean (month)	SD (month)
Age			
Sex	Male	58 (60.4%)	32.04
	Female	38 (39.6%)	10.63

The reliability analysis using Cronbach's α confirmed high reliability in all domains (.844-.982) (Table 3). Additionally, very high reliability was confirmed for the overall scale (.989).

Table 3. Results of Cronbach's α

Domain	Mean (Max)	SD	Cronbach's α
Overall scale	623.54 (1030)	130.53	.989
Environment and daily life	204.20 (235)	13.44	.844
Comprehension	50.02 (60)	9.09	.906
Concept formation	165.56 (330)	58.70	.982
Consent	46.98 (55)	6.51	.822
Self-expression	162.78 (350)	58.38	.981

The goodness-of-fit analysis using structural equation modeling to verify construct validity also confirmed high goodness-of-fit across all indices. The structural equation model used for the study is shown in Figure 1.

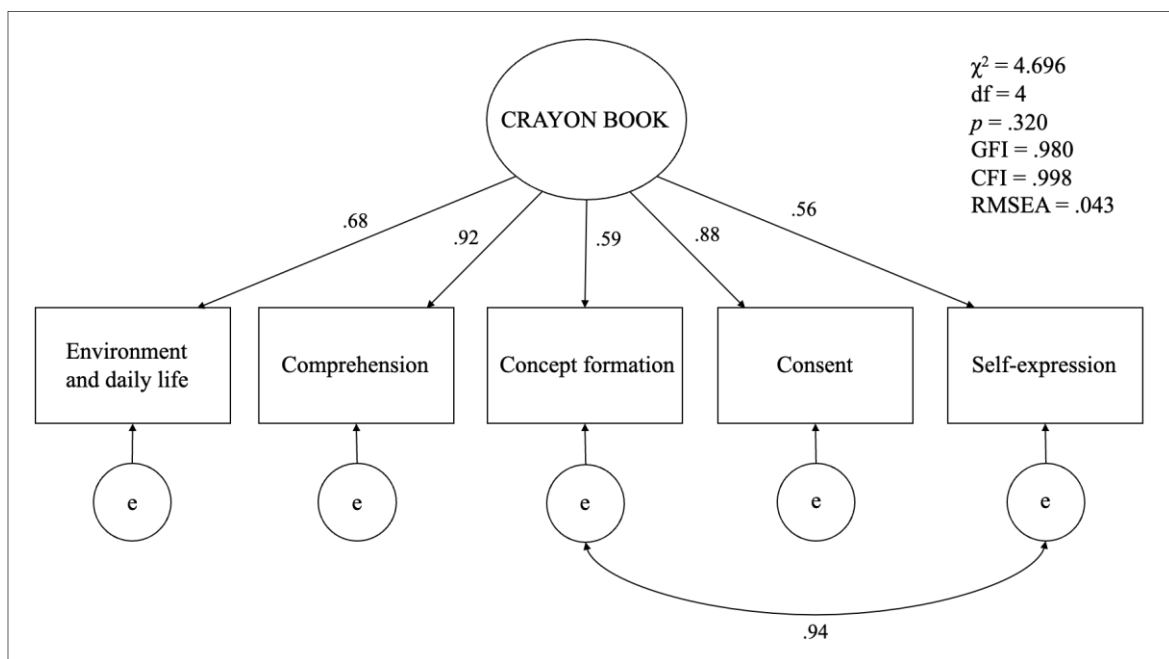


Figure 1. Structural Equation Modeling of CRAYON BOOK

4. Discussion

This study aimed to verify the reliability and validity of the CRAYON BOOK, a comprehensive scale designed to evaluate the early childhood education environment, caregivers' interactions with children, and the development of children's concept formation and self-expression. The results of statistical analyses of the data collected at daycare centers verified high reliability and construct validity.

In the structural equation model used to verify construct validity (Figure 1), covariance was observed between the domains of concept formation and self-expression, confirming a high correlation in the children's development. While the domains of “environment and daily life”, and “comprehension”/ “consent” reflect the evaluators' assessment of education, the domains of concept formation and self-expression represent an assessment of children's development. It is reasonable to consider that these domains, especially, showed high relevance as they reflect the children's growth as perceived by the evaluators.

In early childhood education in Japan, it has been pointed out that many scales are difficult for kindergarten and daycare teachers to evaluate on a daily basis ⁷⁾. Early childhood children grow every day, and there is a need for scales that allow teachers to incorporate professional elements and assess them regularly ⁷⁾. The CRAYON BOOK's reliability and validity were verified based on data evaluated by daycare staff, confirming its usefulness as a scale for assessing and recording children's growth. As a result of this study, the CRAYON BOOK became the first comprehensive assessment scale in Japan's early childhood education field, capable of assessing children's development on a daily basis, which had been a long-standing need⁹⁾.

The CRAYON BOOK is designed as a comprehensive assessment scale, capturing the multifaceted nature of early childhood education. By analyzing these aspects, it is expected to clarify how the quality of early childhood education influences children's cognitive development, such as language, mathematics, and artistic sense.

In Japan's early childhood education facilities, education is provided based on standardized guidelines, and the use of the CRAYON BOOK is expected to improve the quality of early childhood education across all facilities. As quantitative data accumulated using the CRAYON BOOK at each facility grows, it will help to clarify which early childhood education practices are linked to children's development. Globally, numerous studies, such as the Heckman Report, have measured the outcomes of early childhood education from social and economic perspectives, emphasizing its importance; For example, The Perry Pre-school Project⁴⁾, National Institute of Child Health and Human Development¹⁵⁾, The Effective Pre-school, Primary Education and Secondary Education¹⁶⁾. However, these studies have not evaluated the early childhood education practices themselves, leaving room for detailed analysis of what types of education lead to which social outcomes. By using the CRAYON BOOK to assess and record early childhood education and collecting longitudinal data over the long term, it is expected that the challenges of previous research can be addressed, enabling a more detailed analysis of the relationship between children's growth through early childhood education and their future social and economic outcomes.

5. Limitations and Future Research

The CRAYON BOOK was developed as a comprehensive assessment scale for early childhood education. By increasing the amount of data collected in the future, it will be possible to comprehensively understand how the content of early childhood education influences children's development. If the causal relationships between the individual items can be clarified in detail, it will also be possible to elucidate the relationship between the quality of early childhood education and children's growth.

The CRAYON BOOK was developed as a comprehensive assessment scale for early childhood education. By increasing the amount of data collected in the future, it will be possible to comprehensively understand how the content of early childhood education affects children's development. If the causal relationships between the individual items can be clarified in detail, the relationship between the quality of early childhood education and children's growth can also be elucidated.

Acknowledgments

We would like to extend our sincere appreciation to the teachers of the daycare centers for their invaluable assistance in the data collection process for this study.

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