



Università
Ca' Foscari
Venezia

Master's Degree Programme

In

Languages and Civilizations of Asia and Mediterranean Africa (Japanese)

Thesis

**The importance of “handwriting” in a digital society
and the reconstruction of literacy skills—focusing on
the role of handwriting and calligraphy in Japanese
education—**

Supervisor

Prof. Paolo Calvetti

Co.Supervisor

Prof. Giuseppe Pappalardo

Degree Candidate

Mina Hamamoto

Student ID number [908711]

Academic Year

2024/2025

Index

Introduction ...pp.4-5

Chapter 1 : The multilayered nature of Japanese language and the challenges of “writing”

1.1 Coexistence of four different writing systems: The cognitive load placed on learners by the mixing of *hiragana*, *katakana*, *kanji*, and *rōmaji* ... pp.6-13

1.2 The vast system of *kanji*: The process of mastering the 2,136 commonly used *kanji* and the curriculum for the nine years of compulsory education ... pp.13-15

1.3 The difference between “reading” and “recognizing”: The cognitive differences between ‘selection’ through digital conversion and reproduction through handwriting ... pp.15-19

Chapter 2 : The emergence of calligraphy education and the sociological significance of “beautiful (Neat) handwriting” in Japan

2.1 The history of handwriting education in Japan ... pp.20-23

2.2 The distinction and fusion of transcription and calligraphy ... pp.23-26

2.3 “Neat handwriting” as a social norm ... pp.26-30

Chapter 3 : Embodied intelligence—the role of stroke order and writing instruments—

3.1 The logic behind stroke order ... pp.31-36

3.2 Stationery as an auxiliary tool and the evolution of the culture of “writing” ... pp.36-39

3.3 Touch and memory: The effects of handwriting on the brain from a scientific perspective ... pp.39-48

Chapter 4 : Changes in literacy skills brought about by digitalization

4.1 Literacy rates and the “quality of literacy” from the postwar period to the present ... pp.49-56

4.2 The decline in time dedicated “writing,” as observed through statistics ... pp.56-63

4.3 The phenomenon of *kanji* attrition and the overall decline in literacy skills among the digital native generation ... pp.63-71

Chapter 5 : Redefining the role of handwriting in developing literacy skills

5.1 Spatial cognition and character structure ... pp.72-81

5.2 Persistent thinking skills ... pp.81-86

5.3 A suggestion for a hybrid approach to Japanese language education ... p.86-95

Conclusion ... pp.96-99

Bibliography

- Sources ... pp.100-104
- Documents and materials from the Internet (Webography) ... p.105

Introduction

In the global imagination, Japan is regarded as one of the world's most technologically advanced countries and a leader in digital integration. Yet underneath this high-tech facade lies a profound and enduring commitment to the physical act of writing. As the new world standard moves toward a paperless, digitalized existence, Japan finds itself at a critical juncture: the GIGA School program, which provides one digital device for every student, high-speed Wi-Fi environment, and modernized education. It also integrates cloud tools, digital textbooks, and AI-driven personalization to replace traditional lectures. This now clashes with a centuries-old tradition of calligraphic education for the development of literacy. The acceleration and increasing demand for online learning due to the COVID-19 pandemic has significantly intensified this tension, resulting in a remarkable reduction in opportunities for practicing manual writing in the classroom.

While exploring if digital transitions are compromising the cognitive foundations of Japanese literacy, this research analyzes that manual text production remains an irreplaceable pillar of literacy acquisition, even in a digital-first era, due to the unique structural complexity of the Japanese writing system. To understand the necessity of handwriting practice in Japan, one must first acknowledge the unique stratification of its writing system. Unlike alphabetic languages, Japanese relies on the symbiotic coexistence of four distinct scripts: *hiragana*, *katakana*, *kanji* (Chinese characters), and *rōmaji* (the Latin alphabet). The cognitive load required to navigate this system is immense. Through nine years of compulsory education, a student must master a total of 2,136 *jōyō kanji* (*kanji* characters designated for common use). This process involves more than memorizing shapes; it demands a broad comprehension of the internal logic of characters, including their components, such as *hen* (left-side radical), *tsukuri* (right-side radical), and *kanmuri* (top radical).

The current digital shift has given rise to a phenomenon in which “digital natives” can recognize and read characters but struggle to recall how to write them, mnemonic difficulties that threaten deep structural understanding of the language. The Japanese education system considers handwriting not simply as a physical skill, but as a fundamental pillar of national language education. All students in elementary and middle school are required to participate in *shosha*

(practical penmanship). Unlike *shodō* (literally translated as the Way of calligraphy), which is also appreciated as an artistic and spiritual examination, *shosha* focuses on the utility, precision, and legibility of handwritten characters. Within Japanese pedagogy, students are introduced early to *hitsujun* (correct stroke order), a practice based in the belief that the flow and sequence of strokes are essential to a character's structural integrity and aesthetic balance. This emphasis reflects a larger cultural conviction: that an ordered hand is the mark of a disciplined mind. Such beliefs persist in adulthood and professional life; for instance, many Human Resources departments still require handwritten résumés as a measure of an applicant's reliability, character, and sincerity. This traditionalism exists in complex tension with Japan's rapid social digitalization.

Despite the expansion of digital devices, many companies and institutions maintain a deep-seated reliance on paper-based materials for meetings and records. This persistence is partly rooted in the culture of *inkan* (personal seals), where the physical act of stamping one's surname remains the definitive mark of approval. While digital *inkan* are emerging, physical documents still retain a unique "official" gravity until today. This is most evident in governmental processes. Passport applications, for example, continue to authorize original paper documents (such as copies of birth certificates) over digital reproductions. The central hypothesis of this research is that this preference for paper is not merely bureaucratic inertia, but a recognition of handwriting as an act of embodied cognition. Therefore, writing by hand is not simply mechanical repetition; it is a process of securing concepts through the body. The tactile resistance of paper and the pressure of the pen create a sensory interaction that stimulates the brain's linguistic centers more effectively than choosing characters on a digital screen. The global success of high quality and performance Japanese stationery, from precision mechanical pencils to specialized *kanjireنشūchō* (kanji-practice notebooks) serves as further evidence of the cultural conviction that writing by hand remains a fundamental human technique that digital tools cannot fully replace. As the digital dependency of new generations rises, available data indicate a decline in students' vocabulary and composition skills compared to the pre-ICT era. What we may be witnessing is a shift from the elimination of total illiteracy to the rise of functional illiteracy, where individuals can break down text but lack a deep grasp of its meaning.

Chapter 1: The Multilayered Nature of Japanese Language and the Challenges of “Writing”

1.1 Coexistence of four different writing systems: The cognitive load placed on learners by the mixing of *hiragana*, *katakana*, *kanji*, and *romaji*

The writing system of the modern Japanese language represents one of the most complex, layered, and fascinating orthographic landscapes. According to *Kokugo seisaku hyakunenshi* (One Hundred Years of Language Policy), Agency for Cultural Affairs (2006) points out that “the Japanese language as a native language, not only plays a role in an individual’s personal development throughout their life, but also serves as the foundation for society as a whole to preserve, create, and develop culture, as well as to build and maintain a better society.” (母語としての国語は生涯を通じて個人の自己形成にかかわるだけでなく、社会全体にとっても、文化を継承し創造・発展させるとともに、より良い社会を構築し維持していく基盤となるものです。) ¹Unlike the majority of historical-natural languages, which rely on a single writing system of a predominantly phonetic or logographic nature, such as the Latin, Cyrillic, or Arabic alphabets, Japanese is characterized by the coexistence and constant synergistic interaction of four distinct graphic codes within the same textual space: *kanji* (Chinese characters), *hiragana*, *katakana* (the two phonetic syllabaries collectively designated as *kana*), and finally, *rōmaji* (the Latin alphabet). Each of these systems fulfills precise and irreplaceable morphological, syntactic, lexical, and pragmatic functions. *Kanji* function primarily as logograms, conceptual meanings and lexical roots such as nouns, verbal and adjectival stems. *Hiragana*, characterized by cursive and rounded strokes, is a phonetic syllabary (phonogram) designed for writing grammatical elements, particles, inflectional suffixes (*okurigana*), and native words lacking a corresponding logographic character. *Katakana*, with its sharp and angular lines, is also a phonogram, notably used, nowadays, for transcribing loanwords from foreign languages (*gairaigo*), Western proper nouns, onomatopoeias, and terms to which a particular visual or emphatic elevation is intended to be given. Lastly, *rōmaji* is used for international acronyms, indexing purposes, digital input interfaces, and technological environments.

¹ 国語施策百年史, Agency for Cultural Affairs, 2006, 序, p.2, line 7.

This graphic density inevitably raises intricate questions from the perspectives of psycholinguistics, cognitive sciences, and second language acquisition. Explicitly, the analysis of this phenomenon must be bifocal; amid for Japanese native speakers, the coexistence of four different characters that are morphologically and functionally so diversified represents an optimized mechanism for the rapid and fluid comprehension of texts, for learners of Japanese as a second or foreign language, it establishes one of the primary sources of cognitive load, demanding an enormous effort on the architecture of working memory and the acquisition of mental reading schemas. In the field of the psychology of reading and visual information processing, a fundamental presumption concerns the modalities through which the human eye scans written text via intermittent movements and eye fixations. In western languages, the segmentation of the textual flow into units provided with autonomous meaning of words is systematically guaranteed by using interword spacing. The Japanese language, on the other hand, historically adopts *scriptio continua*, which is a linear writing without blank spaces and separating the components of a sentence.

Due to the absence of physical word spacing, the function of lexical and morphological delimitation is attained precisely by the orthographic alternation between different writing systems, a phenomenon known as *kanji-kana-majiri* (mixed writing of Chinese characters and *kana*). For a Japanese native speaker, this graphic differentiation possesses a highly functional nature. *Kanji*, emerging visually on the graphic plane thanks to their greater structural complexity and stroke density, function as actual “visual beacons” or semantic foundations that indicate the beginning of a word enabled with full lexical meaning, such as a noun or the root of a verb. Immediately following, the presence of *hiragana* characters, visually lighter and curvilinear, signals the presence of relational or inflectional elements, such as syntactic particles or conjugational endings. This sharp morphological contrast allows Japanese native reader to perform an automatic and immediate division of the text at a sub-attentive level. As mentioned in the official guidelines concerning the nature of characters for common use (*Jōyō kanji no jitai jikei ni kansuru shishin*, 2016), the physiognomy and abstraction basic in the “character form” (*jitai*, 字体) act as stable integrated configurations that are recognized directly by the brain without the need for a prolonged phoneme-by-phoneme decoding. The reading process in fluent Japanese readers does not rely primarily on sequential phonological recoding; rather, it operates through direct visual-

orthographic recognition, in which conceptual meaning is activated in parallel by the graphic configuration of *kanji* (Amano, 1987; Tzeng & Singer, 1978-1979). As reading skills mature, analytical decoding shifts toward an automated visual analyzer (Gibson & Levin, 1975; Amano, 1987). Consequently, the visual contrast between the geometric density of *kanji*, the fluidity of *hiragana*, and the angularity of *katakana* provides an automatic visual segmentation mechanism that enhances reading speed and fluency compared to homogeneous graphic scripts (Amano, 1987).

To prove the absolute functionality of this mixed writing system, psycholinguistic and pedagogical research has frequently analyzed the effects of dismantling a text of this graphic alternation. If a native adult Japanese reader is subjected to a text entirely written in a single writing system, *hiragana* alone for instance, one witnesses a true cognitive paradox; the reading speed drops drastically, and comprehension times are significantly lengthened. Without the assistance of *kanji* as visual and conceptual demarcations, the text turns into an undifferentiated sequence of phonetic syllables. The adult reader is forced to abandon the strategy of direct visual recognition and must activate taxing processes of phonological recoding and contextual disambiguation to mentally reconstruct word boundaries and identify correct syntactic links. This phenomenon is further aggravated by the exceptionally high rate of homophony that characterizes the Japanese language; While spoken Japanese relies primarily on context to resolve homophony, *kanji* provide an immediate graphic distinction in written text. This is particularly valuable in headlines, where words like *kōshō* or *shisen*, which possess dozens of different meanings can be identified instantly without relying solely on surrounding context. The elimination of logographic characters thus generates a paralyzing semantic ambiguity that forces the mind into a continuous process of post-hoc hypothesis generation and verification over the text.

The sole exception to this scenario is represented by preschool children or those in the very first years of primary education. As thoroughly documented in the *Commentary on the Course of Study for Elementary Schools: Japanese Language*, (MEXT, 2017), the initial linguistic development of the child is based on a mental lexicon built on a predominantly phonic-aural basis. For children who only know these characters (*hiragana* and *katakana*), reading monocomponent texts is primarily more accessible because they maintain a solid oral linguistic competence and simply need to map the sounds they already know onto elementary graphic symbols with a one-on-one correspondence (one character = one mora).

However, as described in the same ministerial document (MEXT, 2017), this phase is strictly transitory. As soon as the child's vocabulary expands and confronts more articulated and abstract textual structures, the educational system systematically and progressively introduces *kanji* precisely in order to overcome the limits and inefficiency of purely phonetic reading, educating the pupil toward a mature, fluid, and differentiated decoding. The necessity of preserving and regulating this articulated graphic system, recognizing its fundamental value for daily life and the intellectual efficiency of the nation, has been the focus of fierce historical debates and institutional language policies in Japan over the last two centuries.

While reconstructed in the historical work “National Language” Education and Kanji Policy in Modern Japan (Xing Zhenyi, 2008), the modernization introduced in the Meiji era with the launch of the national school system, *Gakusei*, in 1872, immediately faced the problem of the efficiency of writing. Many intellectuals of the era and radical reformers proposed the total abolition of *kanji*, considering them an archaic, medieval, and cumbersome burden that slowed down mass education. They encouraged a transition to a writing system exclusively based on *kana* or even the complete romanization of the language via *rōmaji*. These debates led to the establishment of specific state organs, such as the National Language Research Committee (*Kokugo Chōsa Iinkai*, 1902), tasked with studying systemic orthographic reforms (Agency for Cultural Affairs, 2006). Despite both strong internal and external pressures, particularly during the Allied occupation period following World War II, when an attempt was made once again to lay down *rōmaji* to facilitate democratization and simplify literacy, the Japanese state deliberately chose not to give up the mixed system. Institutions and linguists understood that the elimination of *kanji* or one of the syllabaries would harm the cognitive, expressive, and deep comprehension capacities of citizens, compromising the transmission of cultural heritage and the accuracy of public and scientific communication. Therefore, reforms were oriented not toward abolition, but toward a rationalization and limitation of the number of characters for common use (from the *Tōyō Kanji* list of 1946 to the current *Jōyō Kanji Hyō*), establishing a sustainable balance between the innate complexity of the system and the practical necessity of securing universal literacy.

In the current *Commentary on the Course of Study for Elementary Schools: Japanese Language* (*Shōgakkō gakushū shidō yōryō kaisetsu: kokugo-hen*, 小学校学習指導要領解説 国語編) and Lower Secondary School (*Chūgakkō gakushū shidō yōryō kaisetsu: kokugo-*

hen, 中学校学習指導要領解説 国語編), promoted by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) in 2017, the management of the coexistence of the four characters is structured according to a rigorous spiral pedagogical progression. The Japanese educational system splits the learning objectives of the national language into structural macro-areas. Especially, the acquisition of writing systems is included under the category of “Knowledge and Skills” (*chishiki and ginō*, 知識及び技能), but it is steadily regulated in relation to the development of the “Abilities of Thinking, Judgment, and Expression” (*shikōryoku, handanryoku, hyōgenryoku*, 思考力、判断力、表現力等). This involves learning the different letters is not understood as a mere exercise in isolated mechanical memorization, but as the acquisition of an integrated cognitive tool, indispensable for textual interaction and comprehension in daily life. In primary school, the curriculum prescribes the gradual learning in total of 1,026 characters of *kanji*, associated simultaneously with the combination of *hiragana* for syntax and *katakana* for specific lexical functions (onomatopoeia, scientific terms, loanwords) (MEXT, 2017). With the transition to lower secondary school (MEXT, 2017), students complete the study of the 2,136 characters of the common-use list (*jōyō kanji*), further expanding their competence in using *rōmaji* for technological purposes and international documenting. The ministerial documents highlight how this multidimensional mastery is a fundamental prerequisite: for a Japanese citizen, knowledge of each of these characters cannot be lacking, because the absence of even one of them would preclude access to fundamental portions of daily social, informational, and professional dissertations. While for the native speaker, the co-presence of these four graphic codes translates into automation, fluidity, and reduced annotative effort, for the non-native learner (Japanese as a second language or foreign language learner) the same orthographic structure constitutes one of the primary sources of cognitive load, constructing itself as a linguistic and executive barrier of the top tier.

Referring to the Cognitive Load Theory developed by John Sweller (1988), the human mind possesses a working memory characterized by an extremely limited capacity for processing information in terms of time and attentional space. Sweller (1988) highlights that effective learning and expertise rely on the acquisition of domain-specific knowledge structures known as schemas, which allow individuals to categorize information and optimize their processing capacity. When learners lack the appropriate schemas, they are forced to depend on general, highly demanding

problem-solving strategies that require a large amount of cognitive processing capacity. Because human cognitive capacity is fixed, devoting entire mental resources to managing complex information restricts selective attention and leaves insufficient capacity available for schema acquisition and learning. When a non-native learner comes up against a text in contemporary Japanese, their working memory is subjected to an overload because of three main factors in subsequent:

1. The intrinsic cognitive load of multiple mapping: The learner must operate at the same time on graphic codes based on radically opposite principles. They must process *kana* syllabaries (stable phonograms) and simultaneously *kanji* (complex logograms). Furthermore, for every single *kanji*, they must not memorize a single phonetic association, but rather a plurality of readings historically based on the encounter between the native language and the Chinese language (the *on'yomi* and *kun'yomi* readings). The selection of the correct reading fully depends on the syntactic environment and the lexical context, forcing the student into continuous observation and cognitive switching that saturates short-term memory resources.
2. The extraneous cognitive load coming from visual complexity: The structural decoding of *kanji* requires a detailed analysis of the order and direction of strokes, as well as the recognition of internal components called radicals (*bushu*). As evidenced in the guidelines on character shapes (*Guidelines on Character Styles and Forms in the List of Commonly Used Kanji*, 常用漢字表の字体・字形に関する指針, 2016), minimal graphic variations (*jikei*, 字形), points of contact, and the presence of strokes ending with an abrupt stop (*tome*), a hook (*hane*), or a sweep (*harai*) require a very fine visual-spatial attention. For a native, these variations fall within an internalized abstract concept (*jitai*), when in fact for a foreigner, they represent a visual disturbance factor that weighs heavily on the visual-dimensional sketchbook of working memory²
3. The bottleneck of lexical decoding: Because the student's working memory is entirely adapted by the low-level effort aimed at recognizing individual *kana* characters, identifying the meaning of the *kanji*, and selecting its appropriate reading, a dramatic temporal phase

² Sweller (1988: 259) mentioned that "Novices, not possessing appropriate schemas, are not able to recognize and memorize problem configurations and are forced to use general problem-solving strategies [...] when faced with a problem."

shift occurs. The necessary remaining cognitive resources for high-level processes, such as macro-textual comprehension, syntactic analysis of the sentence, semantic integration, and long-term retention of content turn out to be drastically reduced or completely exhausted.

This explains why the reading and comprehension times of a non-native learner are infinitely longer compared to those required for a text in a language equipped with a linear and transparent alphabet. The foreign student experiences a constant sense of mental fatigue since the mixed-linear orthography of Japanese requires a parallel and constant activation of different brain modules for example, visual, logographic, syllabic, and alphabetic that have not yet been automated through years of schooling and linguistic engagement.

Therefore, the in-depth analysis of the coexistence of four different writing systems in modern Japanese features a profound asymmetry between the cognitive experience of the native speaker and that of the non-native learner. For the Japanese linguistic community, the combined use of *kanji*, *hiragana*, *katakana*, and *rōmaji* is not a historical elaboration or an artificial complication, but a highly evolved and functional orthographic device. It ensures maximum fluidity and reading speed, resolves structural problems related to homophony and *scriptio continua*, and performs as a pillar for the organization of critical thinking and communication in daily life. As historically confirmed by national institutions and strictly applied in modern educational programs (*Gakushū shidō yōryō kaisetsu*, 学習指導要領解説), mastery of each of these four codes is an essential condition for practical and civic literacy. Ministerial Curricular Guidelines for Primary School suggests the importance of language art education as “to help students understand the characteristics of the Japanese language as it relates to daily life and use it appropriately.”

(日常生活に必要な国語について, その特質を理解し適切に使うことができるようにする。)³ This is consistent with the educational philosophy that places the appropriate use of the Japanese language in daily life and the cultivation of critical thinking and imagination at the core of its educational goals.

³ 小学校学習指導要領, p.15, 国語科の目標.

From a glottodidactical perspective, this awareness commands the development of targeted teaching methodologies for foreign students. Cognizant of the enormous intrinsic and extraneous cognitive load that the mixed system exerts on the working memory of learners, instructors must not fall into the error of oversimplifying texts by eliminating *kanji* on the part of writing exclusively in *hiragana* or *rōmaji* for prolonged periods; such a pedagogical choice would prevent students from developing those visual text-segmentation schemas that form the basis of adult reading fluidity. To balance character acquisition and communicative competence, one viable approach adapts the systematic progression of Japanese elementary curricula, aligning character learning directly with contextualized usage. By reducing extraneous load through the use of clear textual supports, the analytical decomposition of *kanji* radicals, and gradual exposure to loanwords in *katakana*, it is possible to lead the non-native learner toward a progressive automation of decoding processes, ultimately allowing them to appreciate the extraordinary efficiency and expressive richness of this unique graphic ecology.

1.2 The Vast System of *Kanji*: The process of mastering the 2,136 commonly used *kanji* and the curriculum for the nine years of compulsory education

The modern landscape of Japanese literacy is anchored by the *jōyō kanji* (Characters for Daily Use), a list currently consisting of 2,136 characters. The selection of these characters was not arbitrary, but the result of a century of language policy aimed at balancing tradition with the practical needs of a modernizing state. As described in the One Hundred Years of Language Policy (Agency for Cultural Affairs, 2005), the initial post-war era saw the introduction of the *tōyō kanji* in 1946, which was purposed to limit the number of characters to 1,850 to improve literacy and simplify printing. This confining policy eventually grew into the more flexible *jōyō kanji* list in 1981, which was further expanded in 2010 to its current count. The selection criteria focused on high-frequency characters found in modern media, law, and daily life, ensuring that a citizen with a standard education could maneuver the complexities of contemporary society. A crucial moment in the history of *kanji* was the simplification of character forms. Before 1946, the standard was *kyūjitai* (Old Character Forms), which often featured sophisticated and labor-intensive stroke counts. The move toward *shinjitai* (New Character Forms) was driven by a need for efficiency in both writing and printing. The Guidelines on Kanji Forms (*Jōyō kanjihyō no jitai jikei ni kansuru*

shishin, 常用漢字表の字体・字形に関する指針) perceive that while these simplifications made the script more accessible, they did not entirely eliminate the old forms. *Kyūjitai* persist today in specific “islands” of tradition: they are frequently found in surnames to preserve family lineage and heritage, in old novels where they offer a specific historical atmosphere, and in historical documents. This dual existence creates a bi-layered literacy where modern speakers primarily use simplified forms but must recognize older forms in formal or cultural contexts.

The mastery of *kanji* is a central pillar of the Japanese compulsory education system, which spans six years of elementary school and three years of junior high. According to the Elementary School Course of Study (*Shōgakkō gakushū shidō yōryō*, 小学校学習指導要領), children are introduced to 1,026 *kyōiku kanji* (kanji for educational purposes) progressively by the end of the sixth grade. The Junior High School Course of Study (*Chūgakkō gakushū shidō yōryō*, 中学校学習指導要領) then assigns students with learning the remaining characters of the 2,136-character *jōyō* list, concentrating on reading and understanding them within more abstract and academic texts. However, recent trends indicate a rising demand for literacy beyond the compulsory level. As higher education in high schools and universities becomes the norm, students are increasingly expected to master *hyōgai kanji* (extra-tabular characters) and specialized terminology. This shift reflects a society where standard literacy is no longer sufficient for professional or academic success, pushing the boundaries of what is considered commonly used. This structured, pragmatic curriculum in Japan contrasts sharply with the pedagogy found in China. As detailed in Deno (2022), Chinese literacy is fundamentally tangled with artistic and cultural identity from an early stage. While Japanese children practice *kanji* primarily as a practical skill for standard daily life, Chinese students begin with formal *shufǎ* (calligraphy) education in the third grade as part of their language arts curriculum. Rather than relying on modern standardized forms, their education focuses on the accurate replication (*rinsho*) of classical masterworks by calligraphers like Ouyang Xun and Yan Zhenqing. This cross-cultural deviation proves that while Japan approaches character mastery through a linear, utilitarian educational framework, meanwhile China encloses character learning within a deeper matrix of national heritage and aesthetic appreciation from childhood.

While *kanji* originated in China, Japan has significantly localized the script. Deno’s research, “An Assessment of the Current State and Challenges of Calligraphy Education in Japan:

With a Focus on a Comparison with Calligraphy Education in China” (*Nihon no shosha shodō kyōiku no genjō ninshiki to kadai: Chūgoku no shohō kyōiku to no taihi o chūshin ni shite*, 日本の書写・書道教育の現状認識と課題—中国の書法教育との対比を中心にして—)

(2022) remarks that there are characters exclusively used in China and others unique to Japan, known as *kokuji* (national characters). These logograms, referred to as *kokuji* (national characters), were coined sectionally to express specific Japanese words using traditional character-formation principles, with examples including *hataraku* (働く - 'to work') and *tōge* (峠 - 'mountain pass'). This divergence illustrates that kanji is not merely a borrowed script but a living, adapted system that reflects the specific ecological and cultural realities of Japan. A common misunderstanding of the Japanese script is the belief that *hiragana* and *katakana* are separated from *kanji*. In practice, both phonetic systems are derived from *kanji* through a process of extreme simplification known as *man'yōgana*. In general terms, *hiragana* originated in the cursive simplification of entire characters, while *katakana* was formed by taking specific fragments of characters to serve as phonetic transcription. Both processes serve distinct phonetic and stylistic functions from their inception. There is a fascinating historical paradox in how these scripts are taught. In the modern classroom, children learn *hiragana* and *katakana* first because they are phonetically simpler and easier to write. However, historically, *kanji* was the first script accepted and used in Japan. The development of *kana* followed centuries later as a means of writing more quickly and facilitating the reading of Chinese texts by adding Japanese grammatical markers. The educational decision to teach *kana* first is a modern luxury of intermediate ease, disregarding the chronological reality where the complex “parent” (*kanji*) arrived long before the “children” (*kana*) were born. Evidence from the One Hundred Years of Language Policy (Agency of Cultural Affairs, 2005) suggests that this sequence was formalized to reduce the initial barrier to entry for young learners, even though it reverses the actual evolution of the Japanese language.

1.3 The difference between “reading” and “recognizing”: The cognitive differences between ‘selection’ through digital conversion and reproduction through tawdriving

The landscape of human expression is withstanding a seismic shift. As information technology filters every facet of daily life, the act of writing has transitioned from a physical

movement of pen on paper to the digital manipulation of keys and screens. According to the Public Opinion Survey on the Japanese Language (2021), over 90% of respondents believe that the spread of information devices is altering how language is used, with the primary concerns being the decrease in handwriting and the decline in the ability to write *kanji* accurately⁴. For adults, this shift may seem like a matter of efficiency. However, for children in the educational stages of literacy, the transition involves a fundamental change in cognitive processing. “Thought and language,” written by Lev Vygotsky (1934) argued that language is not just a tool for communication but a mediator of thoughts that promotes cognitive development⁵. Writing allows a child to transform fleeting, abstract thoughts into solid, visible forms. When this process is interfered by a digital selection system rather than a manual reproduction process, the nature of how a child recognizes and understands a letter changes.

The historical and biological significance of the hand cannot be exaggerated. Philosophers like Kant and modern neurologists alike have referred to the hand as the external brain or second brain. This is not merely metaphorical; Penfield’s study⁶ (1975) reveals that approximately 30% of the cerebral cortex is dedicated to controlling the movement and sensation of the hands and fingers. The act of handwriting, grasping a pen, applying pressure on paper, and moving in specific directions, engages these neural pathways in a way that typing cannot. Research by Wilson (1998) underlines that the evolution of the human brain is mostly linked to our ability to control our fingers with precision. When children use physical materials to write, they are not just outputting data; they are stimulating the sensory-motor systems that support cognitive health and development. Contrawise, a lack of manual practice may lead to the stagnation of the neural systems associated with these complex movements. The title of this chapter highlights a critical distinction: the difference between reproducing a character and simply choosing one.

1. Reproduction (Handwriting): When a child writes by hand, they must retrieve the visual image of the character from long-term memory and reconstruct it stroke by stroke. This is a generative process. To write a *kanji* character like “書” (‘to write’), the child must

⁴ Minagawa, Takeuchi, (2024), “A Study on Education That Takes into Account the Cognitive and Thinking Processes Associated with “Handwriting” and “Typing,”” p.136, line 4-12.

⁵ Vygotsky, L. S.(1934), Thought and language. Takeguchi, Minagawa (2024) “A Study on Education That Takes into Account the Cognitive and Thinking Processes Associated with “Handwriting” and “Typing,”” Naruto University of Education Research Bulletin Vol. 39 (p.155-165)

⁶ Takeguchi, Minagawa (2024: 155-156) cited Penfield’s study based on “The mystery of the mind : a critical study of consciousness and the human brain.” (1975).

coordinate the movement of the hand with the mental image of the character's structure, including the specific sequence of its many strokes. This active reconstruction reinforces the representation of the character in the brain.

2. Selection (Digital Typing/IME): In digital writing, particularly in Japanese, the process is one of selection. The user types the phonetic reading (Hiragana) and then chooses the correct *kanji* from a list of candidates provided by the Input Method Editor (IME). This is a recognition-only task. The brain does not need to know how to create the character; it only needs to be able to *read* or identify it from a list.

This distinction is vital for letter recognition. Studies such as Otsuka and Murai (2020, 2021)⁷ have shown that the mastery of *kanji* handwriting is closely related to highly developed language and cognitive abilities. When handwriting is suppressed in favor of digital devices at an early age, it may negatively impact not only writing skills but also broader linguistic knowledge and the ability to construct complex sentences.

Evidence from psychologically approached research accentuates the necessity of physical handwriting for children. A study by Ogino (2023) investigated the relationship between the ability to write correct and well-organized characters and academic achievement. They found that in the lower grades of elementary school, there is a strong correlation between the accuracy of character form and the child's visual information processing and visual perception abilities. However, it should be noted that this correlation does not necessarily involve a causal relationship; it remains unclear whether enhanced visual perception directly drives handwriting accuracy or if both are influenced by other developmental factors. Learning to write requires a high cognitive load on visual working memory. For a child to write a character 'well,' they must have a detailed and precise mental image of that character. In the upper grades, the demand for visual working memory increases as characters become more complex, requiring the child to recall and reproduce intricate details. This mental exercise is what builds deep recognition for complex characters. As studied by Otsuka and Murai (2021), while literacy acquisition in phonographic scripts (e.g., *kana* or alphabetic orthographies) is predominantly driven by phonological processing, logographic scripts like *kanji* demand greater visuospatial and visuomotor integration; therefore, by physically

⁷ Otsuka and Murai's study, "The multidimensionality of Japanese kanji abilities" (2020), "Cognitive underpinnings of multidimensional Japanese literacy and its impact on higher-level language skills" (2021) warn, if children use digital devices from an early age, potentially hindering their development of handwriting skills, there is a risk that this could affect even language and cognitive abilities that do not require handwriting.

reproducing the lines, the child wires the character into their cognitive system. On the other hand, if a child only selects characters, they bypass this critical phase of visual-motor integration, which may lead to a shallower understanding of the character composition and spatial layout.

Beyond the individual character, the use of physical notebooks gives a broader cognitive function. Ishigami (2024) identifies several key functions of the learning notebook, including Thinking (*shikō*, 思考), Record-keeping (*bibō*, 備忘), and Evaluation (*hyōka*, 評価).

- Note-taking as thinking: Handwriting in a notebook is not just about copying what is on the blackboard; it is a process of creating learning. The act of organizing thoughts on a page, deciding where to place information, using arrows to connect ideas, and summarizing one's own words is a sophisticated cognitive exercise.
- Small Steps to the Whole: Notebooks allow children to see their learning as a series of “small steps” that eventually form a cohesive whole. This physical record of the process of thinking is often lost in digital-based environments where text is easily deleted, moved, or replaced without a trace of the original mental burden without struggle.

For children learning multiple writing systems, such as the combination of *hiragana*, *katakana*, and *kanji* in Japanese, the cognitive challenge is immense. The Japanese Ministry of Education's guidelines emphasize that the foundation of language education is “Knowledge and Skills,” which includes the correct formation of characters. In the early years (Grades 1-2), the curriculum focuses on the basic forms of characters, size, and arrangement. Children are taught to pay attention to details such as the connection of dots and lines and the order of strokes. This is not merely for the sake of aesthetics. By underlining reproduction through handwriting, the educational system aims to develop the eye for detail and the hand for execution, which together form the basis of literacy. Evidence suggests that focusing on correct and well-organized writing is a form of learning in itself for younger children. It forces the child to engage with the language at a granular level, ensuring that they do not just read but truly recognize the components of their writing system.

While digital literacy is essential for the modern world, it should not come at the expense of the cognitive benefits of handwriting. The difference between selection and reproduction is the difference between passive identification and active creation. For children, the physical act of

writing on paper with a pen provides a unique and irreplaceable sensory-motor experience that stimulates the brain, strengthens visual memory, recognize several different writing systems collectively, and facilitates deeper thought and understanding. As we integrate tablets and keyboards into the classroom, we must remain cautious. Ogino (2023) highlights that “In the higher grades, the necessity of evoking detailed images of characters to write them precisely suggested a high load on visual working memory.”

(上学年で整った文字を書くためには文字の詳細なイメージを思い浮かべる必要性から視覚性ワーキングメモリーへの負荷の高さが示唆された。) We must make sure that children still have ample opportunity to use analogue tools, not as a rejection of technology, but as a necessary foundation for the cognitive development required to master any language. Handwriting is not a relic of the past; it is a vital technology for building the brain of the future.

Chapter 2: The emergence of calligraphy education and the sociological significance of “beautiful (neat) handwriting” in Japan

2.1 The history of handwriting education in Japan

The foundation of Japanese handwriting education lies in the adoption of Chinese characters (*kanji*), which were introduced to Japan between the late fourth and early fifth centuries, primarily via the Korean peninsula. Before this, Japan lacked a formal writing system, relying entirely on an oral tradition. However, the integration of *kanji* was full of linguistic challenges; the morphologic and syntactic structures of Chinese differed vastly from the Japanese language. To overcome this, at the beginning, Japanese scholars used *kanji* phonetically to symbolize Japanese sounds, a method known as *man'yōgana*. This system allowed for the preservation of Japanese poetry and proper names but remained inconvenient for daily use. During the Heian period (794–1185), this phonetic use of *kanji* met with a profound transformation, leading to the creation of two unique syllabaries: *hiragana* and *katakana*.

- *Hiragana* evolved from *sogana* (grass script), a highly cursive and simplified form of *kanji*. It became the script of literature and personal expression, typically used by women of the imperial court to write masterpieces like *The Tale of Genji* (*Genji monogatari*, 源氏物語).
- *Katakana* was developed mainly by Buddhist monks as a transcription for annotating Chinese texts, using fragments or specific components of *kanji* to represent sounds.

This unique Japanese mixture of various scripts, logographic *kanji* and phonetic *kana* became the standard for Japanese literacy today, allowing for a functional and effective way to express complex and sophisticated ideas alongside Japanese grammatical particles.

In the early Meiji era, as Japan shifted from an old society to a modern nation-state, education went through a massive overhaul. The *Gakusei* (Education System Order) of 1872 attempted to provide universal education to all citizens. Traditionally in Japan, handwriting was taught not only in *terakoya* (private temple schools) but also to elite warrior children in *hankō* (domain schools). In both institutions, education relied on using brushes, focusing on the specific needs of various social classes. However, the Meiji government sought to standardize handwriting as a tool for national unity. In 1900, the Elementary School Ordinance marked a significant shift: the subject previously known as *shūji* (calligraphy/brush writing) was renamed *kakikata* (literally translated as “how to write”), emphasizing practical handwriting over artistic pursuit. During this period, the use of hard pens lead pencils and stone pens, became more prevalent in classrooms, nevertheless brush writing remained a crucial part of the aesthetic and moral training within the Japanese language curriculum.

Following World War II, the Japanese writing system encountered intense scrutiny. Critics argued that the complexity of traditional Kanji frustrated mass literacy and economic progress. This brought about several waves of simplification and standardization:

- *Tōyō kanji* (1946): The government introduced a list of 1,850 “Characters for Daily Use” to limit the number of characters taught in schools and used in official documents. This era saw the introduction of *shinjitai* (new character forms), which simplified complex traditional characters (*kyūjitai*) to make them easier to write and read. For example, the character for round was simplified from 圓 to 円. A parallel movement of character modernization occurred in China with the introduction of Simplified Characters (简体字, *jiǎntǐzì*), which experienced its first major modern wave between 1949 and 1977. However, approach of China followed fundamentally different aesthetic and linguistic principles compared to Japan’s pragmatic simplification. As highlighted in Deno (2022), while Japan primarily treated character simplification as a tool for practical daily communication,

China led this transition while continuously viewing characters as the very core of its cultural identity and artistic tradition.

- *Jōyō kanji* (1981): Replacing the *tōyō kanji*, this list of 1,945 characters transitioned the policy from restriction to standardization, acknowledging that literacy levels had improved.
- Revised *jōyō kanji* (2010): The list was expanded to 2,136 characters, reflecting the impact of digital devices. Because digital devices like computers and smartphones allow users to type complex characters easily, the government considered it necessary for students to be able to read a broader range of *kanji*, even if they did not need to write them all by hand from memory.

In the late 1990s and early 2000s, Japan implemented the *yutori* (relaxed) education policy. Highly concerned about examination hell and high student stress, the Ministry of Education reduced the overall curriculum content by approximately 30%. While the number of *kanji* students were required to learn through nine years of mandatory education stayed relatively stable, around 1,006 in elementary and 939 in junior high school, the instructional hours dedicated to drill-based practice were significantly reduced. This era underlined the ability to survive, prioritizing critical thinking and self-directed learning over routine-based memorization of character shapes. However, critics later argued that this led to a weakening in basic academic skills, prompting a post-*yutori* return to more severe standards in the 2008 and 2017 guidelines.

The current educational curriculum, ran by the 2017/2020 guidelines, came up against the challenge of balancing traditional handwriting skills with the rapid advancement of Information and Communication Technology (ICT). While 43.8% of students now express a preference for typing over handwriting, the curriculum continues to highlight the cognitive and motor benefits of manual writing.

Modern practice focuses on the 3 elements:

1. Handwriting as a Cognitive Tool: Compared to typing, handwriting functions as a complex cognitive tool supported by neuroscientific and psycholinguistic evidence. Studies utilizing functional magnetic resonance imaging (fMRI) and near-infrared spectroscopy (NIRS) demonstrate that the motor act of writing simultaneously and in parallel activates multiple brain regions responsible for language, spatial structuring, rhythm, and fine motor

coordination (Kawahara, 2020). Writing by hand stimulates multiple areas of the brain, improving information retention and reading skills compared to typing.

2. Sensory and Rhythmic Learning: Current handwriting instruction incorporates the rhythm of movement, treating the act of writing as a physical discipline that builds fine motor skills and attention span.
3. Integration with ICT: Current guidelines suggest that while ICT should be used for information processing, the foundational skill of *shosha* remains essential for comprehension of the structure and beauty of the Japanese language.

Therefore, the history of Japanese handwriting education is a journey of adaptation, transforming a foreign script into a national identity. From the simplification of *kanji* for post-war efficiency to the current struggle against digital rearrangement, handwriting remains an important foundation of Japanese culture and language. In the context of Japanese socio-education, the enduring value weighed on neat handwriting reminds us that the pen or brush is far more than a communication tool; it is a widely documented practice traditionally believed to reflect an individual's character and cognitive discipline (Otsuka, Murai, 2021).

2.2 The distinction and fusion of transcription and calligraphy

In the philosophy of Japanese literacy and its aesthetics, a clear distinction exists between the sensible act of writing and the artistic pursuit of calligraphy.

- *Shosha* (書写): Situated firmly within the area of expertise of National Language education (*kokugo kyōiku*), *shosha* focuses strictly on practicality, structural correctness, and legibility. Its primary objective is to supply students with the ability to write characters accurately and efficiently to help seamless communication in daily life. The assessment metrics for *shosha* are objective, focusing on standard stroke order (*hitsujun*), proper balance of each character, and textual clarity.
- *Shodō* (書道): Conversely, *shodō* goes beyond functional communication to enter the realm of fine arts. It values individual artistic expression, spiritual discipline, and the historical inheritance of traditional aesthetic philosophies. Rather than merely adhering to

standard forms, *shodō* utilizes the variance of ink density, brush speed, and spatial composition to demonstrate the calligrapher's inner state and emotional resonance.

Despite these diverse aims, Japanese primary education consciously merges these two spheres, recognizing that the mechanical proficiency developed in *shosha* plays the role as the fundamental prerequisite for the artistic expressions explored in *shodō*. The synchronization of *shosha* and *shodō* in elementary school curricula is predicated on the critical nature of early childhood for developing fine motor skills and spatial awareness. During primary education, the boundaries between linguistic accuracy and artistic discipline are deliberately blurred to forge a robust physical foundation.

In lower primary grades, when students encounter new Chinese characters (*kanji*), the instruction is deeply rooted in the physical mechanics of *shosha*. Teachers meticulously correct fundamental stroke elements, including:

- *Tome* (止め): The clean, controlled stopping of a stroke.
- *Hane* (跳ね): The precise upward flick or hook at the end of a line.
- *Harai* (払い): The gradual, sweeping tapering of a brush or pencil stroke.

This strict enforcement ensures that characters are structurally recognizable, balanced, and highly legible. Interestingly, this rigid emphasis on structural accuracy carries over directly into early *shodō* lessons using traditional brushes (*mōhitsu*). In calligraphy classes, students are drilled on identical principles of character construction, stroke balance, and spatial placement.

According to the Ministry of Education, Culture, Sports, Science and Technology (MEXT) guidelines, brushwork instruction in the upper primary grades requires students to recognize the detailed movement of the brush tip (*hosaki no ugoki*) and the structural connection between individual strokes (*tenkaku no tsunagari*). The flexible nature of the brush tip takes in writing pressure and enables a rhythmic, efficient brush movement (*unpitsu*) rhythm that directly enhances the fluid execution of characters. Consequently, the parallel treatment of these two disciplines reinforces that the physical habits required for daily handwriting also cultivate the muscle memory and aesthetic appreciation necessary for higher-level cultural practice.

The contemporary educational landscape has come under a profound paradigm shift due to the rapid integration of Information and Communication Technology (ICT). Modern curriculum guidelines actively encourage the utilization of digital devices to document student presentations, record reflections, and enhance collaborative learning environments.

“指導に当たっては、様々な場面で話すことを通して、繰り返し表現の工夫を行う場を設けることが有効である。また、自分や友達の発表の様子を録画し、観点に沿って振り返るなど、ICT機器を活用することも効果的である。”

(When providing instruction, it is effective to create opportunities for students to repeatedly refine their expressions through speaking in various contexts. It is also effective to utilize ICT devices, such as by recording their own presentations or those of their friends and reflecting on them based on specific criteria.)⁸

While the adoption of digital devices and social media has enhanced communication versatility, recent national surveys on the Japanese language (Agency for Cultural Affairs, 2025) indicate growing concerns regarding how digital interaction shapes students' linguistic awareness and traditional literacy practices. reduction in the time students spend physically practicing with traditional instruments like pencils and brushes on paper. The tactile feedback of scraping graphite or flow of ink is progressively replaced by tapping or writing on glass screens and typing keyboards. This reduction in tactile handwriting practice shows a distinct challenge to the traditional formation of physical literacy, making the conscious preservation of structured writing time within the curriculum more critical than ever.

Despite the digital shift, the retention of *shosha* and *shodō* within the compulsory education system remains indispensably vital for two primary reasons: linguistic-cultural continuity and real-world social necessity. Characters and writing systems are not merely arbitrary codes for communication; they compose an indivisible component of the Japanese language and cultural heritage. The MEXT guidelines categorize *shosha* under the umbrella of preserving “Our Nation’s Language Culture” (*wagakuni no gengo bunka*). Through the physical act of rendering characters, students internalize the historic evolution of Japanese script, from the ideographic origins of *kanji* to the phonetic developments of *hiragana* and *katakana*. Eliminating or diminishing this practice

⁸ 小学校学習指導要領（平成29年告示）解説, p.97.

would promote detaching future generations from their aesthetic and historical roots, eroding the unique linguistic identity enclosed in the layout, rhythm, and visual harmony of the written language.

From a pragmatic perspective, handwriting continues to hold significant weight in contemporary professional and civic life. Regardless of widespread digitalization, numerous official administrative procedures at municipal offices, financial institutions, and governmental bodies still mandate hand-written forms for authentication, security, and identity verification purposes. Furthermore, within the professional aspect, a considerable portion of employers still highly value or explicitly require hand-written CVs (*rirekisho*) during the recruitment process. A candidate's handwriting is often viewed as a holistic reflection of their character, diligence, attentiveness, and sincerity toward the organization. As a result, guaranteeing the children can write legibly, accurately, and confidently is not an antiquated pedagogical relic, but a crucial, highly practical skill required to maneuver modern societal frameworks successfully.

In summary, the pedagogical synthesis of *shosha* and *shodō* within Japanese primary education maintains a sophisticated educational philosophy that balances practical literacy with artistic and cultural preservation. Although ICT integration reshapes the modern classroom, the physical foundation, cognitive discipline, and cultural appreciation accumulated through tactile handwriting stay entirely irreplaceable. By maintaining the parallel instruction of functional precision and artistic heritage, the compulsory education system cements the future generations retain functionally competent in everyday civic duties while remaining profoundly connected to the aesthetic soul of the Japanese language.

2.3 “Neat handwriting” as a social norm

Adding on to the hypothesis established in the previous section, which outlined the ongoing necessity of handwriting within modern socio-administrative frameworks, such as the submission of official CVs (*rirekisho*) and the execution of governmental procedures, this section explores the psychological and normative dimensions of “neatly handwritten characters” (*totonotta ji*, 整った字). In an era continuously dominated by digital typography, the persistence of

handwritten documents in high-stakes bureaucratic and professional domains is not only an archaic fragment but a functional psychological mechanism. The physical act of writing by hand serves as a continuous variable through which an individual's psychological traits, social compliance, and interpersonal respect are evaluated. Particularly, the presentation of neat, well-ordered characters gives a powerful positive impression, functioning as a critical signal of a candidate's trustworthiness, conscientiousness, and meticulous attention to detail. This section focuses on the psychological underpinnings of these evaluations and traces their normative origins back to the structured pedagogical structure established during primary education. In public and professional communications, handwriting takes the role of a crucial non-verbal signal that heavily influences a person's perception. For example, when an evaluator examines a handwritten resume, the structural integrity, balance, and aesthetic clarity of the characters evokes specific psychological attributions regarding the writer's cognitive and behavioral dispositions. Well-ordered writing is seamlessly associated with positive personality traits, such as attentiveness, diligence, and a high capacity for emotional self-regulation and organization.

In professional and evaluative contexts, neat handwriting functions as a powerful visual signal. It often leads readers to infer that the writer possesses a high level of attention to detail and conscientiousness. The deliberate physical effort involved in maintaining consistent stroke order, balanced character proportions, and linear alignment signals a methodical approach to the task at hand. In the terms of employment applications, this perception is particularly relevant: an applicant who submits a precisely handwritten document is often implicitly recognized as someone who will apply the same level of rigorous care to their professional responsibilities. Instead, inconsistent or sloppy handwriting, even if legible, is inclined to trigger negative biases, prompting evaluators to perceive the author as reckless, disorganized, or potentially lacking respect for the recipient (Ogifu and Okumura, 2023). This psychological bias confirms that evaluators subconsciously project traits of intellectual and operational competence based entirely on visual typographic clarity. Thus, maintaining well-ordered characters serves as a form of social currency, vital for strengthening institutional trust and validating one's reliability within public spheres. This psychological evaluation combines with observational data showing that across various demographic groups from elementary students to working adults, there is an exceptionally high social awareness regarding the strict necessity of mastering neat handwriting. This collective consciousness

confirms that well-ordered writing is universally recognized not only as a mechanical skill, but as a fundamental tool for personal evaluation and social integration.

The societal expectation for neat handwriting is not an irrational cultural preference that emerges spontaneously in adulthood; it is rather, a deeply rooted social norm systematically refined from primary education. In the context of the Japanese educational system, the National Curriculum Guidelines for Elementary Schools (*Gakushū shidō yōryō*) provides a highly structured methodology for introducing these precise writing habits, demonstrating that the micro-level mechanics of penmanship are directly linked to broader communicative and social competencies. According to the official curriculum guidelines for the upper grades, calligraphy and penmanship (*shosha*) instructions explicitly move beyond sheer letter recognition to address the spatial and situational dynamics of writing. Students are trained to determine the size and arrangement of characters in direct relation to the entire sheet of paper. This pedagogical focus obligates children to view the act of writing not just an isolated mechanical exercise, but as a holistic spatial design that requires foresight and structural planning. By mastering the layout, space between characters, and alignment of lines relative to the visual boundaries of the page, students are encouraged to develop an early cognitive framework for organizational clarity and visual harmony. This is further reinforced by instructions on textual clarity, such as understanding the graphical features of the Japanese writing system and appropriately balancing *kanji* and *kana* to optimize readability and ensure that the meaning flows smoothly for the reader.

Furthermore, the curriculum emphasizes a specific awareness of writing speed. The guidelines observe that the appropriate speed of writing is inherently conditional upon the specific situational context. For instance, while high-speed writing or rapid transcription is recognized as necessary for taking administrative notes or copying information from a blackboard within a limited timeframe, a completely different behavioral approach is mandated for formal interpersonal communication. According to Shibata and Omura (2018), factual evidence from two dual-task experiments reveals that handwriting demands a lower cognitive load than typing, with the latter more heavily disrupting information retention. The curriculum explicitly imposes that when writing their own names on personal belongings or when composing letters addressed to superiors, students must intentionally write slowly with the utmost care. This binary training creates a psychological link between the physical deceleration of writing and the expression of social compliance, respect, and emotional sincerity.

On top of layout and speed, the primary education curriculum highlights the strategic selection of writing instruments based on the communicative objective. Students learn to figure out the physical characteristics of various tools such as pencils, felt-tip pens, fountain pens, or traditional brushes (*mōhitsu*) and set them up to maximize the efficacy of their message. For example, when the objective is to express deep gratitude and respect, such as writing a formal thank-you note to someone who has offered assistance, the guidelines encourage writing beautifully and neatly using an instrument that best conveys that sentiment and gratitude. This instructional element shifts handwriting from a solitary cognitive task to an empathetic act of communication, wherein the physical properties of the written line are consciously adjusted to respect the reader's cognitive comfort and social status. The continuous training in accurate transcription and aesthetic precision exercised into individuals during their developmental years has profound, lifelong implications for both personal psychology and societal cohesion. By training these micro-behaviors early in life, the educational system effectively codes the social norm that external physical order reflects internal mental order.

First, the requirement to write accurately and neatly feeds cognitive discipline and executive functioning. As Karin (2012), stated, letter perception for pre-literate children only comes after handwriting, not after typing or tracing experience. The constant practice of balancing stroke pressure, monitoring spacing, and complying with strict graphic standards improves the brain in sustained attention and impulse control. This simultaneous mental and motor engagement fosters an autonomous and creative learning attitude that digital typography cannot replicate. When primary education emphasizes that characters must be written precisely as prescribed, it instills a psychological respect for standardized rules and shared social systems. This behavioral conditioning translates into adulthood as a generalized capacity for compliance with organizational protocols and administrative accuracy. Second, this early conditioning builds up the analytical biases of society at large. Because almost every member of society experienced the same primary education curriculum, the standard for what constitutes acceptable or trustworthy handwriting becomes universally internalized. As a result, when an adult evaluates a handwritten resume, they are not merely observing ink on paper; they are subconsciously measuring the applicant's degree of socialization and alignment with foundational educational values. A well-ordered resume indicates that the individual has successfully absorbed and retained the virtues of patience, respect, and structural awareness taught in youth.

Moreover, the pedagogical emphasis on tuning handwriting to the recipient, such as writing meticulously for superiors or selecting specific tools for notes with specific purposes, solidifies the role of handwriting as an instrument of empathy and social bonding. In public life, a beautifully ordered document has a function as tangible proof of the writer's willingness to invest time and devotion of energy for the benefit of the reader. This dynamic introduces an interesting paradox in modern professional and academic environments, a phenomenon thoroughly documented within psychological and educational literature. In an evaluative climate where efficiency and speed are predominant, the deliberate expenditure of time required to produce immaculate handwritten text might initially seem counterintuitive. However, experimental studies confirm that this deviation from rapid, digital norms functions as an exceptionally powerful visual cue. Evaluators and recipients routinely interpret well-ordered characters not merely as a mechanical output, but as an implicit signal of the writer's underlying capability and motivation. In particular, academic experiments demonstrate that beautiful handwriting significantly enhances an author's perceived intelligence and general favorability (Inukai & Shimomura, 2017), whereas less legible or sloppy writing causes readers to underestimate the author's actual competence (Chase, 1986) or infer a lack of academic motivation (Sandler et al., 1992). In consequence, a strong psychological link is forged between well-ordered characters and personal or institutional reliability: the medium itself communicates a willingness to prioritize care over mere convenience. Paradoxically, while evaluators rely on visual investment as a proxy for positive traits, comparative research reveals that these impressions are often derived from cognitive biases, such as halo effect, rather than actual personality traits or skills (Shiota et al., 1998; Matsuno, 2012), ultimately distorting object assessment.. In brief, the psychological phenomenon of attributing trustworthiness and precision to individuals with neat handwriting is inevitably related to the systematic pedagogical foundations laid during primary education. As outlined in national educational standards, instructional practices regarding spatial arrangement, contextual speed variation, and persistent tool selection transform the physical act of writing into a complex sociolinguistic behavior. Ultimately, neat handwriting assumes the role of a visible metric of an individual's conscientiousness and capacity for social integration, ensuring that even within a highly digitized society, the handwritten public document remains a crucial psychological grip for establishing mutual trust and professional credibility.

Chapter 3: Embodied intelligence—the role of stroke order and writing instruments—

3.1 The logic behind stroke order

In the Japanese educational system, handwriting instruction (*shosha*) is not only considered as a mechanical sub-skill of literacy; as mentioned earlier, it is rather explicitly categorized within the national curriculum as an essential component of the linguistic culture of our nation (*wagakuni no gengo bunka*). According to the Commentary on the MEXT Curriculum Guidelines, the Japanese language serves as the root of human intellectual and cultural activity, playing an indispensable role in individual self-formation, the improvement of social life, and the preservation and inheritance of culture. Consequently, *shosha* education is systematically designed to cultivate primary writing competencies that students can apply throughout their academic and daily lives. A rigorous, systematic breakthrough is noticeable right from the initial weeks of elementary school. Formal instruction begins in April of the first grade, where students transition from simply recognizing characters in their school environment to establishing the physical and mechanical foundations of writing. Before focusing on character structure, the curriculum makes use of rhythmic mnemonic songs, specifically the “Good Posture Catchphrase” (*yoi shisei no aikotoba*) and the “Pencil Grip Catchphrase” (*Enpitsu no mochikata no aikotoba*), to hold proper somatic habits before students carefully write their own names. As the year unfolds, the educational path builds from basic motor skills to complex spatial awareness:

<Systematic Curricular Progression in Lower-Grade *shosha*>

1. April: Environmental awareness, posture chants, pencil grip songs, and name-writing baseline
2. May–June: Structural foundations (stroke endings “*tome/harai*”, mid-stroke variables, and strict *hitsujun*)
3. July–September: Spatial formatting (4-quadrant box analysis, geometric shapes, and *kana* distinctions)
4. October–March: Character typology (*kanji* mechanics, stroke length/direction, and *shosha* gymnastics)

The fundamental requirement constructing this entire educational path is the sheer mastery of stroke order. This structural convention commands the arrangement and direction of every line within a character. To comprehend why the Japanese educational gear places such a profound emphasis on a standardized sequence of physical movements, one must analyze the biomechanical, cognitive, and aesthetic logic that links the correctness of execution to the visual beauty and structural integrity of the written character.

The principal premise of *shosha* philosophy is that visual aesthetics are an emergent property of correct physical execution. In other words, a character becomes beautiful because it was written correctly. This phenomenon is deeply rooted in the biomechanical pressure of human hand movement and the historical development of Japanese logographs (*kanji*) and phonographs (*kana*) originated from traditional calligraphy with brush (*shodō*). When writing a character, the human hand does not merely find isolated geometric lines; it executes a continuous track of motion across a two-dimensional space. Even when the writing instrument is lifted off the paper between strokes, the physical movement continues through the air. This invisible track of motion is known as *hitsui* (calligraphic intent) or *unpitsu* (the movement of the brush tip). The MEXT curriculum guidelines feature this continuity by instructing students to remain conscious of the connection between strokes and the movement of the writing tip (*hosaki no ugoki to tenkaku no tsunagari*).

To make this abstract calligraphic concept accessible to lower-grade students, the *shosha* curriculum applies to sensory-vocal programming. When learning stroke endings (*shūhitsu*), such as the clean stop (*tome*) and the smooth sweep (*harai*), students are taught to synchronize their hand

movements with vocal descriptors, such as; *pi-ta-tto* (abruptly holding the pencil still) for *tome*, and *sū-tto* (gradually fading out the pressure) for *harai*. In the same way, complex mid-stroke paths (*sōhitsu*) like sharp folds (*ore*), sharp turns (*orikaeshi*), deep curves (*magari*), and upward warps (*sori*) are reinforced using rhythmic vocal cues like *gū-tto* to control pencil pressure and deceleration through the direction. Following the MEXT curriculum guidelines, these elements form the core of:

<The Mechanics of Visual Balance>

- Stroke sequence (Adherence to *hitsujun*) and somatic vocal cues (*pitatto* / *sūtto*)
- Continuous kinetic track
- Natural center of gravity and symmetrical proportions
- Visual harmony and balanced structural form of each character

Standardized stroke order is the historical concentration of the most natural, ergonomically efficient pathways for the human hand. By following this optimized sequence, several aesthetic outcomes are guaranteed:

- Balance of gravitational core: characters are constructed within an abstract framework. Correct stroke order ensures that the weight of the character is evenly distributed around a central axis, avoiding the character from leaning or sagging to one side.
- Proportional consistency: the curriculum demands that students pay meticulous attention to the length, direction, intersection, and contact points of individual strokes (*tenkaku sōgo no sesshikata ya majiwarikata, chōtan ya hōkō*, 点画相互の接し方や交わり方、長短や方向). When characters are written in the proper sequence, previously executed strokes serve as spatial landmarks for subsequent strokes.
- Organic flow (*ryūdei*): Correct stroke order ensures that the momentum of one stroke naturally generates the entry angle and pressure of the next. This creates a cohesive visual

rhythm where the strokes come into sight organically linked rather than mechanically assembled.

Beyond its physical output, stroke order acts as a powerful cognitive framework that facilitates a deep structural understanding of complex characters. The performance of writing is a multi-sensory process involving visual, tactile, and kinesthetic feedback. *Hitsujun* converts the static, visual geometry of a character into a dynamic, temporal sequence of rhythmic movements.

Human memory is highly receptive to materialistic patterns and rhythm. By assimilating the sequence of movements, stroke order provides an internal rhythm to the act of writing, reducing the cognitive load required to memorize and reproduce complex orthographic structures. To fully internalize this relationship between rhythm and anatomy, the curriculum implements a unique methodology known as *shosha* gymnastics (*shosha no taisō*, 書写の体操) as a conclusion of the learning cycle. Students ally themselves with desks and carry out full-body physical gestures coupled with rhythmic vocalizations, physically imitating the precise properties of initial strokes (*shihitsu*), mid-strokes (*sohitsu*), and final stroke endings (*shūhitsu*) in mid-air. By mapping characters like 『一』, 『小』, 『人』, 『日』, 『七』, and 『子』 using large-muscle motor memory, the abstract rules of stroke sequence are converted into an intuitive physical schema.

<The Shosha Gymnastics Cognitive Loop>

Vocal mnemonic command (e.g. “*ore*”, “*magari*”)



Full-body mid-air physical gesture (gross motor action)



Internalized micro-movement schema (fine motor action)



Precise, balanced pencil execution on paper

Kanji and *kana* characters are highly interchangeable. The MEXT guidelines mandate that students must understand how characters are systematically constructed from different components. In lower-grade *shosha*, this spatial decomposition is taught through highly structured visualization techniques:

- The 4-quadrant box cell: to master the starting location of a character (*shihitsu no ishi*), students utilize a grid cell split into four numbered quadrants. Exercises include analyzing exactly which “room” (quadrant 1, 2, 3, or 4) a character like 『にじ』, 『うた』, or 『へや』 begins in, obligating students to read characters structural-centrally rather than as arbitrary lines.
- Geometric boundary enclosures: from July to September, students start learning to deduct the overall approximate silhouette (*waikei*) of characters. They physically trace pencil borders around characters like 『せみ』, 『すいか』, 『の』, or 『ふうせん』 to determine whether their true underlying form corresponds to a square (*shikaku*), a triangle (*sankaku*), or a circle (*maru*).

By internalizing *hitsujun* through these visual and physical containment fields, students physically accomplish the structural decomposition of the character every time they write characters. It develops the brain to recognize the boundaries between radicals and sub-components, directly enhancing their ability to decipher, categorize, and recall complex logographs.

To evaluate the exact structural degeneration that occurs when stroke order is violated, it is necessary to contrast the spatial outcomes of compliant and non-compliant handwriting. When a writer understands and follows *hitsujun*, the character displays structural stability; deviation, however, introduces systemic distortions into its geometry. In compliant writing, the character fits perfectly within its invisible bounding box, maintaining balanced margins on all sides. On the contrary, a non-compliant character undergoes spatial drift, expanding or compressing carelessly and disrupting the page layout. Furthermore, proper directional momentum ascertains that compliant strokes intersect and connect at precise coordinates (*tenkaku sōgo no sesshikata*). When

stroke order is violated, however, gaps emerge at critical junctures, or lines overshoot their targets because the hand is forced to approach from an unnatural angle.

However, modern observational research introduces a critical, nuanced perspective regarding the enforcement of rigid aesthetic standards. For example, recent studies by educational psychologists (Ogifu and Okumura, 2023) show that while basic character accuracy interacts with academic achievement, evaluating handwriting on an ultra-strict criterion of being correct and well-organized does not significantly yield higher academic correlation scores compared to a more flexible criterion of simple legibility (*handokukanō*). Crucially, cognitive science reveals that forcing students particularly upper-grade elementary students to focus excessively on microscopic typography and perfect symmetry requires a severe cognitive overload on their visual working memory. This visual working memory strain can act as an artificial barrier for neurodivergent learners, such as children with developmental dyslexia or working memory deficits. Recognizing these cognitive boundaries, the Agency for Cultural Affairs (2016) issued guidelines asserting that handwriting evaluations should not overly penalize minor stylistic variations, provided the essential structural skeleton (*jitai*) of the character remains identifiable and legible. Therefore, while stroke order (*hitsujun*) remains an invaluable kinematic and cognitive stage for motor optimization, contemporary pedagogy increasingly perceives stroke order not as a tool for rigid typographic policy, but as a dynamic, efficient system to reduce cognitive friction and promote fluent, lifelong communication.

3.2 Stationery as an auxiliary tool and the evolution of the culture of “writing”

In an era dominated by digital transformation and automated text input (autocorrection), the continuous hyper-sophistication and precise segmentation of analog tools for handwriting in Japan present a significant socio-cultural paradox. While manual writing has seen as a stagnation in many post-industrial societies, the Japanese stationery ecosystem demonstrates a unique direction of qualitative evolution. This section focuses on the hypothesis that the intense technological advancement of writing instruments and structured paper media provides pragmatic verification that the act of manual writing (*shoji*) remains an essential, deeply institutionalized body technique (*shintai gihō*, 身体技法) and meta-cognitive practice in contemporary Japan. This

phenomenon does not indicate a hierarchy of cultural development compared to other countries but rather highlights a distinct socio-technical adaptation to Japan's unique linguistic and educational infrastructure. The evolution of Japanese pencils, ballpoint pens, and fountain pens transcends mere utilitarian efficiency, coming into contact with sensory ergonomics and consumer psychology. Ikeda (1989) identified a profound paradigm shift in market trends, observing that stationery has transitioned from a collection of simple functional tools into complex sensory artifacts capable of delivering tactile pleasure and psychological satisfaction. According to Ikeda (1989), as society achieved material abundance, consumer consciousness shifted from social conformity (*tanin-nami*) toward a highly individualized aesthetic baseline (*jibun-nami*). Ikeda (1989: 151) identified a profound paradigm shift in market trends, observing that within an era of material affluence, writing tools “Even stationery, an indispensable part of our daily lives, has evolved in this era of abundance and affluence from being merely a tool to something that brings joy and a sense of satisfaction through ownership, leading us into an era where the very value of its existence is being questioned.” (ライフワークに欠かすことのできない文房具も、豊かな時代、リッチな時代の中で、単に使う道具から楽しみかつ所有する満足を得られるものとなり、存在価値観を問われる時代となってきた。) To satisfy this demand for individual expression, domestic manufacturers continuously developed and pursued the optimized page-tip interface, seeking to eliminate every vector of physical friction. The implementation of low-hardness rubber grips in the late 1980s was specifically engineered to mitigate musculoskeletal fatigue during prolonged writing sessions (Ikeda, 1989). This improvement toward reducing bodily friction eventually culminated in global innovations such as core-rotation mechanisms in mechanical pencils and thermo-sensitive erasable inks. By treating the writing instrument not as a disposable commodity but as an intimate bodily extension, Japanese design successfully stimulates what can be termed “motivation to write,” (*shoji iyoku*, 書字意欲) the inherent proactive desire to engage in the physical act of writing.

While writing instruments offer the dynamic interface of execution, the highly differentiated paper media utilized within the Japanese educational sphere serve as a spatial architecture that structures human thought and bodily movement. Unlike patterned plain or ruled paper common in Western contexts, the Japanese market features an array of notebooks engineered

for specific cognitive tasks, such as kanji practice grids divided by sub-faint crosshairs (*kanjirenschūchō*), or multi-lined guides for Roman typography. From the perspective of cognitive design and material culture, these specialized formats operate as vital supporting devices that mediate the relationship between the physical hand and internal consciousness. As articulated by Nishiyama et al. (2011), the act of writing is fundamentally a two-way interaction between the body and its immediate material environment. Stationery design does not merely capture pre-formed thoughts; rather, it actively drives the psychological custom of meta-cognitive externalization under the concept of write, layout, and think (*kaite, narabete, kangaeru, 書いて、並べて、考える*) (Nishiyama et al., 2011). By accommodating environmental variables, such as the layout, geometry, and structural constraints of paper, stationery directly influences how users manipulate data, organize concepts, and reflect on their own cognitive processes (Nishiyama et al., 2011). The structural diversity of Japanese notebooks accordingly functions as an externalized cognitive prosthesis, guiding the physical trajectory of the writer's hand into highly disciplined spatial rhythms. Ultimately, these specialized formats confirm the necessity of analog media by continuously discovering the interaction between the thinking body and stationery (*kangaeru shintai to bunbōgu no sōgo sayō*, *考える身体と文房具の相互作用*), a somatic relationship through which users actively explore and construct universal knowledge (Nishiyama et al., 2011: 8).

The structural hyper-evolution of stationery in Japan is deeply settled down in and reinforced by the state-mandated educational apparatus. A rigorous examination of the *Commentary on the Course of Study for Elementary Schools: Japanese Language* declared by the Ministry of Education, Culture, Sports, Science and Technology (MEXT, 2017) explains that *shosha*, formal penmanship and calligraphy is treated as a core pillar of national literacy. MEXT (2017) distinctly mandates that primary and secondary education must systematically guide students to pay thorough attention to the precise configuration of stroke elements, correct stroke order, and the proportional balance of characters. This institutional structure transitions from hard-pen alignment in early childhood to traditional brush pen calligraphy (*mōhitsu*) and the mastery of semi-cursive styles (*gyōsho*) at the lower secondary level (MEXT, 2017). This intensive cultural and pedagogical commitment to achieving formal balance in handwriting is directly linked to the profound visual-spatial processing demands imposed by the Japanese writing system, which

necessitates the simultaneous integration of logographic *kanji* and phonetic syllabaries (*hiragana* and *katakana*). To fulfill these rigid national standards without exhausting the limited working memory capacity of developing children, highly advanced practical technologies, such as specialized tools that prevent lead breakage or ensure uniform lines, become an absolute functional necessity. The educational system willingly sustains the high cognitive load associated with *shosha* because handwriting is conceptualized not as a trivial data-transcription mechanism, but as a disciplined corporal art form through which cognitive discipline and cultural continuity are externalized onto the page.

In brief, the hyper-sophistication and meticulous segmentation of the contemporary Japanese stationery market are not superfluous byproducts of consumer capitalism, but rather highly rational socio-technical responses to a cultural infrastructure that positions manual writing as a vital body technique. The physical manipulation of text supported by specialized instruments (Ikeda, 1989) and structured spatial media (Nishiyama et al., 2011), under institutional mandates (MEXT, 2017), establishes a comprehensive ecosystem where analog tools function as advanced cognitive and somatic prosthetics. Thereby, the enduring vitality of Japanese stationery provides robust empirical validation for the hypothesis that the physical act of writing remains an essential bodily technique crucial to the cognitive architecture and cultural identity of modern Japan.

3.3 Touch and memory: The effects of handwriting on the brain from a scientific perspective

The rapid spread of information and communication technology (ICT), such as personal computers and tablet devices in recent years, along with the establishment of “one device per student” environments in educational settings, is rapidly shifting the analog, physical act that humans have practiced for many years, holding a writing instrument and writing characters while feeling the resistance of paper toward digital handwriting via keyboard typing or stylus pens on LCD screens. This trend is gaining momentum not only in Japan but worldwide. According to the Public Opinion Survey on the Japanese Language (*kokugo ni kansuru yoron chōsa*, 国語に関する世論調査) conducted by Japan’s Agency for Cultural Affairs, 90.6% of respondents stated that the spread of information devices affects language usage and linguistic ability, with the top specific concerns being “a decrease in handwriting” (89.4%) and “a decline in

the ability to write kanji accurately by hand” (89.0%) (Minagawa & Takeguchi, 2024). Although the percentage of young people (ages 16–19) expressing these concerns is lower than that of other age groups, this is presumed to be due to environmental factors, specifically, the fact that opportunities for handwriting are barely being maintained in school education. It is predictable that if all learning environments become fully digitized in the future, the trend toward a decline in handwriting among this age group will become even more severe. The act of “writing” is not simply the output of characters; rather, it is a highly complex cognitive activity involving a complicated interaction of fine motor skills in the fingers, tactile feedback, spatial cognition, and language processing. In this section, we focus specifically on language learning among children in the early grades of elementary school, who are in the middle of cognitive development, and discuss, based on the latest experimental findings, the effects that tactile stimuli associated with handwriting, such as “pen pressure” and “paper resistance,” have on the brain’s language areas and memory systems. We will clarify the differences in cognitive load resulting from the use of digital devices, as well as the neuroscientific and cognitive neuroscientific distinctions between analog handwriting using paper and pen and digital handwriting on tablet devices. Finally, based on the scientific evidence from prior research, we will comprehensively demonstrate why the physical act of handwriting is irreplaceable for the efficient acquisition and retention of the Japanese writing system, which is considered extremely complex by global standards.

In assessing the substantial differences between handwriting-based learning and learning using digital devices, the quantitative assessment of the “cognitive load” associated with the act of writing itself is a critically important academic approach. As reported by Shibata and Omura (2018) conducted a rigorously controlled experiment using the dual-task method to compare the effects of handwriting and keyboard typing on human memory and cognitive resources. Their experiment was structured so that participants simultaneously performed a “primary task” listening to a lecture and memorizing information and a “secondary task” designed to measure reaction time. The results of the experiment proved that text input via typing significantly delayed reaction times on the “secondary task” compared to handwriting. This indicates that the act of typing itself consumes more cognitive resources (working memory) than handwriting, and consequently significantly interfere with the primary cognitive activity of “information retention and encoding.” Additionally, a key finding of this study is that the increase in cognitive load and the phenomenon of memory interference connected with typing were similarly observed even among skilled typists

who can type very quickly using the touch-typing method (Shibata and Omura, 2018). This suggests that, regardless of proficiency in operating the device, the act of keyboard input itself innately requires a high level of external cognitive load on the central executive.

The existence of this cognitive bottleneck is further substantiated from the perspective of “depth” of processing by the well-known study by Mueller and Oppenheimer (2014), “The Pen Is Mightier Than the Keyboard.” They examined the differences between notetaking on laptops by typing and handwritten notetaking with pen and paper among college students. The results of the experiment showed that students using laptops had a very strong tendency to transcribe lecture content “verbatim.” Because typing is fast and involves few physical constraints, students mechanically map the audio they hear keyboard movements without deeply processing it in their brains. In contrast, because handwritten notetaking is limited by the physical speed of writing, it is impossible to transcribe all the verbal information from a lecture. This physical constraint forces the note-taker to engage in active and generative information processing. That is to “digest the content, summarize it, rephrase it in their own words, and select core concepts” (Mueller and Oppenheimer, 2014). As a result, the group that wrote by hand achieved significantly higher scores than the group that used laptops, not only in factual recall but also in tests of “conceptual understanding, application, and integration,” which require higher-order thinking. For early elementary school students who are in the initial stages of schema construction, the process of embedding the shapes and meanings of characters into long-term memory, the verbatim and passive processing associated with digital devices carries the risk of superficial cognition; in contrast, the generative nature of handwriting and the appropriate cognitive load, engages are prerequisites for deep language acquisition. The core biological mechanism by which handwriting more powerfully activates the brain and consolidates memory lies in the integration of precise finger movements (motor-sensory feedback) with pen pressure and paper resistance (tactile feedback).

Longcamp et al. (2008) used behavioral experiments and functional MRI (fMRI) to investigate how the input mode (handwriting vs. typing) used when learning new characters, graphic shapes, affects subsequent visual cognition and neural networks in the brain. In their study, adult participants were presented with unfamiliar graphic shapes (new characters) and were instructed to practice writing them, one group using traditional “handwriting with pen and paper,”

and the other using “computer keyboard input.” In a character recognition test, which includes a task involving distinguishing characters from their mirror images, conducted after training, the group that learned by handwriting showed significantly higher accuracy in identifying the correct orientation of characters than the group that learned by typing, and this effect persisted for several weeks (Longcamp et al., 2008). When the brain mechanisms are responsible for this behavioral advantage were measured using fMRI, it was confirmed that specific brain regions were significantly activated even when participants were only “looking at” the characters they had learned by handwriting. More specifically, the motor-sensory network, which includes the “left inferior frontal gyrus (Left Broca’s area)” and “bilateral inferior parietal lobules,” regions involved in motor execution, imagery, and the observation of behavior was strongly activated only in the handwriting group. This discovery holds extremely significant scientific implications. Essentially, the physical act of handwriting firmly strengthens the brain not only the “visual shape” of characters but also the “visual-motor memory trace,” which is necessary for writing them. When children later read characters, the brain does not process them solely in the visual cortex; instead, it simulates and reactivates the motor programs used during previous handwriting, thus significantly refining the identification and recognition of characters. By contrast, with uniform movements like typing, where pressing any key results in the same “key strike,” character-specific visual-motor memory traces are not formed, making it difficult to establish neural connections with language centers such as Broca’s area. Above all, to correct errors such as “mirror writing” (reversing the left and right sides of characters), which frequently occur in the early elementary school years, and to stabilize spatial shape recognition, the neurological imprinting of the motor sensations associated with handwriting is essential.

Furthermore, a study using fMRI conducted by Umejima et al. (Umejima, Ibaraki, Yamazaki & Sakai, 2021) at the University of Tokyo quantified the direct differences in brain activity during memory retrieval between writing in a paper notebook and on a digital device, such as a tablet or smartphone. The researchers had participants complete a routine schedule-writing task using each medium and then asked them to retrieve that memory while inside an MRI scanner. The results of the experiment revealed that, although the group using paper notebooks took significantly less time to encode information (writing/typing) in comparison with the group using digital devices, their correct response rate for specific questions in the subsequent memory recall task was statistically and significantly higher than that of the tablet group (Umejima et al., 2021).

Moreover, during the recall task, the group using paper notebooks showed activity in the “lateral premotor cortex” and “inferior frontal gyrus (Broca’s area), the “visual cortex,” which processes visual information, and the “hippocampus,” the center for memory formation and retrieval, were significantly higher than those in the digital device group. Behind this phenomenon lies the overwhelming abundance of “spatial and tactile cues” provided by paper-based media. When writing with a pen on paper, humans engage in “associative learning,” in which they link and store in their brains, alongside linguistic information, the physical context of “where on the page they wrote, what kind of handwriting they used, and how much pressure they applied.” In environments such as the smooth screens of digital devices, where physical location changes fluidly as users scroll, these spatial and tactile cues are completely absent. As a result, the hippocampus and language areas cannot be effectively stimulated, leading to a decline in the efficiency of memory retrieval.

These findings are fully consistent with the experimental studies reported by Kawahara (2020) using near-infrared spectroscopy (NIRS). Kawahara measured blood flow which changes in oxygenated hemoglobin concentration in the region surrounding Broca’s area during three tasks: “copying,” in which participants transcribed a text; “description,” in which they constructed sentences to describe a picture; and “spontaneous writing,” in which they composed a text based on their own episodic memories. The results showed that in the “spontaneous writing (composition)” task, which involves the deepest cognitive engagement and requires logical thinking, blood flow in the handwriting condition was statistically and significantly higher than in the typing condition. It has been demonstrated that handwriting acts as a powerful trigger for increased blood flow, activating the neural networks in the brain’s language center (Broca’s area) as thinking becomes more profound.

As the key argument of this section, we discuss why the physical act of “handwriting” serves as the scientific basis for efficient acquisition when learning Japanese which retains a writing system of such complexity that it has few parallels worldwide, based on the multidimensional language ability model published by Otsuka and Murai (2021). While the orthography of alphabetic languages consists of dozens of “phonographic characters,” the Japanese writing system consists of simple phonetic characters corresponding to syllables: *kana* (*hiragana* and *katakana*), simple phonetic characters corresponding to syllables and a vast number of *kanji*

(logographic characters: logographic script), in which a single character conveys its own meaning (semantics) and multiple readings (*on'yomi* and *kun'yomi*), are highly blended together, giving the Japanese writing system its unique character. *Kanji* have extremely complex visual structures, such as stroke counts and the geometric arrangement of radicals, and school-age children, especially lower-grades, must dedicate significant cognitive resources to mastering them. Otsuka and Murai (2021) proposed a theoretical model suggesting that Japanese *kanji* proficiency is not processed by a single memory capacity, but rather consists of a three-dimensional, multifaceted structure comprising reading accuracy, writing accuracy (handwriting ability), and semantic comprehension, that is a three-dimensional, multifaceted structure of mutually independent yet interrelated components. Using a sample of healthy adults, they quantified the causal relationships between these components and basic cognitive abilities (phonological processing, rapid naming [RAN], visuospatial processing, and syntactic processing) using multiple reversion analysis and path analysis.

Statistical analysis revealed that each dimension of *kanji* proficiency depends on different cognitive foundations within the brain. While phonological processing was a common factor across all dimensions, reading accuracy was associated with naming speed. The ability to quickly identify different characters and semantic comprehension was associated with syntactic processing ability. Ultimately, the cognitive factor that is most strongly predicted and determined is the acquisition of writing accuracy (handwriting ability). The central focus of this study was, uniquely, visuospatial processing ability (Otsuka & Murai, 2021). *Kanji* are composed of multiple dots and lines adapting to specific spatial-geometric rules, such as radical structures including *hen* (left-side radical), *kanmuri* (top radical), and *kamae* (enclosing radical). The act of handwriting *kanji* requires a process wherein this complex visuospatial information is temporarily disassembled within the brain and chronologically mapped onto the motor trail of the hand (i.e., stroke order). During this process, the tactile sensation of the pencil contacting the paper, the control of writing pressure, and the proprioceptive feedback obtained from the paper's resistance strongly couple the networks of the visuospatial processing areas, such as the parietal lobe, the visual cortex, and the motor cortex. This integration facilitates the long-term consolidation of an accurate writing schema for *kanji* within long-term memory. Besides, the most fundamental finding of this study lies in the path analysis results presenting how the three dimensions of acquired *kanji* proficiency contribute to advanced human linguistic ability (intellectual productivity). Practicing an essay-writing test,

the researchers evaluated the density of ideas (the richness of concepts and propositions within a text), which acts as an indicator of intellectual productivity at the text level and linguistic complexity.

Statistical analysis revealed that among the three dimensions of *kanji* proficiency, only the writing (handwriting accuracy) dimension significantly anticipated driven density of ideas and textual complexity (intellectual context construction), either directly or indirectly (Otsuka & Murai, 2021). It was proved that even if individuals possessed high scores in reading and semantic comprehension, those with low writing (handwriting) proficiency exhibited significantly lower intellectual density (density of ideas) during advanced text construction. This suggests that individuals who have sufficiently refined their ability to actually handwrite and accurately output *kanji* from school age through adolescence construct highly robust and abundant retrieval circuits (access routes) for linguistic knowledge including vocabulary and concepts within long-term memory through the physical movement of handwriting. Mediated by this thoroughly acquired linguistic knowledge, they can ultimately produce superior texts with high intellectual density, even when composing in digital environments such as on computers. Sweller's study (1988) indicated, "The cognitive load imposed on a person using a complex problem solving strategy such as means-ends analysis may be an even more important factor in interfering with learning during problem solving. [...] The cognitive-processing capacity needed to handle this information may be of such a magnitude as to leave little for schema acquisition, even if the problem is solved."⁹

However, when Otsuka and Murai (2020) analyzed the vast data from the *Japan Kanji Aptitude Test* (*Nihon kanji noryōku kentei*, 日本漢字能力検定), they confirmed that while scores for reading and semantic comprehension were maintained, the writing (handwriting) ability alone showed a significant decline over the years, in perfect conjunction with the recent period of rapid smartphone and tablet proliferation. If an early transition to digital input and the simplification of handwriting progress in the initial stages of formal education, thereby suppressing training in accurately handwriting *kanji*, the negative consequences will not be limited to a simple output deterioration where individuals merely become unable to write *kanji* by hand. The suppression of handwriting inhibits the development of the writing dimension of *kanji* proficiency. The evidence

⁹ J.Sweller (1988: 261), "Cognitive Load During Problem Solving: Effects on Learning"

indicates a severe scientific risk (a causal chain) where this inhibition, like a row of falling dominoes, reduces the efficiency of acquiring the vast linguistic knowledge (vocabulary and general education) that should be acquired in the future, eventually causing a comprehensive subsidence of text composition ability (idea density) and advanced intellectual capacity, which are the fruits of logical thinking. The acquisition of *kanji* through handwriting during school age extends beyond ordinary language acquisition; it functions as the foundation for building a lifelong cognitive reserve in the brain.

In formal education and language learning, writing characters with a stylus on a tablet screen and writing characters with a pencil or pen on paper are both categorized under handwriting, making it easy to misunderstand them as having equivalent cognitive effects. Nonetheless, from the perspectives of cognitive neuroscience and physical movement, a definitive distinction exists between the two. The primary differentiating factor lies in the consistency versus diversity of tactile feedback regarding sensory quality (Lundberg, 2014; Wilson, 1998). When drawing characters with a plastic stylus on the smooth glass screen of a tablet, the frictional resistance generated between the pen tip and the screen remains constantly steady (homogenous and extremely low friction), regardless of the character's shape, stroke direction, drawing speed, or the intensity of the writing pressure applied. Even when children attempt to express *tome* (abrupt stops) or *hane* (upward hooks), the pen tip slips on the glass surface, failing to produce distinct variations (differentiation) in the kinesthetic feedback (sense of force and position) exerted on the muscles of the fingers and hands.

Other way round, in analog handwriting using paper and a pencil, dynamic frictional resistance is transmitted to the fingers in real time due to the micro-texture (minute irregularities) of the paper fibers and the wear of the pencil lead. At this moment of a character's *tome*, a large reaction force corresponding to strong writing pressure is transmitted. When writing smooth curves, an appropriate viscous resistance corresponding to speed is fed back in parallel and with high precision to the primary somatosensory cortex and motor cortex of the cerebral cortex, mediated by body awareness and cutaneous mechanoreceptors. As Wilson (1998) points out, the regions allocated to finger and hand control and sensory reception in the human cerebral cortex account for approximately 30% of the entire cortex, and it is precisely the richness of quality (tactile diversity) of the sensations returned from the fingers that directly contributes to strengthening the

neural connections (synaptic structures) of the brain's language areas (Broca's area) and spatial processing areas (parietal lobe). Digital handwriting on tablets significantly reduces this diverse tactile feedback, thereby rendering the formation of motor-perceptual traces in the brain incomplete. Likewise, as demonstrated by the above-mentioned study by Umejima et al. (2021), the spatial arrangement, physical positional relationships of information on digital screens changes fluidly due to scrolling and screen switching. In contrast, paper notebooks keep a physically fixed, two-page spread space, allowing handwritten characters to couple firmly with physical contexts (spatial indices) such as the thickness of the notebook, the left or right side of the page, and the texture of the paper. Handwriting on tablet devices provides only the same identical context, an even glass texture and a fixed chassis size, regardless of which character is written where, which weakens the encoding of episodic memory by the hippocampus and minimizes memory retrieval efficiency.

Jaashan et al. (2023) highlight that in language learning such as EFL/foreign language learning and native language literacy, inadequate handwriting acquisition or handwriting disfluency (poor handwriting) in the early stages brings about a negative chain reaction (knock-on effects) on subsequent academic performance and evaluation. Children whose physical control of handwriting movements is inexperienced and whose character output has not achieved automatization have excessive attentional resources consumed by the mere maintenance of character forms. Handwriting on the slippery, smooth screens of tablet devices urges an extra motor-control load on children to control the writing instrument, further straining working memory capacity. As a consequence, the cognitive resources that should be allocated to essential aspects of language learning, such as spelling accuracy, vocabulary acquisition, and text comprehension are depleted, leading to long-term learning delays. The appropriate frictional resistance provided by paper and pen physically guides and stabilizes children's finger movements, encouraging the early automatization of writing actions, which turns out to be scientific evidence ensuring the healthy development of overall linguistic ability.

In the contemporary era of advancing educational digitalization, and acknowledging the transition to the preceding stage of classical and universal frameworks such as Vygotsky's linguistic mediation theory (1934) and Sweller's cognitive load theory (1988), this section reveals

the unique cognitive neuroscientific value inherent in the embodiment of handwriting, based on concrete findings from recent experimental cognitive science and brain science:

- **Superiority of Cognitive and Generative Processing:** The dual-task experiments by Shibata and Omura (2018) pointed out that typing involves an inherently higher cognitive load on the brain than handwriting and interferes with memory. Additionally, Mueller and Oppenheimer (2014) proved that the physical constraints associated with handwriting force generative processing, wherein information is deeply digested and reconstructed, thereby intensifying conceptual understanding.
- **In line with the neural mechanisms described above,** fMRI research confirms how physical writing shapes brain activity. Longcamp et al. (2008) identified character-specific motor-perceptual traces in Broca's area and the inferior parietal lobule, reinforcing visual recognition and mirror-image discrimination. Likewise, building on earlier points regarding spatial processing, paper-based handwriting has been shown to co-activate the hippocampus and Broca's area alongside fixed spatial cues, thereby maximizing retrieval efficiency (Umejima et al., 2021; Kawahara, 2020).
- **Causal Path in Japanese (*kanji*) Acquisition:** The multidimensional model by Otsuka et al. (2021) indicated a decisive causal path wherein the ability to accurately handwrite *kanji* depends on the brain's visuospatial processing ability, and only the precision of this handwriting acquisition (the writing dimension) facilitates future access to linguistic knowledge and directly determines intellectual depth (density of idea) in text composition.
- **Tactile Differences Across Media:** The consistency, low-friction environment of tablet glass surfaces severely lacks dynamic feedback (sensory quality) to the body awareness from the fingers, which causes motor-control disfluency and consequently elevates cognitive load (Jaashan et al., 2023). The diverse frictional resistance and writing-pressure feedback provided by paper and pencil constitute the sensory foundation that stabilizes children's character schemata.

While the introduction of ICT devices in educational settings dramatically improves convenience and information accessibility, it carries the risk of profound cognitive developmental costs: namely, the loss of embodiment (tactile and kinesthetic senses) in writing. Especially during the early school years such as lower elementary grades, when learning complex writing systems like

Japanese, training to write characters using paper notebooks and pencils, while physically sensing writing pressure and frictional resistance, serves as an irreplaceable scientific foundation for constructing future logical thinking skills, intellectual productivity, and lifelong cognitive reserve. Rather than rapidly substituting digital tools as simple replacements for handwriting, reconstructing educational curricula with analog handwriting at their core, aligned with the biological and physical mechanisms of the human brain, and carefully designing the division of roles between media represent the highest priority tasks in contemporary educational policy.

Chapter 4: Changes in literacy skills brought about by digitalization

4.1 Literacy rates and the “quality of literacy” from the postwar period to the present

Modern literacy education in Japan has been promoted as a national imperative of universal education since the promulgation of the *gakusei* (Education System Order) in 1872. As Xing (2008) argues, the Meiji government’s *kanji* policy and national language education, which sought to provide homogenous education to all citizens in response to the collapse of the feudal class system and the emergence of a modern civil society, positioned the foundation for the dramatic increase in compulsory school enrollment. In postwar Japan, which succeeded this path of modernization, the discourse asserting that the Japanese possess an exceptionally high level of literacy was firmly established by the first, and to date the only nationwide literacy survey conducted in 1948 under the leadership of the Ministry of Education and the National Institute for Japanese Language, among other organizations (Agency for Cultural Affairs, 2006). The survey reported a remarkably low illiteracy rate of approximately 2%, effectively maintaining the achievement of near-universal literacy throughout the nation. The findings of this survey exemplified international evidence of the high educational standards achieved by Japan during the postwar reconstruction period were subsequently embraced as proof of the quality of the nation’s workforce, which upheld its period of rapid economic growth. The findings of this survey highlighted international evidence of Japan’s high educational standards during the postwar reconstruction period and were widely accepted by society as a guarantee of a high-quality

workforce that would support the subsequent period of rapid economic growth. However, since the 1948 survey, no comprehensive nationwide literacy survey of the same scale has been conducted to this day¹⁰. In consequence, the extremely high literacy rate, which is taken for granted in modern society, relies heavily on a kind of conventional wisdom rooted from the limited data structure of the immediate postwar period and the subsequent high school enrollment rates, or on a fixed self-perception.

With advances in psycholinguistics and educational research, the concept of literacy has evolved from basic literacy, defined as the ability to decode written symbols into sounds or to write one's own name to functional literacy, which comprehends the capacity to process and apply linguistic information effectively within diverse social contexts. Amano (1987) verified that the development of phonemic awareness and linguistic awareness is crucial during the early stages of children's acquisition of the Japanese *kana* writing system. At the same time, Amano (1987) suggested that the automatization of decoding does not necessarily lead directly to higher-order reading comprehension or conceptual understanding. In other words, beyond the mechanical processing of grapheme–phoneme correspondence lies the acquisition of cognitive processes that enable individuals to perceive the logical structure of texts and to evaluate them critically. As the concept of literacy has expanded in this manner, the issue of functional illiteracy has emerged as a major concern in contemporary developed societies. Functional illiteracy refers to a condition in which individuals are capable of reading and writing everyday words and understanding simple sentences, yet are unable to comprehend complex explanatory texts, official documents, legal contracts, and other forms of written communication essential for participation in modern society, or to integrate such information into their own reasoning and apply it effectively in social contexts. Although the rate of formal illiteracy in contemporary Japan remains exceptionally low, concerns have been raised regarding the quality of higher-order literacy, as reflected in fluctuations in Japan's performance on reading literacy assessments such as the Program for International Student Assessment (PISA). These concerns relate particularly to learners' ability to infer authors' intentions, compare and synthesize multiple sources of information, and construct coherent interpretations based on textual evidence. In this regard, the central challenge of contemporary language education has shifted decisively from eliminating formal illiteracy, the inability to read

¹⁰ Uesugi (2022) noted that the fact that no nationwide literacy surveys have been conducted in Japan since the 1948 survey, yet literacy surveys do exist at the local government level.

written text which characterized the immediate postwar period, to overcoming functional illiteracy, in which individuals can decrypt written language but are unable to construct deep meaning from it or engage it effectively in intellectual and social contexts.

An examination of the postwar evolution of the *Courses of Study*, which serve as Japan's national curriculum standards, uncovers that the educational system's conception of the quality of literacy has sustained continual transformation in response to changes in social structure and shifting perspectives on academic achievement. In the *Courses of Study* of the 1960s and 1970s (the Shōwa 30s and 40s), the consolidation of fundamental knowledge and skills was strongly featured, reflecting the demands of the rapidly industrializing society during Japan's period of high economic growth (Agency for Cultural Affairs, 2006). Within Japanese language education, considerable instructional time was devoted to the cultivation of linguistic skills, including the reading and writing of kanji, accurate orthography, and mastery of grammatical rules. During this period, Japan's *kanji* policy was in a transitional phase, moving from the restrictive implementation of the *tōyō kanji list* established in 1946 toward a more flexible approach that responded to the evolving needs of society. Thus, school education set particular emphasis on the automatization of handwriting, requiring students to produce accurately the *kanji* necessary for everyday communication. The primary educational objective of this era can therefore be characterized as the development of standardized literacy through the repetitive acquisition and mastery of accurate linguistic knowledge and skills. However, as the adverse effects of knowledge-intensive, cramming-based education and the growing problem of students' maladjustment to learning became increasingly noticeable as social issues, educational policy shifted in the latter half of the 1980s toward what came to be known as *yutori* (relaxed) education. Within Japanese language education during this period, focus was allocated to reducing mechanical repetitive drills and fostering pupils' interest, motivation, and learning attitudes, as well as their ability to express themselves in rich and meaningful ways. Because priority shifted away from providing the acquisition of a fixed body of foundational knowledge and toward cultivating positive attitudes toward language and promoting the development of individual potential. At the same time, however, this educational shift gave rise to new challenges, including a decline in students' fundamental academic competencies and insufficient training in the cognitive skills required for the logical comprehension and analysis of written texts.

Following these shifts in conceptions of academic achievement, the contemporary Japanese curriculum has arrived at the framework based on the “*three pillars of competencies*” articulated in the *Commentary on the Course of Study for Elementary Schools: Japanese Language* (MEXT, 2017). While maintaining the general direction established in the 2008 revision, the 2017 revision explicitly weighs greater emphasis on achieving an appropriate balance between the acquisition of knowledge and skills and the cultivation of thinking, judgment, and expressive abilities (MEXT, 2017). More specifically, contemporary Japanese language education no longer prioritizes the simple accumulation or memorization of factual knowledge. Rather, its central objective is to refine the quality of students’ understanding of knowledge and thereby foster robust academic competence (MEXT, 2017). In the domain of *kanji* instruction, for example, students are expected not solely to memorize the forms of individual characters or reproduce them accurately in writing. Instead, they are encouraged to acquire knowledge and skills that can be applied meaningfully in authentic contexts, that is to understand the semantic functions that particular *kanji* perform within texts and to select them appropriately according to the demands of the linguistic context. Such knowledge is regarded as living knowledge and skills (*ikite hataraku chishiki, ginō*, 生きて働く知識の技能), capable of being flexibly prepared in actual language use.

Furthermore, the *Heisei 29 Curriculum Guidelines* advocate for an “education curriculum open to society” and aspire to ensure that children develop the qualities and abilities necessary to shape the society of the future (MEXT, 2017:6). The concept of literacy delineated here goes beyond mere academic proficiency in Japanese language studies; it refers to the ability to connect diverse texts found in the real world, such as charts, statistical data, and digital information, and to proactively organize and disseminate information to solve problems. In other words, it is a communication skill that represents the highest level of “functional literacy.” A comparison of the shifting priorities over time is as follows.

Historical Periods	Underlying Social Context	Key Objectives in Japanese Language Education	The Emphasis on “Quality of Literacy”
Mid- <i>Shōwa</i> period (1955-1965)	Rapid Economic Growth and Industrialization	Ensuring a solid mastery of basic language skills and standardizing writing conventions	Accurate writing and reading, and memorization of <i>kanji</i> (Primary Education)

Late <i>Shōwa</i> to Early <i>Heisei</i> period (1980-2000)	Criticism of Rote Learning, A mature Society	Emotional richness; fostering interest, motivation, and a positive learning attitude toward language	Developing individuality in self-expression and a positive learning attitude toward language
Present (since the <i>Heisei</i> 29 (2017) Notice)	The Information and Knowledge-Based Society (An Era of Unpredictability)	The Three Pillars of Qualities and Abilities: Improving the quality of knowledge comprehension	Functional literacy linked to critical thinking, judgment, and expression skills

One of the most significant transformations in contemporary educational practice has been the drastic decline in the amount of time that children dedicate engaged in handwriting. In the Japanese language curriculum from the postwar period through the middle of the *Shōwa* era, the acquisition of *kanji* and the development of writing skills were largely supported over repeated physical handwriting in notebooks and *kanji* drill books, that is through extensive copying and transcription exercises. In recent years, however, the widespread implementation of the GIGA School Initiative during the 2020s has fundamentally shifted the medium through which writing activities are conducted. With each student now provided with an individual digital device, such as a tablet or personal computer, the nature of written language production in schools has experienced a profound transformation. From the perspective of the curriculum as a whole, the expansion and increasing diversification of learning domains, including the introduction of foreign language (English) education, programming education, and inquiry-based learning within the Period for Integrated Studies have resulted in an increasingly crowded curriculum. Therefore, the amount of instructional time devoted exclusively to handwriting in Japanese language classes has inevitably decreased. Instruction based on repetitive handwriting drills has gradually been shrunk in response to efforts to lessen students' learning burden and to improve instructional efficiency. As a consequence, contemporary *kanji* instruction has shifted toward pedagogical approaches that insist visual selection tasks using digital learning materials and text composition through keyboard input, rather than the mechanical repetition of handwritten character practice.

This decline in handwriting and the transformation of methods for acquiring written language are not restricted to the context of formal schooling; rather, they have been experimentally documented as broader changes in linguistic practices and language awareness

across Japanese society. Linear comparisons of the *Public Opinion Survey on the Japanese Language (Kokugo yorinchōsa)*, conducted periodically by the Agency for Cultural Affairs, provide clear evidence of a structural shift in the ways Japanese people engage with written language and handwriting. In earlier surveys (e.g., the 2006 survey), respondents were asked which factors had been most helpful in learning *kanji*. An overwhelming 68.7% identified “writing characters repeatedly by hand,” indicating that repetitive handwriting was still widely honored as the foundation of *kanji* acquisition and literacy development (Agency for Cultural Affairs, 2007). Although subsequent surveys have consistently pointed to a decline in opportunities to write by hand in everyday life, a trend closely associated with the widespread diffusion of digital information and communication technologies. As digital devices have become increasingly integrated into daily activities, handwriting has gradually been displaced by keyboard and touchscreen input, resulting in a marked shift in both the frequency and the function of handwritten language use.

According to the most recent *Public Opinion Survey on the Japanese Language* (FY2024 Survey; conducted in March 2025), the realities of Japan’s contemporary information society, most notably the explosive proliferation of social networking services (SNS), have given a profound influence on the ways in which people use written characters and verbal expressions, as well as on broader patterns of language use and reception (Agency for Cultural Affairs, 2025). The survey found out that approximately 90% of respondents believed that the widespread use of SNS has influenced the use of written language, vocabulary, and linguistic expression in society, combined responses indicating that it “has an influence” (Agency for Cultural Affairs, 2025). When respondents were further asked to identify the specific forms that this influence has taken, the following trends emerged:

- An increase in the use of abbreviations: 80.1% (the highest proportion)
- An increase in new words and usages of existing expressions: 76.9%
- An increase in expressions understood only within particular social groups: 45.1%
- An increase in the use of emojis and related pictographic symbols: 35.9%

These findings suggest that digital communication environments are reshaping not only the vocabulary retained in everyday communication but also the forms, conventions, and shared norms

through which language is produced and interpreted. The survey therefore provides practical evidence that contemporary literacy practices are increasingly mediated by digital communication platforms, where linguistic efficiency, informality, and group-specific methods of expression have become prominent characteristics of language use.

The normalization of digital communication, particularly through social networking services (SNS), has not just enhanced the convenience of everyday communication; it has also transformed the linguistic and cognitive processes of children and adolescents, thereby changing the very nature of literacy. Supplementary questions included in the FY2024 Public Opinion Survey on the Japanese Language (Agency for Cultural Affairs, 2025), unveil that respondents perceive a number of challenges aligned with interpersonal communication via SNS. Among the most frequently referred concerns were the difficulty of discerning the emotional intentions of communication partners (45.0%) and the predominance of fragmented information in the content encountered online (20.1%), with the recent tendency being especially pronounced among respondents in their twenties and younger (Agency for Cultural Affairs, 2025). The survey further indicates that respondents aged 16–19 were more likely than any other age group to report that they increasingly use spoken-language expressions even when writing (Agency for Cultural Affairs, 2025). This finding suggests that the act of writing is undergoing a fundamental transformation. Rather than serving primarily as a reflective process through which individuals organize their thoughts and construct coherent, logically structured texts, writing is increasingly functioning as a medium for immediate, conversational exchanges that resemble spoken interaction. In other words, written communication is becoming progressively characterized by the rapid and affective exchange of symbolic expressions, blurring the traditional distinction between written and spoken language.

The decline of handwriting has important connotations not only for writing practices but also for the cognitive processes that underlie literacy acquisition. Handwriting stimulates the brain's sensorimotor systems, assisting the encoding of the spatial organization and fine-grained orthographic features of characters, such as stroke endings, hooks, and sweeping strokes in *kanji*. Moreover, because handwriting is naturally slower than digital text entry, it boosts sustained reflection and supports the deeper processing of linguistic information. On the contrary, digital writing environments, characterized by automatic character conversion, copy-and-paste functions,

and the selection of standardized expressions, substantially alleviate the cognitive demands related to text production. Although such technologies reinforce efficiency, they may simultaneously diminish learners' ability to voluntarily retrieve and accurately reproduce *kanji* from memory. Namely, while individuals may remain capable of recognizing characters when they are presented with visual recognition, they may increasingly struggle to generate those same characters independently from memory (recall). This disconnection between recognition and recall has been identified as a characteristic feature of functional literacy in contemporary information society. Likewise, the proliferation of abbreviations and the predominance of fragmented manners of information consumption have been identified as factors that may hold up the development of sustained reading comprehension and coherent written expression among children and adolescents.

The remarkable achievement of postwar Japanese education in scaling down illiteracy constitutes a firmly established outcome of the comprehensive *kanji* policies implemented since the modern period, together with the institutionalization of compulsory education. However, underneath Japan's exceptionally high level of formal literacy lies a new challenge: the growing threat of functional illiteracy, the condition in which individuals are capable of reading written text but are unable to comprehend its meaning in depth or, more broadly, the transformation in the qualitative dimensions of literacy itself. As the prior discussion has demonstrated, the *Course of Study* has progressively reconsidered its educational objectives across successive periods, shifting its emphasis from the repetitive acquisition of basic skills toward the cultivation of higher-order competencies and dispositions. At the same time, regardless the digitalization of education has substantially reduced the amount of time devoted to handwriting, while the widespread use of fragmented textual communication, exemplified by social networking services (SNS), has contributed to declines in students' sustained linguistic cognition and their capacity for linguistic retention and retrieval. On top of that, the multiple-choice examination system that has long characterized Japanese education has, it must be acknowledged, unevenly nurtured the ability to identify and process linguistic information while simultaneously digging out learners' capacity to construct and articulate logical arguments independently. In doing so, it has fortified the structural foundations of contemporary functional illiteracy. Looking ahead, the central challenge facing Japanese language education and language policy is present in determining how to reintegrate forms of reading and writing that require reflective and logical thinking into both the curriculum and assessment systems, while continuing to benefit from the convenience afforded by digital

communication. Rather than remaining satisfied with the simple automation of textual decoding, future educational reform must seek to ensure a genuinely functional quality of literacy, one that enables learners to engage in deep contextual interpretation and to articulate and communicate their own ideas effectively in the public sphere. Achieving this objective will require the integrated reform of both the national curriculum and the university entrance examination system.

4.2 The decline in time dedicated “writing,” as observed through statistics

In contemporary educational settings, the introduction of Information and Communication Technology (ICT) devices has fundamentally transformed students’ styles of learning. Particularly notable are the qualitative and quantitative changes in the act of writing within Japanese language education. The conventional practice of handwriting with pencils and manuscript paper is increasingly being replaced by the production of digital texts through tablet keyboards, flick input, and, more recently, speech recognition technologies. This absolute reduction in time dedicated to analog handwriting, along with the transition toward digital environments, has exerted multifaceted influences on students’ vocabulary development and their ability to organize and compose written discourse. A review of the history of Japan’s national language policy reveals that both Japanese language education and language planning have traditionally emphasized the standardization of orthography, including the use of kanji and kana, as well as the cultivation of accurate written language appropriate for formal contexts. As documented in *Kokugo seisaku hyakunenshi* (*One Hundred Years of National Language Policy*), compiled by the Agency for Cultural Affairs, governmental bodies such as the *Kokugo chōsa iinkai* (National Language Research Committee) and the *Kokugo shingikai* (National Language Council) have continuously deliberated on how best to solidify the foundations of linguistic literacy among the Japanese population while responding to successive social transformations, including modernization and postwar educational reforms. However, the radical progress of contemporary information-based society has profoundly challenged the conventional framework of written language, necessitating a qualitative reconfiguration of both linguistic awareness and literacy itself. Drawing primarily upon statistical data from the *Kokugo ni kansuru yoron chōsa* (Public Opinion Survey on the Japanese Language), which has been conducted over many years by the Agency for Cultural Affairs, this section examines the transformation of Japan’s linguistic environment before and after the widespread introduction of ICT. Particular attention is paid to the increasing casualization of

written language associated with the proliferation of social networking services (SNS) and the widening gap in the recognition and understanding of traditional vocabulary and idiomatic expressions. These issues are analyzed from the complementary perspectives of educational studies and sociolinguistics.

The widespread adoption of social networking services (SNS) has been a principal driving force behind the digitalization of everyday writing practices. According to statistical data from the *Reiwa 6-nendo kokugo ni kansuru yoron chōsa (Reiwa 7-nen 3-gatsu chōsa) (FY2024 Public Opinion Survey on the Japanese Language [Survey Conducted in March 2025])*, which is the most recent survey published by the Agency for Cultural Affairs, 89.3% of respondents indicated that the proliferation of SNS has had either “a significant impact” or “some impact” on the use of written characters, words and expressions, and language more generally in contemporary society. This remarkably high proportion suggests that digital communication has evolved beyond a mere means of interpersonal communication and now functions as a medium through which the linguistic system of society itself is being reshaped and adjusted. The survey’s supplementary questions provide more specific evidence regarding the nature of these perceived influences. Among the reported effects, the most frequently mentioned was “an increase in the use of abbreviations” (80.1%), followed by “an increase in new usages of existing words and the creation of new words” (76.9%), and “an increase in expressions understood only within particular social groups” (45.1%). These tendencies were recognized most prominently among respondents in their teens and twenties, providing statistical evidence that supports the increasing casualization of language in everyday contexts outside formal educational settings.

The increasing informalization and erosion of conventional written language in out-of-school contexts have blurred the traditional boundary between written and spoken language. The *heisei 29-nendo kokugo ni kansuru yoron chōsa (FY2017 Public Opinion Survey on the Japanese Language)* included an investigation into public perceptions of the relationship between written and spoken language. The survey referred to the growing frequency in digital communication, including e-mail and SNS posts of expressions characteristic of spoken language, as well as the regular use of punctuation marks and symbols such as question marks and exclamation marks, both of which depart from the conventional norms of formal written Japanese. Contemporary children and adolescents, who are constantly exposed to an abundance of emojis, symbols, and

katakana-based expressions in their daily communication, may therefore have relatively fewer opportunities to acquire systematically the standard writing skills and linguistic accuracy expected in formal and public contexts. Although digital text production offers the advantages of facilitating revision and deletion, it also possesses structural characteristics that encourage rapid exchanges through short messages. In this regard, opportunities to develop the ability to construct coherent and logically organized texts have diminished. Students who have become accustomed to the SNS-based style of communication, in which context is frequently neglected, and meaning is conveyed through successive short phrases, often encounter structural difficulties when required to compose extended texts. To be specific, recent classroom observations and previous research like Amano (1988) have reported challenges in the appropriate use of conjunctions to express logical and causal relationships, as well as in organizing longer compositions with a coherent paragraph structure.

The raising erosion of conventional written language and the growing informalization of linguistic expression in out-of-school contexts have blurred the boundary between written and spoken language. The *heisei 29-nendo kokugo ni kansuru yoron chōsa (FY2017 Public Opinion Survey on the Japanese Language)* investigated public perceptions of the relationship between written and spoken language. The survey indicated that digital communication, including e-mail and SNS posts, largely incorporates expressions characteristic of spoken language, along with the frequent use of punctuation marks and symbols (e.g., “?” and “!”), thus departing from the conventional norms of formal written Japanese. Contemporary children and adolescents, who are regularly exposed to a wide range of emojis, symbols, *katakana*-based expressions (*gairaigo*), and other nonstandard forms of standard written representation, may accordingly have fewer opportunities to learn systematically the standard writing proficiency that is, the linguistic accuracy and linguistic conventions expected in formal and official contexts. While digital text production offers the advantage of allowing writers to revise and delete text easily without friction, it also possesses structural characteristics that encourage rapid exchanges through short messages. This tendency has cut down opportunities for learners to develop the ability to construct coherent and logically organized extended texts. Students who have become accustomed to the SNS-based style of communication, in which contextual information is frequently omitted and meaning is conveyed through a succession of brief phrases, have been reported in both educational practice and previous research to experience structural difficulties when composing longer texts. In particular, they often

struggle to retain conjunctions appropriately in expressing logical and causal relationships and to organize their writing into coherent paragraph structures.

A particular noteworthy issue in this section concerns the discrepancy between the original, dictionary-defined meanings of traditional words and idiomatic expressions and the meanings that have become widely adopted in contemporary usage. Across successive editions of the *kokugo ni kansuru yoron chōsa* (*Public Opinion Survey on the Japanese Language*), respondents' understanding of a number of idiomatic expressions has been examined consistently. The survey findings have repeatedly brought out that, regardless of generation, a substantial proportion of respondents decode these expressions in ways that differ from their original meanings. Against this background, the present study proceeds the following hypothesis: the deviation between the original meanings of traditional idiomatic expressions and their commonly accepted interpretations has been further accelerated by the introduction of ICT, together with the broader processes of digitalization and the widespread adoption of social networking services (SNS).

A remarkably noteworthy issue in this section concerns the phenomenon of divergence between the original (i.e., dictionary) meanings of traditional words and idiomatic expressions and the meanings that have become widely accepted in contemporary usage. In the public opinion surveys conducted each year, respondents' understanding of the meanings of several idiomatic expressions has been examined consistently. The results have repeatedly shown that, across all generations, a substantial proportion of respondents interpret these expressions in ways that differ from their original meanings. On the basis of these findings, I propose the following hypothesis: the divergence between the original meanings of traditional idiomatic expressions and their meanings as commonly understood has been further accelerated by the introduction of information and communication technology (ICT), as well as the continuing digitalization of society and the widespread diffusion of social networking services (SNS).

To examine this hypothesis, a curricular comparison with historical statistical data is undertaken. At the time of the *Public Opinion Survey on the Japanese Language* (*Kokugo ni kansuru yoron chōsa*) conducted by the Agency for Cultural Affairs in fiscal year 2024 (*Reiwa* 7), the Internet had not yet become widely available to the general public, and text-based communication via mobile phones remained extremely limited. During this period, language was acquired primarily

through books, newspapers (paper-based media), television, school education, and face-to-face communication within the family. Analysis of the data from that survey, including respondents' attitudes toward language and their use of designated expressions with more recent data, from the latter half of the *heisei* 20s [approximately 2013–2018] through fiscal year 2024 [*reiwa* 6]) suggests that the cognitive structure underlying lexical knowledge has undergone significant transformation. For example, in the surveys conducted in fiscal years 2015, 2016, 2017, and 2024, respondents were asked about the meanings of traditional idiomatic expressions such as *yakubusoku* (dictionary definition: a condition in which something is disproportionately small or too light for the person, commonly misused as being unqualified), *shiodoki* (dictionary definition: the perfect time to start or finish something, commonly misused as giving negative nuance to quit or finish something.), *hatenkō* (dictionary meaning: to be the first to accomplish something that no one has ever done before, commonly misused as a bold and reckless behavior), and *kakushinhan* (dictionary definition: a crime committed under a sense of duty or mission based on political, moral, or religious convictions, as defined by law, commonly misused as taking action even though one knows it is wrong or will cause trouble, or a person who takes such action). The results often showed that the proportion of respondents selecting meanings different from the original ones either exceeded or was roughly corresponding to the proportion selecting the original meanings.

Why might digitalization have accelerated this divergence? One plausible explanation is inherent in the distinctive characteristics of information circulation within digital environments. In the pre-digital era, language acquisition generally involved consulting dictionaries or reading extended contextual materials, such as chapters of books, through which the precise meanings of words and their cultural backgrounds were acquired in a systematic manner. In contrast, in digital environments, particularly on social networking services (SNS) and content summarization platforms, words are circulated in fragmented contexts. Children and adolescents nowadays frequently witness traditional idiomatic expressions in influencers' posts, short texts of approximately 140 characters, or subtitles accompanying videos that last only a few seconds. Due to this, even when an expression is used incorrectly, the digital environment's unique capacity for rapid dissemination and repeated visual exposure increases the likelihood that the incorrect interpretation, rather than the original one, will become cognitively entrenched as the ordinary or standard meaning. Besides that, the widespread adoption of predictive text input including autocorrection on digital devices and AI-assisted writing tools has dramatically reduced

opportunities for children and adolescents to pause and verify the meanings of unfamiliar expressions by consulting dictionaries or other reference materials. As the automation of cognitive processes has advanced alongside the fragmentation of information, the importance of vocabulary instruction aspires to foster a systematic understanding of the precise meanings of words and their cultural backgrounds has become considerably greater than it was prior to the introduction of ICT. From a statistical perspective, the finding that approximately 90% of respondents recognize that language use is being transformed through SNS constitutes indirect but strong evidence supporting the hypothesis that digitalization has accelerated changes in lexical semantics.

As discussed above, the alternation in the linguistic environment of children and adolescents toward digital media has implications that extend far beyond changes in vocabulary or the deterioration of orthographic conventions. More fundamentally, it is directly linked to transformations in communicative competence itself, that is, the ability to establish and maintain relationships with others through language. The *Public Opinion Survey on the Japanese Language (kokugo ni kansuru yoron chōsa)* for 2016 (*heisei 28*) focused specifically on the questions of “What constitutes communicative competence?” and “What aspects of communication with others are considered most important?” Although the survey revealed widespread recognition of the importance of communicative competence, it also highlighted the difficulties respondents experience in adopting appropriate linguistic practices, particularly with respect to showing respect for others and using language appropriately when expressing opinions or engaging in discussion. Accordingly, one of the principal challenges in contemporary Japanese language education is not just to ascertain the acquisition of what may be termed classical literacy, the basic ability to read and write, but also to improve multidimensional communicative competence and digital information ethics, enabling learners to choose language that demonstrates respect for others in digital environments. Based on data from *reiwa 6* (FY2024; survey conducted in March 2025), more than 75% of respondents identified “avoiding language that hurts or provokes others” as either an important issue for improving the quality of communication on social networking services (SNS) or a point they themselves should be mindful of. Other highly ranked responses included “avoiding language that may lead to misunderstanding” and “carefully considering the content before posting.”

These statistics indicate that the act of writing in digital environments is invariably accompanied by the risks of instantaneous dissemination and exposure to an indeterminate audience. In the era of handwritten composition on traditional manuscript paper (known as *genkō yōshi*), written texts were accessible only to a limited readership, typically teachers or other designated individuals, and the process of revision proceeded at a relatively premediated pace under pedagogical guidance. On the other hand, children and adolescents equipped with ICT devices now live in an environment in which a single tap enables them to communicate their writing to a global audience. As a consequence, even the production of brief texts demands, to an unprecedented degree, both the lexical sensitivity to anticipate how particular word choices may influence readers and the ability to organize discussion logically so as to prevent misunderstandings coming up from structural inconsistencies. Accordingly, the promotion of information ethics in digital communication should not be regarded entirely as an issue within the domain of moral education. Rather, it must be perceived as a challenge fundamentally rooted in the core objectives of Japanese language education, namely the cultivation of lexical competence and coherent writing skills. Students who lack proficiency in standard written expression and instead rely on inconsistent orthographic practices, such as the inappropriate mixing of emojis and other symbols or the indiscriminate transcription of colloquial speech into writing are more likely, and unintentionally, to generate misunderstandings and interpersonal conflict in digital spaces.

By observing the statistical data and the historical evolution of educational policies examined in this section point out that the introduction of information and communication technology (ICT) has exerted a dual impact on students' Japanese language proficiency. Statistical evidence strongly suggests that the reduction in time spent to analog handwriting may have imposed a constraining, and potentially adverse, effect on students' ability to construct logically coherent texts and to acquire vocabulary grounded in lexicographical accuracy. Likewise, the increasing casualization of language associated with the widespread use of social networking services (SNS), together with the accelerating semantic divergence of traditional idiomatic expressions, sets up an inevitable transformation of the linguistic environment confronting the digital-native generation. The challenge facing Japanese language education in the years ahead is not to reject digitalization outright or to revert to the analog pedagogical practices of the past. As successive reports issued by the Agency for Cultural Affairs have consistently emphasized, the "Japanese language proficiency required in the coming era" refers to the capacity that qualifies

individuals to understand accurately the changing conditions of society while serving as a foundation for both personal development and the construction of a better society.

4.3 The phenomenon of *kanji* attrition and the overall decline in literacy skills among the digital native generation

The rapid advancement of information and communication technology (ICT) in contemporary society has fundamentally transformed the nature of human communication, creative, and expressive activity. The widespread adoption of digital devices, including personal computers, tablet devices, and smartphones, has enabled the quick and instant sharing of information, the efficient processing of vast quantities of data, and the rapid production of written text through keyboard typing and flick-input methods. For this reason, the temporal and physical costs associated with text production have been significantly reduced, allowing individuals to disseminate their thoughts to large audiences in real time. These technological developments have thus provoked substantial benefits for communication and information exchange. In educational settings, the implementation of the “one digital device per student¹¹” initiative has also progressed steadily. From this perspective, the acquisition of typing skills as a form of digital writing, together with the promotion of collaborative learning through the effective use of digital tools, has come to be regarded as an indispensable foundation of contemporary education, equipping learners with the competencies necessary to participate effectively in an increasingly information-oriented society.

From a historical perspective, the acquisition of written language and the standardization of orthographic conventions, that is, the dissemination of literacy have been considered as central national objectives in the process of state modernization, serving not only to promote national integration and establish modern educational systems but also to enhance the overall efficiency of society (Xing, 2008). A review of the evolution of *kanji* policy and Japanese language education in modern Japan reveals that the central concern has consistently been how to represent and transmit language with the greatest possible efficiency and accuracy, thereby achieving a balance between practical utility and educational effectiveness. From this point of view, the automation and increased efficiency of text production brought about by contemporary digitalization may

¹¹ GIGA school program.

appear to represent the culmination of humanity's long-standing pursuit of reducing the cognitive costs associated with writing while maximizing communicative efficiency. Paradoxically, however, the benefits of digitalization have been accompanied by a decline in overall Japanese language proficiency, including reading comprehension and vocabulary knowledge. Most notably, with respect to literacy, serious phenomena such as *Character Amnesia* and the weakening of literacy have become increasingly evident. According to the Fiscal Year 2021 *Public Opinion Survey on the Japanese Language (kokugo ni kansuru yoron chōsa)* conducted by the Agency for Cultural Affairs, 90.6% of respondents answered that the widespread use of digital devices has affected language and its usage. Furthermore, when asked about the specific nature of these effects, the two most frequently referred responses were “fewer opportunities to write characters by hand” (89.4%) and “a decline in the ability to write *kanji* accurately by hand” (89.0%). These findings uncover that a substantial proportion of the public discerns a serious erosion of opportunities for handwriting and a corresponding deterioration in the ability to recognize and reproduce *kanji*. This phenomenon spreads beyond the quantitative issue of insufficient *kanji* writing practice. Relatively, it suggests that an overreliance on the character-conversion functions provided by digital devices may be fundamentally undermining the cognitive framework of structural recognition through which the human brain has acquired, organized, and retained written characters over the course of several millennia.

Among younger individuals (aged 16–19), these concerns were reported less frequently than among older age groups, with approximately 60% expressing such views, likely because opportunities for handwriting are still well maintained within the school curriculum in some measure. Nevertheless, as the “one tablet device per student” model becomes increasingly embedded in everyday educational practice, the tendency to be unable to write or recall *kanji* is rapidly spreading throughout the school-age population of the digital-native generation. This section examines how excessive reliance on the character-conversion functions provided by digital devices may expend a detrimental influence on the human capacity for the structural recognition of written characters. Drawing upon recent findings from neuroscience and cognitive psychology, it further presents a detailed, evidence-based discussion of why the physical act of writing by hand plays an essential role in the maintenance and improvement of literacy.

The fundamental distinction between *kanji* and other writing systems based on phonographic characters, such as *hiragana*, *katakana* and the Roman alphabet, is inherent in the fact that each *kanji* character is a logograph or, more precisely, a morphographic character, that naturally encodes semantic information. As a result, the recognition and acquisition of *kanji* require not only advanced visuospatial processing to navigate their complex structural configuration, but also the capacity to analyze and encode their sequential organization. In the conventional process of handwriting with traditional writing instruments, the writer must actively retrieve the visual and orthographic representation of the target *kanji* from long-term memory and reconstruct the character stroke by stroke in physical space. This motor execution relies on a strictly prescribed stroke order, a dynamic temporal and graphomotor sequence that seamlessly integrates visual, motor, and kinesthetic feedback, thereby reinforcing cognitive consolidation and facilitating long-term orthographic retention. the writer must actively retrieve (i.e., recall) the visual representation of the target *kanji* from long-term memory and reconstruct the character stroke by stroke in physical space according to the prescribed stroke order, which constitutes a temporal and motor sequence. This series of cognitive operations compels the writer to assist closely to the spatial relationships among the constituent elements of the character and has long played a crucial role in reinforcing structural awareness of *kanji*.

However, typing and predictive text functions on digital devices have fundamentally transformed this active process of retrieval. By only entering a phonological code, whether phonemes through *rōmaji* input or syllables through flick input, users are immediately presented with candidate *kanji* characters on the screen. Eventually, the writer's task has shifted from actively retrieving the structural representation of a character from memory to visually recognizing the intended *kanji* from among multiple candidates and selecting it. In other words, the cognitive process has regressed from recall to recognition. In this process of converting phonological representations into orthographic forms, the automatic conversion functions of digital tools effectively externalize the complex cognitive operations that would otherwise be performed by the human mind. As Amano (1987) argues, the act of converting linguistic information into written code instinctively involves dividing the continuous speech stream and engaging in in-depth analyses of phoneme–grapheme correspondences, the linguistic properties of words, and the internal structure of morphemes. Heavy reliance on automatic conversion bypasses these essential stages of phonological and morphological analysis of words, as well as structural analysis of

characters. As a consequence, members of the digital-native generation increasingly exhibit a phenomenon that may be described as “*kanji* attrition”: although they retain a vague familiarity with the overall silhouette or outline of a *kanji* character and are therefore able to recognize it, they are often unable to reconstruct the character independently because they no longer retrieve the precise strokes or the geometric arrangement of its radicals and other constituent components, that is, its internal orthographic structure. Dependence on automatic conversion thus undermines the cognitive framework through which characters are perceived as complex structural arrangements, reducing the cognitive demands of writing to the macroscopic task of selecting an appropriate symbol from a list of candidates.

Why then is the analog, bodily act of writing by hand, rather than digital typing, so effective in restoring structural awareness of written characters and improving literacy? In reply to this question, recent research in embodied cognition, together with neuroscientific studies engaging functional magnetic resonance imaging (fMRI), has provided compelling practical evidence. Once an orthographic representation has been determined at the cognitive level, it is subsequently transmitted to the motor level. The motor level refers to the process by which the orthographic representation encoded in the brain is translated into coordinated movements of the muscles and joints that is, a graphomotor task and ultimately realized as a sequence of strokes in physical space. Several theoretical models have been proposed to explain motor control at this level. These include the closed-loop theory, which emphasizes the role of continuous sensory feedback in regulating movement; schema theory, which posits that motor behavior is caused through the application of generalized motor programs stored in the brain; and computational models of motor control, such as the minimum-jerk model and the minimum torque-change model, which mathematically characterize the smoothness and efficiency of human movement (Kōno, 2019).

In handwriting, the motor level involves far more than the pure “inscription” of characters. In accordance with the *hitsujun* (stroke order, i.e., the temporal sequence of execution) and the directionality and length of individual strokes and their spatial configuration encoded in orthographic representations, dynamic and character-specific motor controls are issued to the muscles of the fingers and wrist. Through this process, distinctive motor schemas (motor memory) are encoded in the brain. Typing, flick input, and automatic character-conversion functions on digital devices fundamentally transform or effectively bypass, the complex cognitive processes

that conventional handwriting requires at both the cognitive and motor levels. In keyboard typing, regardless of whether the intended output is the *hiragana* character “あ” or a *kanji* with a highly complex orthographic structure, the motor action executed is invariably reduced to the same simple and uniform movement: pressing a designated key vertically. This movement bears no intrinsic relationship to the visual form or structural properties of the character being produced. Because of this, the motor-level feedback associated with the character-specific method of handwriting is entirely eradicated. Even more meaningful is the fact that automatic character-conversion functions effectively take responsibility for the encoding processes at the cognitive level. The user only needs to input phonological information (e.g., via *rōmaji*), without actively retrieving the internal orthographic structure of the target character from the brain’s visual orthographic lexicon. Because text production is completed simply by recognizing and selecting the correctly shaped character from a list of candidates displayed on the screen, the cognitive loads linked with the fine-grained analysis and reconstruction of character structure are drastically reduced. That is to say, the process shifts from one of active orthographic encodings to one of visual recognitions, therefore substantially minimizing the depth of cognitive processing required for character production.

Correspondingly, excessive reliance on the automatic character-conversion functions of digital devices has the potential to trigger a radically disruptive effect on the cognitive processing of the Japanese writing system, particularly its *kanji* component. In conventional handwriting with pen or pencil, the accurate production of *kanji* requires far more than a vague perception of the overall character shape (Gestalt). Instead, writers must actively analyze the fine-grained spatial arrangement of individual strokes, the configuration of their intersections, and the balance among constituent components that is, the internal orthographic structure of the character, and sequentially construct it stroke by stroke in accordance with the temporal and motor constraints imposed by *hitsujiun* (stroke order). This process installs substantial demands on spatial-analytic processing. Predictive text and automatic character-conversion functions, however, fundamentally transform this process. Once the user enters a phonological representation (the *on* reading), artificial intelligence and conversion algorithms infer the intended lexical item from the linguistic context and immediately present the completed *kanji* as a holistic graphic symbol on the screen.

At this stage, the user's cognitive task is reduced to little more than visual filtering, determining whether one of the displayed candidates corresponds to the intended lexical item.

Under these conditions, writers are no longer required to precisely scan the internal orthographic structure of *kanji*, for example, whether a single stroke is missing or superfluous, or correctly where a particular stroke extends beyond another. In consequence, the neural representation of *kanji* regresses to a coarse-grained visual representation consisting primarily of a macroscopic visual silhouette, destitute of detailed structural information. This composes the cognitive mechanism underlying the increasingly common phenomenon among the digital-native generation whereby individuals can readily recognize and read *kanji* when they see them, yet are unable to reproduce them accurately from memory on a blank sheet of paper. The erosion of orthographic-structural representations has implications that extend well beyond a localized decline in *kanji* writing proficiency. It has been cautioned that such deterioration may employ negative knock-on effects on broader language abilities and, in conclusion, on overall academic performance. A study by Jaashan et al. (2023) examining the relationship between literacy acquisition and academic achievement demonstrated that deficiencies in accurate handwriting skills and the weakening of handwriting behavior are associated with statistically significant reductions in learners' language acquisition, conceptual understanding, and, ultimately, performance on formal assessments.

The act of writing characters by hand functions as a form of cognitive framework, cultivating attentiveness to the basic elements of language while supporting the deep internalization of its morphological and grammatical structures. Complete reliance on automatic character-conversion technologies effectively gets rid of this scaffold. Consequently, it directly contributes to an extensive deterioration of language proficiency, manifested in a diminished capacity to select contextually appropriate vocabulary and a decline in the ability to comprehend and analyze texts logically. Why does the analog, physical practice of handwriting exercise a uniquely powerful effect in maintaining and enhancing literacy and structural awareness of *kanji*, in comparison with digital typing? Contemporary research in Embodied Cognition and neuroscience employing functional magnetic resonance imaging (fMRI) provides remarkably vigorous biological evidence in response to this question. When the human brain processes written characters, it does not merely perceive their visual forms through the visual cortex. Rather, the recognition of characters and the motor execution involved in producing them by one's own hand

are inseparably integrated within the human brain's neural networks. James and Engelhardt (2012) used fMRI to investigate how different manners of letter learning handwriting, typing, and tracing affect subsequent neural development during letter perception in preschool children, approximately five years of age, who had not yet fully acquired literacy. Their study examined the extent to which these distinct learning modalities influenced patterns of brain activation associated with later character recognition.

The participating children were assigned to one of three training conditions. In the first condition, they reproduced the presented letters or shapes by copying them freehand onto blank paper. In the second, they learned the same stimuli by typing them on a keyboard. In the third, they practiced by carefully tracing letters that had been pre-drawn with dotted outlines. Following this training phase, the participants underwent fMRI scanning while performing a task in which the previously learned letters were merely presented visually, requiring no overt writing or motor response. Brain activity evoked during passive visual perception of the learned characters was then measured. The results revealed a striking pattern of neural differences. Although the participants were only viewing the letters, significant activation of the brain's reading circuit, the network especially signed up during reading in educated adults was observed exclusively in the children who had learned the letters through handwriting. More specifically, strong activation was detected in the left fusiform gyrus, including the Visual Word Form Area, which is specialized in orthographic processing, the left inferior frontal gyrus, and the posterior parietal regions. By contrast, children who had learned the letters through typing or simple tracing exhibited no comparable recruitment of these reading-related neural circuits (James and Engelhardt, 2012).

The scientific implications of this finding are profound. Handwriting demands the execution of an active motor program in which individuals intentionally generate irregular strokes and construct typefaces through a process of trial and error. During this process, physical feedback from the fingertips and the dynamic coupling of visual feedback enable the brain to interactively encode the visual form of a letter and the motor direction that produces it as a single, inseparable neural representation. On the contrary, typing fails to establish an association between typefaces and the motor actions that generate them, while tracing remains largely a matter of passive visual tracking. In that case, neither process gives rise to the neural networks necessary for active structural representation. In other words, the neural connection that enables humans to accurately

recognize and interpret written characters is revised only through the embodied experience of actively constructing those characters by moving one's own hand.

As discussed throughout this section, the progressively common phenomenon of *kanji* attrition among today's digital-native generation, together with the drastic decline in literacy and Japanese language proficiency, should not be attributed to a deterioration in individuals' intellectual capacities or to weakness in educational practice. Rather, these developments are more appropriately understood as the inevitable consequence, from the perspectives of cognitive science and neuroscience, of the disruption of the intrinsic coupling between corporal action (handwriting) and cognition (the retrieval of orthographic structure) upon which the human language-processing system has traditionally depended. Specifically, the automatic character-conversion functions of digital devices and the uniform motor patterns involved in typing have severed this fundamental relationship, thereby inherently transforming the mechanisms through which orthographic knowledge is acquired, represented, and maintained. As the theory of character recognition proposed by Kōno (2019) suggests, the stable consolidation of writing into long-term memory depends on the integrated functioning of three components: phonology, orthography, and motor schema. Digital predictive text systems externalize (i.e., automate) much of this process, therefore transforming human beings from active constructors of orthographic structure into passive selectors of symbols. However, as the experimental studies of James and Engelhardt (2012) and Mueller and Oppenheimer (2014) have found out that, the embodied act of intentionally controlling a writing tool and gradually constructing the spatial structure of characters stroke by stroke dynamically commits the brain's language and reading networks. This process functions as an irretrievable biological mechanism through which deep semantic processing and strong memory encoding are achieved. As the information society continues to advance, it is neither possible nor desirable to completely abandon the advantages afforded by digital tools, including their speed, editability, and ease of information sharing. The continuous integration of ICT into education and everyday social life will therefore remain an inevitable direction for future development. Nevertheless, we must sustain firm awareness of the possibility that the persistent pursuit of convenience may progressively and, over the medium to long term, perhaps permanently, weaken the very cognitive foundations upon which human intellectual activity depends. Accordingly, future educational practice and intellectual production require the establishment of a cognitively knowledgeable division of labor, a hybrid approach that provides learners and knowledge workers

to benefit from the efficiency of digital technologies while strategically integrating handwriting with pen and paper in situations where the initial acquisition of *kanji*, the summarization and reconstruction of concepts, and the rich encoding of memory are cognitively indispensable. Such an approach does not reject digitalization; rather, it seeks to optimize the respective cognitive advantages of digital and analog media according to their distinct functional roles. Ultimately, the traditional, embodied practice of writing characters by hand constitutes the indispensable biological and cognitive foundation for reconstructing the literacy of the digital-native generation in the fullest sense of the term.

Chapter 5: Redefining the role of handwriting in developing literacy skills

5.1 Spatial cognition and character structure

The primary objective of this section is to clarify the processes supporting the spatial cognition and structural understanding of *kanji*, which occupies a central position in the Japanese writing system, by examining its relationship with physical movement, particularly handwriting. As previously noted, unlike phonographic scripts such as the Roman alphabet or *kana* (which rely on linear sequences), *kanji* constitutes a morphographic system with complex two-dimensional spatial structures. Individual characters are composed of subcomponents, such as *hen* (left side), *tsukuri* (right side), *kanmuri* (top crown), *ashi* (bottom foot), and *kamae* (enclosure) systematically organized within a spatial plane according to precise configurational principle. With the rapid growth of digital devices in recent years, non-handwriting modes of text entry, including keyboard typing, flick input on touchscreens, and predictive text conversion, have increasingly replaced handwriting in everyday writing practices. Against this environment, this section get ahead with the hypothesis that the capacity to spatially identify, process, and mentally construct *kanji* as dynamic configurations of constituent components can be fully cultivated only through the unique

embodied process of handwriting, specifically through the formation of motor-level engrams. This hypothesis is examined from multiple complementary perspectives. Relying on the neuroscientific and cognitive psychological findings discussed in the previous sections, such as the role of handwriting in facilitating long-term memory consolidation and enhancing the comprehension of complex geometric structures, the present analysis further explains the educational intentions incorporated in the curriculum guidelines (*gakushū shidō yōryō*) announced by the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT). Furthermore, rather than confining the discussion to computational or efficiency-oriented scientific perspectives, this section places particular emphasis on children's language development and the historical and social dimensions of culture, arguing that handwriting-based learning possesses irreplaceable educational value in the broader context of human development.

Why is the spatial cognitive ability to perceive *kanji* as configurations of fractional components fully strengthened only through handwriting? Addressing this question requires an examination of the neural mechanisms underlying character processing from the complementary perspectives of both cognitive and motor functions. According to Kōno (2019), writing is “the process of converting phonological representations in the brain into written characters.” This process can be largely divided into two stages: (1) the cognitive level, at which phonological information is transformed into orthographic representations, and (2) the motor level, at which these orthographic representations are translated into actual graphic forms through handwriting movements. Two major theoretical frameworks have been introduced to explain processing at the cognitive level: the dual-route model and the triangle model. The dual-route model put forward the existence of two distinct trails: a semantic route, through which orthographic representations are accessed via semantic information, and a phonological route, which turns into phonological information directly into orthographic representations without semantic mediation and is primarily engaged in processing nonwords and other unknown letter strings. In contrast, the triangle model provides a more compelling explanatory framework for the recognition of writing systems such as *kanji*, in which phonetic and semantic components are intricately integrated. Within this model, visual, semantic, and phonological networks operate in a distributed and parallel manner, collectively supporting the recognition and processing of orthographic representations.

Handwriting is the technique by which orthographic representations retrieved at the cognitive level (i.e., the graphemic buffer) are turned into coordinated patterns of muscular activity at the motor level. Principal theoretical accounts of motor control include the early Closed-loop Theory, Schmidt's Schema Theory¹², and more recent approaches such as computational theoretical models and the synergy model. Among these, the concept of the Generalized Motor Program (GMP) proposed by Schmidt's Schema Theory is particularly important for describing how handwriting influences the spatial representation of character structure. When learners acquire *kanji* through handwriting, the brain develops not only a visual representation of each character as a static image but also a dynamic motor schema defining how its constituent strokes should be executed, that is, the order in which the strokes are produced (*hitsujun*), the direction of each movement, and the appropriate force and speed with which the strokes should be made. Furthermore, digitalized theoretical models, particularly the minimum-jerk model and the minimum torque-change model suggest that articulate human handwriting is achieved through the prior construction of trajectory planning in the brain, by which changes in joint torque and sudden alterations in movement trajectories are minimized. From this perspective, understanding the structural organization of *kanji* components (i.e., *bushu*) involves the execution of a spatially and temporally integrated motor program. For example, after completing the *sanzui* (*hen*) radical, the writer must move the pen tip to the initial stroke position of the *tsukuri* component while maintaining an appropriate spatial pause through controlled movement that minimizes jerk and torque variation. Thus, the perception and production of *kanji* structure are fundamentally grounded in the execution of an integrated motor program that coordinates spatial and mundane aspects of handwriting.

By contrast, keyboard typing and flick input on digital devices mitigate the production of even the most structurally complex *kanji* (e.g., 「鬱」 or 「驚」) to a single, standardized motor program consisting of uniform button-pressing movements. This method of input requires neither torque control adapted to the geometric structure of individual characters nor trajectory planning for regulating the spatial transitions between their fundamental components. Because typed input primarily counts on the visual recognition of characters from a set of preexisting alternatives, it does not require the cognitive demand of actively reconstructing (i.e., recalling) the spatial

¹² Schmidt, R. A. (1975) A schema theory of discrete motor skill learning. *Psychological Review*, 82, 225-260.

configuration and relational organization of individual character components within the graphemic buffer. Thus, handwriting does not simply encode characters as passive visual images. Rather, it structurally maps such features as the boundaries between components, spatial balance, and principles of component arrangement into long-term memory through physical feedback and motor commands generated during writing. This provides a scientific and motor-theoretical account of why handwriting enhances the understanding of complex character structures and promotes more vigorous consolidation in long-term memory.

The contribution of handwriting to the recognition and comprehension of character structure is particularly and systematically incorporated into the curriculum guidelines for elementary education in Japan, as in the *Commentary on the Course of Study for Elementary Schools: Japanese Language*. An analysis of chapters 3 and 4 of the *Commentary on the Course of Study for Elementary Schools: Japanese Language* announced by the Ministry of Education, Culture, Sports, Science and Technology (MEXT, 2017) with special attention to the sections on *kanji* instruction and *shosha* (handwriting instruction) brings out that *kanji* acquisition is conceptualized not only as the memorization of graphic symbols, but rather as the integration of an understanding of the structural properties of characters with embodied motor activity. Especially, within the domain of “Knowledge and Skills” for the third and fourth grades of elementary school, the guidelines put forward the following instructional objective: “Students should understand that *kanji* are composed of structural components such as *hen* (left-side radicals) and *tsukuri* (right-side components).” As this objective points out that the ability to analyze *kanji* as configurations of constituent elements, including *hen*, *tsukuri*, and other component parts (*bushu*, or radicals) is explained as one of the most fundamental forms of structural knowledge to be cultivated progressively through Japanese language education.

More importantly, the Course of Study closely integrates the acquisition of such structural knowledge with the instruction of embodied skills through *shosha* (handwriting practice). The learning objectives for *shosha* give emphasis not to simply the production of aesthetically pleasant handwriting, but also careful attention to the spatial properties of written characters. In particular, students are expected to develop an awareness of:

- the ways in which individual strokes connect and intersect;

- the overall configuration of characters, conceptualized in terms of basic geometric forms such as squares, circles, and triangles;
- the appropriate length, direction, and spatial arrangement of strokes in order to achieve balanced character composition; and
- the ability to construct characters accurately from their primary skeletal framework by following the correct stroke order (*kakijun*).

These instructional objectives indicate that handwriting is not treated merely as a means of improving penmanship. Rather, it plays the part of a pedagogical process through which learners internalize the structural organization of kanji by coordinating visual analysis with motor execution. This means that the curriculum explicitly conceptualizes the acquisition of orthographic knowledge as an embodied process in which intuitive understanding and physical action are mutually fortifying.

The actual instructional and assessment plans for elementary school *shosha* in the academic year 2024 (*kyōiku shuppan*, 2024) further exemplify how these elements are increasingly internalized through children's embodied experiences. For example, in handwriting instruction during the lower elementary grades, before students are asked to write newly introduced characters with a pencil, a series of systematically organized embodied learning activities (*unpitsu shidō*, or pen-movement instruction) is applied.

These activities include:

- *Kūsho* (literally translated as “air writing”): Students use the entire arm or their fingers to trace the trajectory of a character in the air with large, measured movements.
- *Yubi-nazori* (finger tracing): Students follow enlarged model characters printed in their textbooks with their fingers, for the purpose of confirming through tactile and kinesthetic experience the characteristics of the *shihitsu* (initial stroke), *sōhitsu* (stroke progression, including turns, bends, reversals, and connections), and *shūhitsu* (stroke termination, including stops, hooks, and sweeping finishes).

- Practice on *suisho* (water-writing) sheets: Before conventional pencil instruction, students engage in water-writing activities that approximate the experience of brush writing. While producing the dynamic variations in pen pressure and stroke movement, expressed through onomatopoeic cues such as *pitatto* (firm contact) and *sūtto* (smooth glide), they vocalize these sounds, thus embodying motor control through synchronized verbalization and physical action.

Particularly remarkable are instructional activities that stimulate children to perceive the overall configuration of *kanji* as geometric forms such as “squares,” “triangles,” and “circles,” as well as activities in which the writing grid is divided into four quadrants (“Rooms 1–4”) to enable discussion of the appropriate location of the initial stroke. These pedagogical practices constitute highly sophisticated training in spatial cognition, enabling children to represent written characters not merely as flat two-dimensional graphic forms but as structured objects possessing spatial extent, internal organization, and clearly defined boundaries.

Even when introducing activities designated to encourage an understanding that *kanji* are composed of elements such as *hen* and *tsukuri*, for example, exercises in which students categorize characters sharing the same *bushu* (radical), teachers encourage pupils not purely to identify common visual features, but to recognize such characters as belonging to the same “family” because they share similar patterns of handwriting movement. It means that students are conveyed to attend not only to visual similarity but also to the common motor patterns involved in producing these characters. This pedagogical approach suggests that the understanding of radicals is represented cognitively not only as a recognition of shared visual patterns but also as a shared embodied motor program for handwriting (i.e., a generalized motor program, or GMP). Therefore, the structural organization of *kanji* becomes rigidly integrated with motor representations acquired through repeated handwriting practice. Collectively, these observations indicate that the Japanese Course of Study is fundamentally predicated on the assumption that the acquisition of the ability to analyze the component structure of *kanji* is achieved through the handwriting-specific process of tracing and constructing spatial forms by means of bodily movement. From this curricular perspective, digital input methods such as keyboard typing and flick input are inherently incapable of achieving the evaluative criteria for the structural and spatial understanding of characters, corresponding to the curriculum’s Assessment Criteria A and B, because they do not engage the

embodied processes that the curriculum consistently positions as indispensable to the development of such knowledge.

The significance of the cognitive psychological and neuroscientific approaches discussed earlier, as well as of curriculum-based structural acquisition, applies only to the scientific and functional dimensions of the benefits provided by handwriting. The inherent value of handwriting, particularly the practice of learning *kanji* through handwriting, extends beyond the level of efficient information processing and memory consolidation. Rather, it lies in the broader cultural and historical significance of human formation through language (*gengo keisei*) and the transmission of cultural identity. A review of the historical development of *kokugo* (Japanese as national language) education in modern Japan brings to light that *kanji* orthography and its instruction have steadily concerned the focal point of an intense tension between efficiency and tradition. As Xing's study (2019) observes, following the establishment of the Ministry of Education in 1871 and the dissemination of the *Gakusei* (Education System Order) in 1872, Japan's modern educational system was founded upon the ideal of *shomin kaigaku* (education for all), emphasizing social advancement and practical learning. To spread *kokugo* efficiently as a simple and standardized national language accessible to the entire population, the intelligibility of educational content became the paramount objective. Within this context, what emerged as "the most difficult issue" was the so-called *kanji* problem, especially the considerable learning burden imposed by the large number and complexity of Chinese characters.

As early as 1866 (*Keiō 2*), Maejima Hisoka, in his memorial *kanji gohaishi no gi* (Petition for the Abolition of *kanji*), argued

国家の大本は国民の教育にして其教育は士民を論せず国民に普からしめ之を普からしめんには成るべく簡易なる文字文章を用ひさる可からず一略一然らば御国に於ても西洋諸国の如く音符字（仮名字）を用ひて教育を布かれ漢字は用ひられず終には日常公私の文に漢字の用を御廃止相成候様にと奉存候。（The foundation of a nation lies in the education of its people; this education must be made universally available to all citizens, regardless of social status. To achieve this universality, it is essential to use writing systems that are as simple as possible [omitted] Therefore, in our country as well, just as in Western nations, education should be conducted using phonetic characters (phonetic characters) to disseminate education, and that Chinese characters be discontinued; ultimately, I humbly hope that the use of Chinese characters in both daily and official correspondence will be abolished.)

Tetsuo Sakamoto observes, Maejima's proposal was particularly significant because it sought to break the traditional monopoly on education held by the *bushi* (samurai) class, framing script simplification as a fundamental requirement to democratize knowledge across all social strata

(Sakamoto, 1978:38–40). In Sakamoto’s view, Maejima acted as a pioneering enlightened bureaucrat who identified language unification (*genbun-itchi*) as the indispensable foundation for Japan’s modern social and civil development (Sakamoto, 1978:37, 46). This statement suggests that, from the standpoint of practicality and efficiency associated with modernization and the expansion of public education, *kanji* have historically been regarded as something to be abolished or, at the very least, restricted and simplified. This intellectual trajectory was taken forward through Nishi Amane’s advocacy of romanization (*rōmaji*), Shimizu Usaburō’s promotion of a kana-only writing system during the early *meiji* period, and eventually the postwar language reforms executed under the direction of the GHQ, including the announcement of the *tōyō kanji* list (1,850 characters) as part of the democratization of the Japanese language. Viewed against this historical background, contemporary advocacy for *kanji* input through typing and predictive text, coupled with the devaluation of handwriting, represents nothing less than a modern digital reformulation of the *kanji* restriction and abolition movement that has persisted since the Meiji era, with its determined commitment to efficiency and utilitarianism. Renouncing the embodied practice of constructing written characters by one’s own hand and instead merely recognizing and selecting symbols presented by digital devices thoroughly reduces the cognitive and practical burden of learning written characters while maximizing the speed of information transmission. In this regard, it may well be considered as the ultimate realization of the simple written language envisioned by reformers such as Maejima Hisoka.

Yet why did contemporary Japanese *kokugo* education, despite being subjected to repeated and often heated calls for the abolition of *kanji*, ultimately choose to preserve them and continue to position penmanship and handwriting at the core of the *kokugo* curriculum to this day? One possible explanation is that, for the Japanese people, the act of handwriting multiple scripts, *kanji* and *kana* is not simply a practical means (or tool) of communication. Rather, it builds a practice that deeply shapes Japanese ways of thought (*gengo keisei*) while serving as a cultural ritual through which individuals internalize the richness of Japan’s written language culture. Based on the editorial statement of intent for *gendai no shosha* (Reiwa edition), published by Sanseidō, whose guiding principle is “*Cultivating Penmanship Skills for Social Life*” (*Shakai seikatsu ni ikiru shosha no chikara*), the objective of penmanship education is to let learners improve their handwriting in the course of everyday life while, through diverse forms of written expression in society, “experiencing the richness of written culture and writing effectively.” To experience the

richness of written culture is not just to appreciate the cultural heritage of the past as an object of intellectual knowledge. More specifically, it involves reproducing through one's own hand and physically embodying, the aesthetic conventions that generations of predecessors have refined over millennia: the formal beauty embodied in writing styles such as *kaisho* (standard script) and *gyōsho* (semi-cursive script), the harmonious use of *kana* alongside these scripts, and the aesthetic sensibilities regulating character arrangement, spacing, and the use of blank space.

When one perceives a *kanji* character as a spatially integrated harmony between its components such as *bushu* (radical) and *tsukuri* (phonetic or semantic component) and carefully shapes each individual stroke with either a brush or pen, the act of writing comes to embody the writer's inner disposition (spirituality) as well as consideration for others. It is for this reason that the Course of Study Commentary and its accompanying assessment guidelines focus attention on not only technical accuracy, such as the proper connection and execution of strokes, but also students' proactive engagement in learning and their awareness of applying what they have learned to everyday life. Handwriting is understood as a position of *genko keisei* (language formation), where learners deepen reflective thought and cultivate the capacity to express their ideas and emotions with precision and effectiveness. The essential elements (*bushu*) of each *kanji* digest semantic world that has accumulated since antiquity, representations of the sun, water, the natural world, the human body, tools, and countless other domains of human experience. In handwriting, the process of constructing a character while paying careful attention to the spatial relationships among these components, the length and direction of each stroke, and the overall visual balance is, fundamentally, an act of embodying language. Rather than considering language as a flat code for transmitting information, this process inscribes it into the body as a multi-layered cultural symbol granted with historical depth and semantic richness. Only through the embodied experience of creating the spatial harmony of written characters with one's own hand can individuals learn to comprehend the subtle emotions embedded in another person's handwriting and thereby cultivate a profound respect for language together with a refined linguistic sensibility. It is precisely this process of language formation, accustomed to empathy toward others and enhanced by the capacity for nuanced self-expression, that constitutes the most significant benefit of learning through handwriting, a benefit that cannot be entirely understood from the perspective of an efficiency-oriented scientific paradigm alone.

Through the analyses examined in this section, it may reasonably be argued that the hypothesis has been verified, both theoretically and experimentally, that the spatial cognitive ability to perceive *kanji* as configurations of constituent components (radicals) is not cultivated through the mere repetition of passive visual image recognition, such as identifying and selecting characters on digital screens. Instead, such ability becomes strongly structured and consolidated into long-term memory only through the process of handwriting (*shoji undō*), which requires dynamic motor planning within the brain, torque control of the joints, and kinesthetic feedback from the body. Japan's national curriculum guidelines (*Gakushū Shidō Yōryō*) reveal a profound understanding of the inseparable relationship between embodiment and structural comprehension. Through dynamic instructional methods such as *kūsho* (air writing), finger tracing, and guided penmanship exercises, they have established educational practices that enable children to internalize the spatial characteristics of *kanji*, including their general configurations, component arrangements, and stroke order. Furthermore, an examination of the historical tension between efficiency and tradition in modern Japanese language education exhibits that the advantages of handwriting extend well beyond its cognitive superiority in encouraging memory consolidation. Contemporary trends toward digitalization, driven primarily by concerns for practicality and information-processing efficiency, risk reproducing the same structural logic that once underpinned excessive movements upholding the abolition of *kanji*. To abandon handwriting is to renounce the embodied means through which learners inherit not only the rich two-dimensional spatial structure inherent in *kanji* but also the literary and aesthetic traditions accumulated over several millennia, along with the aesthetic sensibilities embodied in *kaisho* and *gyōsho*, as well as the principles of balance and harmony that they represent. Handwriting is, therefore, an immensely sophisticated intellectual and linguistic activity through which individuals recreate and internalize the culturally transmitted forms (*kata*) of written language through their own physical actions. Future research in Japanese language education and cognitive science should not aim to reject the convenience afforded by digital technologies outright. Rather, it should specifically recognize the incomparable value of handwriting in fostering embodied spatial cognition and cultivating rich linguistic competence together with cultural sensibility. Relying on this recognition, future pedagogical inquiry should pursue a higher-order question: how best to design an optimal hybrid educational environment that effectively integrates digital technologies with traditional (or analogue), body-based writing practices.

5.2 Persistent thinking skills

In today's highly information-oriented society, the ways of text production have gone through a dramatic transformation. At the hand of the widespread adoption of keyboard typing, flick input on smartphones, and speech-to-text technologies, opportunities to engage in the traditional practice of physically producing written characters with pen and paper has declined remarkably. As digital devices become more and more essential in educational settings and across a wide range of social activities, handwriting as a physical skill is often disregarded as little more than an outdated and inefficient residue of a previous era. Recent advances in cognitive neuroscience and educational psychology, however, have demonstrated that handwriting, despite appearing to be a relatively simple motor activity, exerts profound influences on the human brain, particularly on attentional processes and the amplifying of thought. The act of carefully and precisely transcribing written characters reaches far beyond a pure means of improving individual literacy. More willingly, it establishes the very process through which strong cognitive resources are cultivated resources that allow individuals to regulate their own thinking, direct persistent attention to detail, and maintain motivation for learning.

Handwriting is not just a motor activity performed in segregation by the muscles of the hand. It is rather a highly coordinated physical action that relies on the transmission of complex neural commands from the brain through the nervous system to the muscles controlling the fingers and hand. On that account, the quality of handwritten text as it features on paper, together with the accurate formation of characters, consistency in character size, appropriate spacing between characters, and proper alignment of lines (*tome*, *hane*, and *harai*), directly reflects the writer's cognitive state at the moment of writing. Indeed, experimental studies involving learners of English as a Foreign Language (EFL) have shown that students whose handwriting is neat and highly comprehensible tend to achieve significantly higher academic performance, as well as on constructed-response examinations. These findings suggest that educating oneself to write accurately pushes beyond the acquisition of penmanship itself; it takes forward careful observation, precision in expression, and the development of meticulous and persistent ways of thinking. This section examines how the practice of writing carefully contributes to the development of brain function, the regulation of attention, and the cultivation of persistent thinking required for deep conceptual understanding. Particular attention is inclined to the potential effects of digitalization

on attentional processes and to why this issue presents a particularly intimidating challenge in the Japanese writing system, whose orthography is characterized by visually and structurally complex characters. Finally, with an eye toward future technological advances, this section explores viable approaches through which digital technologies and handwriting may coexist in a complementary and creative manner.

The cognitive and neuroscientific benefits of handwriting have been consistently demonstrated across previous studies (James and Engelhardt, 2012; Shibata and Omura, 2018; Mueller and Oppenheimer, 2014) as mentioned in precedent chapters. Altogether, these findings suggest that the intended act of writing characters by hand, one stroke and one character at a time, not only solidifies the neural and cognitive foundations for character recognition and reading comprehension but also facilitates the organization and reconstruction of information while reducing cognitive load, accordingly promoting deeper understanding. In other words, handwriting is not simply a means of recording information passively; rather, it is an active cognitive process through which learners take part in repeated trial and error, identify the essential features of what they are learning, and sustain reflective thinking. From this perspective, handwriting possesses significant educational value as a means of cultivating persistent thinking skills, the capacity to engage in persistent, sustained, and resilient thinking, which is regarded as the central focus of this section.

In the meantime, the rapid development of digitalization and the widespread diffusion of the Internet have begun to transform the very architecture of human attention. Although no definitive longitudinal study has conclusively demonstrated that digitalization is, in itself, the direct cause of a permanent decline in human attentional capacity, a considerable body of experimental data suggests that the distinctive modes of information presentation characteristic of digital environments may apply detrimental effects on human attentional processes. According to the review by Firth et al. (2020) on the cognitive effects of Internet use, one of the defining characteristics of the online environment is the continuous stream of incoming information and the resulting phenomenon of media multitasking. Through mechanisms such as hyperlinks, push notifications, and social media timelines, digital devices are designed to constantly redirect users' attention toward competing stimuli. Furthermore, experimental studies presented by Ophir et al. (2009), which examined individuals who routinely engage in extensive media multitasking by

consuming multiple forms of digital media at the same time, have demonstrated that such heavy media multitaskers exhibit revealed abilities to filter out irrelevant environmental stimuli (i.e., distractions) and decreased efficiency in cognitive control during task switching, compared with individuals who carry on little or no media multitasking. These findings indicate that when the habitual mode of interaction with digital environments consists of rapidly and superficially scanning fragmented pieces of information, maintaining sustained concentration, that is, the ability to continuously focus on a single object or task over an extended period may become gradually difficult.

These effects are of particular concern for children and adolescents whose cognitive functions are still in the middle of development. Longitudinal research has pointed out that excessive Internet use may hinder the development of verbal intelligence, while a growing body of both cross-sectional and longitudinal studies across multiple disciplines has reported associations between excessive Internet use and symptoms characteristic of Attention-Deficit/Hyperactivity Disorder (ADHD). In a digital era, where the external storage of information through search engines and other online resources has become easily accessible, the brain is progressively inclined to commit the processes of remembering information and engaging in deep reflection to external systems. Thus, the expansion of digital environments, where attention is continuously disintegrated and careful consideration of details is easily compromised, has brought into sharp relief a serious educational and cognitive challenge: the potential depletion of the capacity for persistent, sustained thinking, in particular, the ability to ponder rigorously and continue with a line of thought until it is fully developed.

The phenomena of the fragmentation of attentional function through digitalization and the decline in attention to detail emerge as particularly problematic within the Japanese writing system as discussed in precedent paragraphs, whose uniquely complex orthography stands in noticeable contrast to the alphabetic writing systems of the Western world. Historically, the Japanese writing system has developed an exceptionally multilayered form of literacy, what may be described as plural literacies through the sophisticated integration of logographs (*kanji*), adopted from China, and original phonographs (*hiragana* and *katakana*), which eventually developed from them. As Lurie (2011) observes, Japanese written culture is fundamentally characterized by the “parallel use and blend of *kanji* and *kana*.” Moreover, each individual *kanji* character itself is composed of

multiple fractional components (segmental elements like radicals and crowns), arranged in elaborate structural configurations. To write *kanji* accurately and cautiously requires an extraordinarily polished capacity to process high spatial frequency information, far transcending the relatively simple combinations of straight-line strokes characteristic of alphabetic writing systems. Recalling the structural parameters explained above that the writer's task requires translating these local features into fluid physical movements. This demands precise regulation of stroke dynamics (*tome*, *hane*, *harai*), total stroke count, and the exact spatial layout connecting constituent radicals and phonetic components. These visual distinctions must then be precisely translated into specific motor trajectories during handwriting. It is exactly this formidable process of producing complex character forms by hand that most fully captivates the brain's reading circuitry identified by James and Engelhardt (2012), while simultaneously activating the anterior cingulate cortex (ACC), which is responsible for error monitoring. Therefore, handwriting *kanji* has acted the part of an effective form of cognitive training, cultivating perpetual attention to fine detail as well as the capacity to regulate complex visual forms through persistent and disciplined cognitive control.

However, digitalization in the Japanese linguistic environment, including *kanji* conversion on personal computers, predictive text functions on smartphones, and flick input, efficiently bypasses this entire process of cognitive training. As discussed above, digital text entry requires users only to engage in the cognitive operation of selecting (recognizing) the appropriate character from candidates presented on a screen based on an inaccurate memory trace. It eliminates the physical and cognitive effort connected with actively constructing (reproducing) complex character forms in all of their visual detail. The outcome extends far beyond the familiar phenomenon that "people can read *kanji* but can no longer write them." More crucially, it implies a decline in the capacity for careful, detail-oriented thinking itself. The decrease of opportunities to construct visually complex characters by hand gradually diminishes both visual and motor attention to the minute structural elements from which those characters are composed, that is, attention to detail. When this tendency is constructed by what Firth (2020) identify as the Internet's disruption of sustained attention, it leaves a serious risk of undermining the very cognitive control commanded to decode the rich vocabulary, conceptual complexity, and subtle contextual nuances of Japanese with precision, and to develop logical arguments through sustained and disciplined reasoning. In the Japanese writing environment, the structural complexity of its orthography has

historically charged a significant cognitive load, which in turn has functioned as a powerful mechanism for training the brain. From this point of view, the disappearance of handwriting because of digitalization has the potential to produce a cognitive and cultural crisis that is even more serious than confronting societies that retain alphabetic writing systems.

The practice of writing each character carefully, one stroke at a time, is far more than a motor skill for acquiring literacy. It makes up the spirit of persistent, disciplined thought, the cognitive foundation upon which human cognitive control, attention to detail, and the deep internalization of concepts are cultivated. Yet the fragmentation of attention and the rapid, consumption-oriented processing of information fostered by digital technologies present a particularly formidable challenge in the Japanese linguistic environment, where they threaten to impede the precise apprehension of complex concepts and the sustained reflection expected by a highly complex writing system. The appropriate response, however, is not to reject the ongoing tide of digitalization. Rather, by making active use of digital pens and by strategically selecting input modalities according to specific cognitive objectives, it is possible to harmonize technological innovation with the preservation of the depth of human cognition. Consciously reintegrating the embodied and intellectual practice of carefully producing each character into everyday life and educational contexts is therefore essential. Such a practice provides a means of withstanding the overwhelming stream of information while fostering an intellectual culture capable of observing phenomena with meticulous attention to detail and engaging in persistent, disciplined reasoning. In this respect, it stands for a crucial passage for transmitting such a refined cognitive culture to future generations.

5.3 A suggestion for a hybrid approach to Japanese language education

The progress in convenience and technological innovation brought about by digitalization is expected to continue relentless in the years ahead. Therefore, a nostalgic approach that seeks to preserve traditional handwriting at all costs while excluding digital devices completely from education and everyday life is neither realistic nor pedagogically legitimate. On the contrary, the unconditional promotion of digitalization and the comprehensive replacement of handwriting with pen and paper cannot be regarded as appropriate from the perspective of cultivating the knowledge, skills, and dispositions that language education is aimed to foster. Within school education, Japanese language (*kokugo*) is regarded as an exceptionally principal domain, serving as the core

of intellectual and cultural activities as human beings and an indispensable foundation for individual self-formation, the enhancement of social life, and the creation and transmission of culture. In consequence, encouraging to develop the ability to understand language accurately and express oneself correctly requires an approach that goes beyond considerations of efficiency alone and instead carefully examines, from multiple perspectives, the effects that different writing media strive for cognition and intellectual development. The objective of education should be to naturally integrate the powerful infrastructure for information processing and sharing provided by digital technologies with the foundation for profound thinking and language development afforded by handwriting, thereby optimizing each distinctive educational function.

Contemporary society has entered an era in which social structures and employment surroundings are going through rapid and increasingly unpredictable transformation, driven by the decline in the working-age population, the progress of globalization, and relentless technological innovation. As the analysis by Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT) indicates, Japan has become a mature society while the rapid procession of a declining birthrate and population aging. In these circumstances, each individual is expected to act responsibly in a sustainable society by drawing on diversity as a driving force and to create new value that contributes to the development of individuals and society, enhancing qualitative well-being in the process. The notable advance in artificial intelligence (AI) has been astonishing. It has even been advocated that AI is entering a stage in which it can theoretically comprehend knowledge and engage in autonomous reasoning. Such developments call into question not only the future of human work but also the very nature of the knowledge and competencies that school education should cultivate. Nonetheless, in spite of how sophisticated AI may become, or even if it acquires the capacity to theoretically understand knowledge and reason independently, the responsibility for defining the purposes of thought and for judging the goodness, correctness, and beauty of those purposes remains a uniquely human role and constitutes humanity's greatest strength. In this mature society, therefore, school education is expected to enable children to reconstruct their goals in response to complex and changing circumstances, critically evaluate diverse sources of information, perceive a wide range of information, accomplish an ideal understanding of knowledge, and reorganize information so as to yield new value, and, ultimately, to develop the capacity to solve problems collaboratively with others.

The evolution of information technology has had a profound impact on language education, particularly on *kokugo* (Japanese language education in schools) and Japanese language education. According to the Programme for International Student Assessment (PISA 2015), following the complete transition from paper-based testing to computer-based testing (CBT), Japan continued to rank among the highest-performing countries in terms of reading literacy; however, its average score declined considerably in comparison to the previous evaluation. One explanation figured for this decline is that Japanese students were unfamiliar with retrieving information from multiple computer screens rather than from printed materials and formulating responses while simultaneously processing such information. Nevertheless, this issue should not be considered just as one of adapting to a new testing format. Rather, it should be perceived as revealing larger challenges in reading literacy that have emerged as the linguistic environment surrounding children has been transformed by the ongoing advancement of information technology. In addition, the results of Japan's National Assessment of Academic Ability and Learning Situation (*Zenkoku gakuryoku gakushū jōkyō chōsa*) and related assessments have similarly identified structural challenges concerning language proficiency. Especially, the following issues have been underlined. At the elementary school level, students experience difficulties in identifying the subject of a sentence, understanding sentence structure and rhetorical devices, summarizing texts according to a given purpose, and deepening their understanding by relating multiple pieces of information. At the junior high school level, students face challenges in writing and speaking with clearly articulated evidence to support the content they wish to communicate and their own opinions, acquiring appropriate information from multiple sources and comparing or relating that information, and critically evaluating texts with respect to the competence of evidence, the development of logical argumentation, and methods of expression. These findings confirm the warning issued by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) that, in an increasingly information-oriented society, “enabling learners to accurately comprehend information presented in written texts and to utilize it in constructing their own ideas constitutes an urgent challenge.” The main task of contemporary language education, therefore, reaches beyond fostering the efficient consumption of digital texts displayed on screens. Rather, it lies in cultivating robust reading literacy that enables learners to reconstruct information through their own reasoning, judgment, and critical reflection.

Therefore, what is required of language education in the years ahead is the establishment of a hybrid approach that maximizes the capacities of digital tools while preserving and further developing the cognitive and educational value of handwriting. Expanding on the principles articulated in the Commentary on the Course of Study for Lower Secondary Schools: Japanese (*kokugo*) issued by the Ministry of Education, Culture, Sports, Science and Technology (MEXT), this section examines the complementary roles of digital tools and handwriting in fostering literacy and the development of solid academic competence. From the perspective of cultivating the knowledge and skills necessary to correctly comprehend and appropriately express oneself in Japanese through language activities that undertake learners in linguistic perspectives and modes of thinking (*kotoba ni yoru mikata, kangaekata*), it proposes a concrete model for the coexistence of these two ways of written communication. As the Course of Study defines, “the competencies required for accurate comprehension and those required for appropriate expression function continuously and simultaneously.” For students to compose their own ideas, the matter of what they ultimately express, they must first accurately understand the objects, events, and thoughts expressed through language. To optimize the relevant roles of handwriting and digital text input as complementary media that support this reciprocal process is accordingly the key to deepening learners’ cognitive engagement and promoting more meaningful learning.

With the increasing sophistication of the information society, the Course of Study for Japanese language education presented a new domain entitled “Matters Concerning the Handling of Information,” which is to be instructed consistently through two interrelated strands: “relationships among information” and “organization of information.” The ability to collect and organize necessary information from various media, apprehend the relationships among pieces of information, and logically construct and express one’s own ideas has become a fundamental competency in contemporary society. According to the systematic progression specified in the Course of Study, instruction should be prepared in stages as follows. In the first year of lower secondary school, students are expected to understand relationships among pieces of information, such as cause and effect and claims and supporting evidence, while acquiring methods of organizing information through comparison, classification, and association. In the second year, students are expected to deepen their understanding of relationships among information, including claims and evidence as well as the concrete and the abstract, and to understand and appropriately use various ways of representing such relationships. In the third year, students are expected to

further amplify their understanding of relationships among information, particularly between the concrete and the abstract, while learning how to evaluate and verify the reliability of information and applying these methods appropriately. Among these learning activities, information retrieval from large-scale databases, the classification of multiple sources, citation and credit of references, the creation of tables and figures, and collaborative editing are domains in which digital tools demonstrate exceptionally high levels of effectiveness. At the same time, however, as evidenced by challenges in reading comprehension observed in computer-based testing (CBT), simply processing on-screen information efficiently does not necessarily enable learners to develop a deep understanding of the relationships among pieces of information or to reconstruct them into an integrated body of knowledge. To accomplish both accurate comprehension and appropriate expression in a persistent manner, it is crucial to make use of digital technologies, which support efficient information processing, in a complementary relationship with handwriting, which consolidates and deepens thinking. As highlighted in the Course of Study Guidelines, knowledge and skills concerning the characteristics and use of language “do not refer only to isolated factual knowledge or fixed methodological routines.” Rather, they should be cultivated through the processes of thinking, making judgments, and expressing ideas so that they become “knowledge and skills” that function effectively in diverse situations of language comprehension and expression. Moreover, the Guidelines draw attention to “knowledge and skills” and “thinking, judgment, and expression” must be developed in close interrelationship. From this point of view, the process of transforming fluid information gained through digital media into stable knowledge by recording it in handwritten notes while actively establishing relationships among ideas provides the essential foundation for acquiring knowledge and skills that can be effectively applied in authentic contexts.

The theoretical groundwork supporting such a hybrid approach can be found not only in research on handwriting instruction (*shosha*) and the embodied nature of character acquisition, but also in recent developments in cognitive science. What we should attempt to establish is a framework for creative coexistence (hybrid literacy) that enables us to gather the full benefits of digital technologies while preserving the distinctive cognitive advantages of handwriting, including raised attention to detail, reduced cognitive load, and the facilitation of deeper thinking. The Course of Study (*gakushū shidō yōryō*) articulates the educational philosophy underlying instruction in *shosha* by stating that it is important to cultivate students’ handwriting abilities

through understanding and applying the content presented here so that such abilities may be applied in learning activities across all subjects as well as in everyday life. It further emphasizes that it is necessary to encourage an understanding of the knowledge and skills related to various forms of written culture that succeed Japan's traditional writing culture while serving the needs of future society, and to develop the ability to write effectively. This embodied approach to writing "effectively" should not be understood only as the mechanical production of graphic symbols. Rather, it is fundamentally connected with the cultivation of *genko kankaku* (linguistic sensitivity), the intuitive capacity to notice correctness and error, appropriateness and inappropriateness, as well as aesthetic quality in the processes of linguistic comprehension and expression.

One tangible approach is to combine writing activities using a digital pen (stylus). Technological innovation has also provided a means of overcoming the conventional difference between analog and digital modes of writing. Digital handwriting, performed with tablet devices and high-performance digital pens (styluses), is becoming increasingly extensive in both educational settings and professional workplaces. As demonstrated by Shibata and Omura (2018), the cognitive benefits traditionally associated with handwriting, such as improved spelling accuracy, enriched memory retention, and facilitated character recognition are observed not only in conventional handwriting with ink pens but also in handwriting produced with digital pens. Activities such as forming characters, creating mind maps, and adding annotations with a digital pen, unlike keyboard typing, actively engage the brain's motor and visuospatial networks. As a result, even within digital learning environments, it is prominent to intentionally integrate handwriting-based intellectual activities rather than relying only on keyboard input. The embodied learning processes specified in the Course of Study for the first year of lower secondary school, including writing in *kaisho* (standard script) with an understanding of correct character formation, character size, and spatial arrangement and understanding the fundamentals of *gyōsho* (semi-cursive script) and applying them to write familiar characters, continue to stimulate the brain's cognitive networks through structural analysis of written characters and spatial perception, even when mediated through a digital-pen interface. Such processes encourage developing deeper learning outcomes that cannot be achieved through typing alone.

More importantly, it is essential to differentiate the roles of input modalities depending on learners' cognitive objectives. Drawing on the findings of Shibata and Omura (2018) and Mueller

and Oppenheimer (2014), handwriting, whether with pen and paper or a digital stylus is particularly well suited to learning activities that aspire to deeper understanding and knowledge construction, such as note-taking during lectures or reading, concept mapping, critical thinking, and the acquisition of new *kanji* and vocabulary. The Commentary on the Course of Study (*shidō yōryō kaisetsu*), in its discussion of vocabulary instruction, points out that the goal is not solely to increase the number of words whose meanings are understood, but also to expand the repertoires of words that learners can use appropriately in speech and writing, while deepening their understanding of word definitions and usage, sophisticating their linguistic intuition, and improving the quality of their vocabulary. To achieve the vigorous acquisition of new vocabulary, embodied and reflective processes through which learners pay attention to the relationship between a word's dictionary meaning and its contextual meaning while actively using it in speech and writing are especially effective. On the contrary, when learners move to the stage of composing style based on organized ideas, preparing reports, collaboratively editing documents, or sharing information, the efficiency afforded by digital text entry via typing becomes a significant advantage. Therefore, it is important to cultivate learners' ability to estimate the cognitive demands of a given learning task and to introspectively determine whether the immediate priority should be efficient information processing or deep thinking. This capacity may be described as cognitive hybrid literacy. Such literacy is closely aligned with the objective articulated under the disposition toward learning and humanity, a pillar of the Course of Study, which calls for supporting an appreciation of the value of language, the improvement of linguistic sensibility, and a perspective of respecting the Japanese language while attempting to upgrade one's linguistic competence. In other words, it equally involves developing learners' capacity to adjust and manage their own language use autonomously and with awareness.

This academic framework can be extensively applied to the three domains of speaking and listening, writing, and reading within the *kokugo* (Japanese language) curriculum. A defining quality of these three domains, brought about by recent curricular revisions, is that they further clarified the learning processes and regularly located in each instructional item. To maximize the pedagogical abilities of each medium, a tangible model illustrating the reciprocal transition between handwriting and digital tools, targeted at each phase of the learning process, is presented below.

- Setting themes, gathering information, and examining content: In the stage of determining a theme based on objectives or intentions, and “organizing materials gathered through various methods to clarify what one intends to convey” via digital databases or the Internet, the extensive searchability of digital platforms holds a distinct advantage.
- Examining structure and forming ideas: handwriting demonstrates its ultimate efficacy during the stages of selecting the text type and designing the structure of the text by considering logical progression to persuade variety of readers according to the gathered materials, or clarifying inter-paragraph relationships to refine the text’s structure and sequence. By utilizing notebooks or paper to manually visualize paragraph structures, logical correlations, and the distinctions between facts and opinions through arrows and diagrams, students strengthen their cognitive processing to secure that their own ideas and supporting evidence become clear.
- Drafting, revising, and sharing: in the stage of refining the text to convey one’s ideas clearly by contemplating modes of expression and appropriately citing references, the revision stage of improving the text by verifying orthography, word usage, and narrative style from the reader's perspective, and the sharing stage of identifying the strengths and areas for improvement in one’s writing based on feedback from readers, textualization via typing and the utilization of collaborative editing tools provide exceptionally high revision efficiency and an optimal platform for mutual evaluation.

Within the learning process of listening inside the speaking and listening domain (incorporating the comprehension of structure and content, scrutiny/interpretation, idea formation, and sharing), the Course of Study explicitly delineates instructional items predicated on handwriting, such as capturing the content of a speech while taking notes or asking questions as necessary and summarizing one’s own ideas formulated on commons and differences. Purely consuming digitally recorded audio makes it complicated to stimulate higher-order cognitive activities, such as listening with attention to the logical progression of the speaker’s argument and summarizing one’s own thoughts in comparison with those of the speaker. The act of generating real-time notes by hand is precisely what nurtures a structural understanding of the discourse. In the same way, in the reading domain, while undertaking digital activities to get appropriate information while

organizing multiple pieces of information based on the objective, handwriting still plays a crucial role. Specifically, during the phases of thinking about the perspectives and ways of thinking presented in the text while reading critically or deliberating or composing essays about what has been understood and thought through reading, manually annotating the text or organizing concepts via mind maps strengthens the connection with anterior knowledge and experience, thus enabling students to expand and deepen their own ideas.

Furthermore, the instructional objective in upper elementary school and lower secondary school *shosha* (penmanship) education, for instance, “choosing writing instruments according to the intended purpose and writing in ways that support their distinctive characteristics” can be interpreted in an expanded sense today. Rather than simply choosing among a pencil, a pen, or a brush, this purpose may be reconsidered as fostering learners’ ability to autonomously select, in accordance with communicative purpose, among keyboards, styluses, and pen-and-paper as alternative writing media. The Course of Study point out that, in Grade 8 (the second year of lower secondary school), students are expected to “understand the writing of *kanji* in *gyōsho* (semi-cursive script) together with *kana* harmonized with it, and write clearly and fluently,” as well as to “select either *kaisho* (block script) or *gyōsho* based on purpose and necessity.” In Grade 9 (the third year of lower secondary school), students are further expected to “encounter the abundance of written culture through diverse forms of written expression in everyday life and produce written characters effectively.” On top of that, the accompanying commentary keeps the long-standing instructional consideration that “instruction in *shosha* using *mōhitsu* (brush writing) should be provided at every grade level so as to cultivate the foundations of penmanship skills in *kōhitsu* (hard-pen writing).” The reasonable underlying this principle is to enable learners to acquire an embodied understanding of the distinctive characteristics of different writing implements, such as their particular physical resistance, writing speed, and effects on letterform and thereby to improve the fundamental linguistic and graphic sensibilities necessary for the effective production of written language. When this traditional philosophy of *shosha* education is redefined within the context of today’s information society, its fundamental objective is to enable students themselves to make independent and rational decisions, according to the purposes and communicative requirements of their own language activities, in relation to the most appropriate way of writing. In particular, they should be able to determine whether *gyōsho* (or handwriting with a stylus) is the most suitable means for producing text that is both comprehensible and rapidly written, or

whether keyboard typing should instead be selected when information is intended for simultaneous distribution and sharing with others. The core of the hybrid approach, therefore, is present in learners' ability to evaluate and select the writing medium best suited to the communicative purpose of the task at hand.

As the foregoing discussion has revealed, the direction that education should pursue in an increasingly digitalized society is neither a widespread transition to digital technologies nor a return to exclusively analog practices. Rather, it is to merge naturally the powerful infrastructure for information processing and sharing supplied by digital technologies with the cognitive foundation provided by handwriting for deep thinking and language development, thereby maximizing the characteristic educational functions of each. Such a hybrid approach establishes a highly effective pedagogical framework for realizing the goals of the Course of Study, in which the domains of knowledge and skills and thinking, judgment, and expression are expected to function in an integrated and mutually strengthening manner as core competencies. This is because learners can thoroughly use the “perspectives and ways of thinking through language” only when they have access to both the external memory offered by efficient digital information processing and the internal cognitive approaches cultivated through handwriting, which integrates reflective thought. The former facilitates the management, organization, and dissemination of information, although the latter supports sustained reflection and the construction of meaning by encouraging learners to reconsider critically the relationships between objects and language, as well as among linguistic expressions themselves. In an era characterized by profound uncertainty, such an educational model enables children to engage proactively with the challenges of a radically changing world while educating the capacity “to solve problems collaboratively with others, critically examine diverse sources of information, achieve conceptual understanding of knowledge, and reconstruct information so as to generate new value.” Therefore, it provides a sustainable and forward-looking model of education for fostering *ikiru chikara* (zest for living), the foundational educational ideal that has long sustained Japanese school education.

Conclusion

The main objective of this thesis has been to investigate the cognitive, pedagogical, and cultural significance of handwriting within the context of contemporary Japanese language education. As society is experiencing a rapid paradigm shift driven by prevalent digitization, traditional literacy practices are being fundamentally reconsidered. In educational institutions and daily communicative contexts, the expansion of digital devices, ranging from smartphones to personal computers, has significantly reduced the frequency of manual text production. While this technological transition proposes unprecedented efficiency and convenience in information processing, at the same time, it raises critical questions in relation to the potential loss of cognitive and pedagogical benefits inherent to the physical act of writing. This research specifically focused on the Japanese language, which possesses one of the most complex orthographic systems in the world, consisting of three distinct scripts: logographic *kanji*, and the two syllabic scripts, *hiragana* and *katakana*. The findings of this study emphasize that handwriting is not simply an archaic

method of graphic reproduction but an essential cognitive tool that plays a foundational role in the acquisition, retention, and deep understanding of this intricate linguistic framework. By analyzing the intersection of orthographic complexity, cognitive development, and technological evolution, this thesis has attempted to reveal the modern position of handwriting and argue for its systematic preservation and evolution within the educational curriculum.

The architectural complexity of the Japanese writing system requires a multi-faceted cognitive approach to literacy acquisition. Unlike solely alphabetic scripts, the mastery of Japanese demands learners to direct a vast template of visual patterns, spatial arrangements, and semantic associations, particularly within *kanji* characters. The experimental analysis and theoretical synthesis conducted in this study demonstrate that the haptic and kinesthetic feedback generated through the act of handwriting is uniquely associated with the cognitive encoding of these complex linguistic structures. When a learner exercises the precise stroke order (*hitsujiun*) and balances the structural proportions of a character, multiple areas of the brain, including the motor cortex and visual processing regions, are simultaneously activated. This sensorimotor integration facilitates the formation of robust mental representations of characters. The physical resistance of the writing instrument against the surface, the directional movement of the hand, and the deliberate spatial positioning required to form balanced characters cannot be replicated by the binary action of keystrokes or the passive viewing of digital screens. As a result, handwriting functions as a critical mechanism for internalizing the semantic, phonological, and orthographic dimensions of the Japanese language. Without the physical instantiation of characters through handwriting, the depth of orthographic memory and the capacity for character recognition are evidently compromised, rendering manual writing an irreplaceable element of advanced linguistic competence. Taking into consideration, the diminishing opportunities for practical handwriting in daily life, this study argues for a fundamental reevaluation of handwriting education, specifically the curriculum designated as *kokugo* (Japanese language) and *shosha* (calligraphy/penmanship education), within foundational primary education. Historically speaking, *shosha* has often been recognized merely as a discipline aimed at aesthetic improvement or the mechanical refinement of penmanship. However, the analysis presented in this thesis reveals that *shosha* possesses a far more profound pedagogical value: it assumes the role as a critical period for cultivating fundamental cognitive frameworks (*shikō no kata*) in developing minds.

The practice of *shosha* needs a high degree of mindfulness, concentration, and observation to established structural principles. Writing characters slowly and carefully requires the practitioner to exercise meticulous attention to detail, such as the subtle distinctions between stops (*tome*), hooks (*hane*), and sweeps (*harai*). This disciplined engagement encourages to improve a learner's capacity for fine visual discrimination, observational acumen, and deeper analytical perception. The habits of mind developed through this process, specifically, precision, patience, and the ability to critically evaluate one's own physical output against an idealized model, are not restricted to the domain of literacy alone. Instead, they create a generalized cognitive template that strengthens a student's capacity for concentration, logical structuring, and detailed analysis across various academic disciplines, including mathematics, the natural sciences, and textual criticism. Therefore, rather than being disregarded as an outdated artistic pursuit in the digital age, the time allocated to *shosha* in elementary education should be strategically reinforced and prioritized as a fundamental cognitive training ground. While this thesis highlights the perpetual necessity of handwriting, it does not stand for a conservative rejection of digital technology. On the contrary, the inevitable progression of digital infrastructure involves a proactive exploration of how handwriting can be meaningfully integrated into modern technological ecosystems. The concept of embodied digital learning derives from this study as a hopeful paradigm for reconciling the cognitive benefits of manual writing with the pedagogical advantages of digital platforms.

Recent advancements in hardware and software design suggest that the dichotomy between analog paper and digital screens is beginning to dissolve. The development of high-precision digital styluses, sophisticated pressure-sensitivity algorithms, and advanced tactile feedback mechanisms allows for the creation of interfaces that closely duplicate the tangible friction and physical sensitivity of traditional paper and pen. If technological evolution continues along this path, future educational devices may successfully replicate the precise sensorimotor feedback loops that are essential for cognitive encoding. Accordingly, future research must shift from an "analog versus digital" binary toward a comprehensive evaluation of how these advanced digital mediums can function as legitimate vehicles for handwriting education. By utilizing these technologies, educational systems can maintain the embodied cognitive processes of writing while simultaneously utilizing digital features such as automated stroke-order feedback, adaptive learning modules, and cloud-based progress tracking. It is necessary to acknowledge the specific limitations inherent to this study, which concurrently clarify critical pathways for future academic

inquiry. The primary constraint encountered during this research is the emerging state of scientific and pedagogical literature regarding the long-term impact of digital devices on human neuroplasticity and cognitive development. Although cognitive psychology and neuroscience offer strong evidence regarding the short-term benefits of handwriting over typing, comprehensive, longitudinal empirical data detailing the long-term neurological consequences of a purely digital education remain insufficient. Because prevalent tablet-based learning is a relatively recent phenomenon, the generational effects on reading comprehension, abstract reasoning, and memory retention have not yet been fully evaluated.

Moreover, the rapid pace of technological innovation exceeds the speed of academic publication, meaning that the specific educational effectiveness of the latest tactile-feedback devices and advanced digital pens has not yet been subjected to exhaustive, large-scale experimental testing. Therefore, the affirmations made regarding the potential of embodied digital learning remain theoretical tone but involve further practical validation. In the coming decades, as digital learning environments become standard across global education systems, a significant corpus of diverse data will inevitably emerge. Future research must make use of interdisciplinary methodologies combining neuroimaging, educational psychology, and linear statistical analysis to measure the precise cognitive differences between paper-based writing and advanced stylus-based digital writing. Such studies will be crucial for determining the optimal structure of hybrid educational curricula.

In conclusion, this thesis verifies that handwriting remains a foundation of cognitive and linguistic development within Japanese language education. The complex interaction of scripts within the Japanese writing system requires an embodied, tangible approach to literacy that cannot be adequately substituted by current standardized digital inputs. While the societal shift toward digitization is inevitable, the principal role of *shosha* in establishing cognitive frameworks, cultivating observational precision, and refining analytical insights must be preserved and strengthened in early childhood education. In the future, the pedagogical challenge lies not in resisting technological integration, but in guiding it so that the physical, embodied act of writing is preserved within new digital architectures. By recognizing the cognitive value of handwriting and actively shaping the evolution of embodied digital learning tools, educational systems can ensure that technological progress enhances, rather than diminishes, human intellectual capability.

Sources

- AMANO Kiyoshi, "*Ōin bunseki to kodomo no literacy no shūtoku*" (Phonemic Analysis and Children's Acquisition of Literacy), *Kyōiku shinrigaku nenpō*, 27, 1988, pp. 142-164.
天野清、「音韻分析と子どものliteracyの習得」、教育心理学年報、第27集、1988年、pp. 142-164.
- BUNKACHŌ (AGENCY FOR CULTURAL AFFAIRS) (a cura di), *Kokugo seisaku hyakunenshi* (A century of Japanese language policy), Tōkyō, Gyōsei, 2006.
文化庁編、『国語施策百年史』、東京、行政、2006年.
- BUNKACHŌ (AGENCY FOR CULTURAL AFFAIRS), *Jōyō kanjihyō no jitai/jikei ni kansuru shishin* (Guidelines on character styles and forms in the list of commonly used kanji), Tōkyō, Bunkachō, 2016.
文化庁、『常用漢字表の字体・字形に関する指針』、東京、文化庁、2016年.
- BUNKACHŌ (AGENCY FOR CULTURAL AFFAIRS), *Kokugo ni kansuru yoron chōsa* (Public opinion survey on the Japanese language), Tōkyō, Bunkachō, 2007, 2017, 2021, 2025.

文化庁、『国語に関する世論調査』、東京、文化庁、2007年、2017年、2021年、2025年。

- CHASE, Clinton I., "Essay Test Scoring: Interaction of Handwriting Quality, Stylistic Errors, and Knowledge of Student Ability", *Journal of Educational Measurement*, vol. 23, n. 1, 1986, pp. 33-41.
- DENO Fumiri, "*Nihon no shosha • shodō kyōiku no genjō ninshiki to kadai: Chūgoku no shofakyōiku to no taihi o chūshin ni shite*" (The recognition of current situation and issue of Japanese calligraphy education: focusing on the comparison with Chinese calligraphy education), *Ōsaka Kyōiku Daigaku Kiyō: Sōgō Kyōiku Kagaku*, Vol. 70, 2022, pp. 91-104.
出野文莉、「日本の書写・書道教育の現状認識と課題—中国の書法教育との対比を中心にして—」、『大阪教育大学紀要 総合教育科学』、第70巻、2022年、pp. 91-104.
- FIRTH, Josh A., TOROUS, John e FIRTH, Joseph, "Exploring the Impact of Internet Use on Memory and Attention Processes", *International Journal of Environmental Research and Public Health*, 17, 24, 2020, pp. 1-12.
- GIBSON, Eleanor J., LEVIN, Harry, *The Psychology of Reading*, Cambridge (MA), MIT Press, 1975.
- HYOUNG Jin-Eui [KEI Shin'gi], "*Kindai nihon no 'kokugo' kyōiku to kanji seisaku*" ('National language' education and kanji policy in mJapan), *Nihon bunka gaku*, 42, 2009, pp. 43-57.
邢鎮義、「近代日本の「国語」教育と漢字政策」、『日本文化學報』、第42輯、2009年、pp. 43-57.
- IKEDA Masato, "*Kansei no bunbōgu*" (Sensory stationery), Pilot Pen Co., Ltd.
池田政人、「感性の文房具」、パイロット万年筆株式会社.
- JAASHAN, Hasan Mohammed Saleh, HALIM, Tanzina, HALIM, Shanjida e ALWARD, Mohammed Ahmed Hasan, "Poor Handwriting and Its Knock-on Effects on EFL Learners' Academic Performance", *Journal of Jilin University (Engineering and Technology Edition)*, 42, 4, 2023, pp. 192-210.

- JAMES, Karin H., ENGELHARDT, Laura, "The effects of handwriting experience on functional brain development in pre-literate children", *Trends in Neuroscience and Education*, vol. 1, n. 1, 2012, pp. 32-42.
- KŌNO Toshihiro, "*Shoji no ninchi riron to undō riron: Shoji ni kansuru daigakuinse・kenkyūsha muke kyōkasho no tame no kenkyū nōto*" (Cognitive and Kinematic Theories of Handwriting: Handwriting Research Notes for a Textbook for Graduate Students and Researchers), Kanazawa seiryō daigaku ningen kagaku kenkyū, Vol 13-1, 2019, pp. 59-63.
河野俊寛、「書字の認知理論と運動理論—書字に関する大学院生・研究者向け教科書のための研究ノート—」、『金沢星稜大学人間科学研究』, 13号, 1, 2019, pp. 59-63.
- MINAGAWA Naohiro, TAKEGUCHI Koji, "'Tegaki' to 'taipingu shoji' ni tomounau ninchi to shikō o kōryō shita kyōiku ni tsuite no ichikōsatsu" (One consideration about the education considering the cognition and thinking accompanied with handwriting or typing), *Naruto kyōiku daigaku kenkyū kiyō*, Vol. 39, 2024, pp. 155-165.
皆川直凡・竹口幸志、「『手書き』と『タイピング書字』に伴う認知と思考を考慮した教育についての一考察」、『鳴門教育大学研究紀要』、第39巻、2024年、pp. 155-165.
- MIYAMOTO Reiko, FUJIMOTO Yasunari, INOUE Kaoru, ITŌ Yūko, "Nihongo no hitsujun ni okeru saūte no unpitsu kinō no sōi" (Differences in Japanese Handwriting Function Between Left and Right Hands Focusing on Japanese Stroke Order), *Sagyō ryōhō*, 42, 3, 2023, pp. 289-298.
宮本礼子、藤本泰成、井上薫、伊藤祐子、「日本語の筆順における左右手の運筆機能の相違」、『作業療法』、第42巻第3号、2023年、pp. 289-298.
- MONBUKAGAKUSHŌ (MEXT), *Shōgakkō gakushū shidō yōryō kaisetsu: kokugo-hen* (Commentario alle linee guida curricolari per la scuola primaria: sezione lingua nazionale), Tōkyō, Tōyōkan Shuppan, 2017. 文部科学省、『小学校学習指導要領解説 国語編』、東京、東洋館出版社、2017年
- MONBUKAGAKUSHŌ (MEXT), *Chūgakkō gakushū shidō yōryō kaisetsu: kokugo-hen* (Commentario alle linee guida curricolari per la scuola secondaria di primo grado: sezione

lingua nazionale), Tōkyō, Kyōiku Shuppan, 2017.
文部科学省、『中学校学習指導要領解説 国語編』、東京、教育出版、2017年.

- LONGCAMP, Marieke et al., "Learning through Hand- or Typewriting Influences Visual Recognition of New Graphic Shapes: Behavioral and Functional Imaging Evidence", *Journal of Cognitive Neuroscience*, vol. 20, n. 5, 2008, pp. 802-815.
- LURIE, David B., "The Development of Writing in Japan", Cambridge (MA), Harvard University Asia Center, 2012.
- MUELLER, Pam A., OPPENHEIMER, Daniel M., "The Pen Is Mightier Than the Keyboard: Advantages of Longhand Over Laptop Note Taking", *Psychological Science*, vol. 25, n. 6, 2014, pp. 1159-1168.
- NISHIYAMA Yūji et al., *Kangaeru shintai to bunbōgu no sōgo sayō* (L'interazione tra corpo pensante e cancelleria), Tōkyō, Tōkyō Daigaku Shuppankai, 2011.
西山裕之ほか、『考える身体と文房具の相互作用』、東京、東京大学出版会、2011年.
- OECD, *PISA 2015 Results: Excellence and Equity in Education*, Paris, OECD Publishing, 2016.
- OGIFU Kenji et al., "Tegaki kanji no totonoisa to gakushū tassei no kanren" (Relazione tra accuratezza dei kanji scritti a mano e rendimento scolastico), *Tokusyū kyōiku kenkyū*, 2023.
荻生健司ほか、「「正しく整った字」を書くことは学力に関連するか—2種の漢字採点における書き成績と学力との関係の比較—」、『特殊教育学研究』、2023年.
- OPHIR, Eyal, NASS, Clifford, WAGNER, Anthony D., "Cognitive control in media multitaskers", *Proceedings of the National Academy of Sciences (PNAS)*, Vol. 106, n. 37, 2009, pp. 15583-15587.
- OTSUKA, Sadao, MURAI, Toshiya, "Cognitive underpinnings of multidimensional Japanese literacy and its impact on higher-level language skills", *Scientific Reports*, 11, 2190, 2021, pp. 1-14.
- PENFIELD, Wilder, *The Mystery of the Mind: A Critical Study of Consciousness and the Human Brain*, Princeton, Princeton UP, 1975.

- SAKAMOTO Tetsuo, "Il contributo di Maejima Hisoka al movimento Genbun-itchi", *Il Giappone*, vol. 18, 1978, pp. 37-46.
- SANDLER, Andrew D. et al., "Neurodevelopmental study of writing disorders in middle childhood", *Journal of Developmental and Behavioral Pediatrics*, Vol. 13, n. 1, 1992, pp. 17-23.
- SANSEIDŌ, "Gendai no shosha: shakai seikatsu ni ikiru shosha no chikara" (Modern calligraphy: The power of calligraphy in everyday life), Tōkyō, Sanseidō, 2024. 三省堂、『現代の書写—社会生活に生きる書写の力』、東京、三省堂、2024年。
- SCHMIDT, Richard A., "A schema theory of discrete motor skill learning", *Psychological Review*, vol. 82, n. 4, 1975, pp. 225-260.
- SHIBATA, Hirohito e OMURA, Kengo, "Reconsideration of the Effects of Handwriting: Comparing Cognitive Load of Handwriting and Typing", *ITE Transactions on Media Technology and Applications*, 6, 4, 2018, pp. 255-261.
- SWELLER, John, "Cognitive Load During Problem Solving: Effects on Learning", *Cognitive Science*, vol. 12, n. 2, 1988, pp. 257-285.
- TAKAHASHI Noboru, NAKAMURA Tomoyasu, "*Kanji no shoji ni hitsuyō na nōryoku: ATLAN kakitori kensa no kaihatsu kara*" (Abilities needed by Japanese children to write kanji: Development of the ATLAN kakitori subtest), *Shinrigaku kenkyū*, Vol. 86-3, 2015, pp.258-268.

高橋登、中村知靖、「漢字の書字に必要な能力—ATLAN書取り検査の開発から—」『心理学研究』, 86, 3, 2015, pp. 258-268.

- TOMIYASU Shingo, "*Kokugo kyōiku ni oite keisei sareru kanjikan ni tsuite no kentō: 'Hitsujun' ni kansuru kanjikan o chūshin ni*" (A study on kanji views formed in Japanese language education: Focusing on kanji views related to stroke order), Shimane Daigaku, 2021, pp. 233-236.
富安慎吾、「国語教育において形成される漢字観についての検討—「筆順」に関する漢字観を中心に—」、島根大学、2021年、pp. 233-236.

- UMEJIMA, Keita, IBARAKI, Takuya, YAMAZAKI, Takahiro e SAKAI, Kuniyoshi L., "Paper Notebooks vs. Mobile Devices: Brain Activation Differences During Memory Retrieval", *Frontiers in Behavioral Neuroscience*, 15, 634158, 2021, pp. 1-11.
- UESUGI Takamichi, "Shikiji chōsa no igi to kadai: Kiso kyōiku hoshō no kanten kara" (Significance and Problems of Literacy Survey: From a Viewpoint of Guaranteed Basic Education), *Kiso kyōiku hoshōgaku kenkyū*, 6, 2022, pp. 29-46.
上杉孝實、「識字調査の意義と課題——基礎教育保障の観点から——」、『基礎教育保障学研究』、第6号、2022年、pp. 29-46.
- UCHIYAMA Hiromi, "*Meiji jidai shoki o kiten to suru shoji kyōiku ni tsuite: Genzai no shosha・shodō kyōiku to no kanren o chūshin to shite*" (On Handwriting Education Starting from the Early Meiji Period: Focusing on Its Connection with Current Handwriting and Calligraphy Education), pp. 3-14.
内山裕美、「明治時代初期を起点とする書字教育について—現在の書写・書道教育との関連を中心として—」、pp. 3-14.
- VYGOTSKY, Lev S., *Thought and Language*, Cambridge (MA), MIT Press, 1962.
- WILSON, Frank R., *The Hand: How Its Use Shapes the Brain, Language, and Human Culture*, New York, Pantheon Books, 1998.

Webography

- BUNKACHŌ (AGENCY FOR CULTURAL AFFAIRS), "*Reiwa 6-nendo kokugo ni kansuru yoron chōsa*" (Public opinion survey on the Japanese language - A.A. 2024), 2025, https://www.bunka.go.jp/tokei_hakusho_shuppan/tokeichosa/kokugo_yoronchosa/
- MONBUKAGAKUSHŌ (MEXT), "*Gakushū shidō yōryō*" (Curriculum Guidelines), 2017, https://www.mext.go.jp/a_menu/shotou/new-cs/1387014.htm