Journal of Infrastructure, Policy and Development 2025, 9(1), 10391.
https://doi.org/10.24294/jipd10391

Review

Piano sight-reading teaching and music education: A systematic literature review

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CITATION

Rui R, Amran MS, Nasri NM. (2025). Piano sight-reading teaching and music education: A systematic literature review. Journal of Infrastructure, Policy and Development. 9(1): 10391. https://doi.org/10.24294/jipd10391

ARTICLE INFO

Received: 19 November 2024
Accepted: 10 December 2024
Available online: 14 January 2025

Abstract: Piano sight-reading competency, which is highly important for an aspiring musician who needs to face diverse musical problems, is an integral part of becoming a smooth performer. The aims of this systematic literature review concerning piano sight-reading pedagogy approaches between 2019 and 2024 are to determine the strengths and weaknesses of the peer-reviewed literature. The article examines cognitive, behavioral, and technological methods and tools of enhancing learning outcomes, based on the concept of cognitive load, constructivism, and behaviorist perspective. The cognitive strategies highlight the role of hand-eye coordination, short-term memory, and visual process; while the behavioral ones emphasize the importance of daily practice and feedback from the teacher. Emerging technologies, like VR and AI-driven platforms, are redefining education and offering unique ways of learning and forgetting. While achievements of the past are notable, challenges such as access and efficacious long-term approaches remain. The next step of research should be to focus on sustainable teaching methods and international perspectives to achieve homogeneous and effective sight-reading teaching worldwide. This essay provides an overview of integrated and adaptable teaching strategies that combine both traditional and modern tools for the development of versatile and confident musicians' skills.

Keywords: piano sight-reading; music education; music teaching

1. Introduction

Sight-reading in piano is essential for musicians and according to Hodges (2019), contributes to complete music education. It assists musicians in grasping the basic concepts of music theory, and moreover, it enables them to perform pieces that neither of the musicians has ever played before. An internal process that establishes a mental model that is assistive for musical self-sufficiency and adaptability (Gazzano, 2019). On the other hand, musical sight-reading is fundamental to the nurturing of music performers who are proficient in improvisation, both as a solo and a group performer (Li, 2023).

On the other hand, some of the teachers and students have complex barriers that they need to overcome in order to obtain efficient sight-reading skills. Common problems most students encounter are difficulties controlling eye movements or reading the various note forms, which hinders progress in music learning (Zhukov and Ginsborg, 2021).

Current pedagogical approaches to teaching music notation and sight-reading encompass a variety of models, with an increasing demand for innovative strategies aimed at enhancing these skills (Wong, 2019). Emerging technologies, such as augmented reality and numerous digital applications, offer the potential to transform

traditional music education (Zeng et al., 2019).

This literature review focuses on papers published from 2019 to 2024, exploring effective teaching strategies and interventions for developing piano sight-reading skills. It aims to provide insights into neurological, behavioral, and technological methods that have shown promise in addressing common sight-reading challenges.

Guided by the question, "What pedagogical methods and strategies can enhance piano sight-reading proficiency among students with varying learning abilities?", this review contributes to the ongoing discourse on a holistic, evidence-based approach to music education (Sherrill, 2022). Beyond identifying effective strategies, it highlights gaps in existing research. This foundation will help educators and curriculum developers refine sight-reading instruction across diverse educational settings.

2. Literature review

The skill of playing the piano by sight, also known as sight-reading, which is defined as the ability to read and play a score instantly without any prior preparation, is very important for any musician (Hodges, 2019). Proficiency in sight-reading adds to a musician's versatility and can, therefore, be useful when participating in a range of musical formats, from solo acts to large ensembles, requiring little time to prepare. In order to aid educators in teaching sight-reading to their students, they have been debating many of the pedagogical techniques that deal with the mind, body, and technology. This study reviews the recent findings from the years 2019 to 2024 to determine the appropriate approach for the instruction of sight-reading in piano.

Solving challenges of cognition dealing with issues such as attention, memory, and perception is the goal of cognitive strategies in sight-reading. Studies have shown that skilled sight-readers own musical cognition functions, which allow them to perceive and interpret music with ease (Zhukov and Ginsborg, 2021). The ability to utilize executive functions, including working memory and attention control, is crucial for the process of music perception and the construction of musical meaning (Zhukov and Ginsborg, 2021). The study conducted by the National Institute of Health (2022) found that there exists a profound correlation between cognitive growth and sight-reading ability in making musicians. The latter is considered as the determining factor in the overall cognitive development of such musicians.

It could be said that a visually perceiving (sight-reading) pedagogy investigates patterning another, very important cognitive domain. The skill called piano sight-reading, which is the fast identification of and understanding of the musical schemes, is necessary here. Wong (2019) has realized that it is quite possible to strengthen students' skills to play unknown notations through patterning exercises. Such tasks are designed to make kids learn by heart the fundamentals of music, therefore resulting in easy shuffling from one piece to another.

Behavioral techniques, which set sight-reading as the result of specified practice and training techniques, are deployed. Studies shall stress the importance of ongoing exercises to boost the feeling for music. Snell and Stringham (2021) have insisted on the strategic implementation of specific exercises, which contribute to such a result that play of more and more complicated pieces makes one absorb more. According to the scholars, intentional practice, which concentrates on problematic areas, occurs to

be another form of practice that is more efficient than ordinary routine practice.

Besides, a great many behavioral strategies use feedback and reinforcement as means of control to provide learning opportunities to students. Sherrill (2022) perceives that productive and initial feedback will assist a student to correct a mistake and improve sight-reading ability. Through these strands of knowledge, educators can deliver targeted guidance that further facilitates the rate of learning for their students.

Technology, which has entered music education, is one of the new and improved ways for arranging sight-reading classes. Technologies such as augmented reality (AR) and digital applications create not only interactive but also more immersive learning experiences. Zeng et al. (2019) researched the promising AR application in music education, discovering its potential to create stimulating learning environments that develop auditory and visual learning components. Their findings suggest that the AR system can provide effective suggestions and consultations, making the sight-reading training process enjoyable and productive.

Moreover, software tailored for practice across the web gives students ideal options for practicing by themselves. Gazzano (2019) has designed an app that provides audio-visual aids and self-paced activities, which helps novices develop their sight-reading skills. The apps have a feature that allows instant feedback to be given. Not just that, they monitor the students' academic progress, and this result in the provision of personalized learning experience. This technological method is similar to the point of view by Dai (2019) as he points out the relevance of adaptive learning devices that are used by students of different learning paces and skill levels.

Certain teaching techniques show the potential to enhance sight-reading performance and therefore are widely used. Techniques employing multi-sensory teaching strategies are getting wider recognition because of their holistic view. Rich (2024) scrutinizes the method of Kodály, which offers a musical lesson around singing, movements, and visualization on piano playing. This approach, therefore, involves combining different sensory learning (visualize, hear, and feel) to support the students in understanding musical concepts and enhancing their sight-reading abilities.

On the other hand, flipped learning models have also been used in sight-reading education on the piano. This technique, known as "reverse learning", entails the establishment of a different learning environment by which practical theories are experienced outside the classroom. Flipping of the classrooms can achieve optimization of learning, allowing students to engage the subjects in their own space at their own time (Pan and He, 2024). Consequently, comprehension of music is greatly enhanced, particularly during the in-class practice of newly sight-read pieces.

Despite this, sight-reading techniques are still being perfected. The process is full of challenges, research gaps, and finding the correct tool to improve it. The majority of experiments examine the effects after systems are in place in the short term, lacking data regarding the sustained effect of these solutions on the long-term ability to read for pleasure. Longitudinal analysis might allow us to know more about how the skills of sight-reading develop over time and how they can be sustained through the stationary musician's career.

In addition, the process of technology incorporation into sight-reading education has the following obstacles: accessibility and cost. Institutions and instructors must deal with such impediments. Future work may address the efficiency and mass

production of educational tools suitable for multiple educational environments.

3. Purpose of the study

In this research paper, the aim is to conduct a systematic review and synthesis of the latest literature from 2019 to the present, focusing on the pedagogy of piano sight-reading. The study explores cognitive, behavioral, and technological approaches to determine how these methods can effectively enhance sight-reading skills for students across different proficiency levels. It seeks to delve deeply into this perspective, examining evidence-based practices while identifying gaps in current research. The central question is: "What strategies and pedagogies can accelerate the acquisition of piano sight-reading skills accurately and efficiently in diverse contexts?"

4. Theoretical foundation

Research on instruction of piano sight-reading represents the main purpose of this paper, which is to demonstrate the grounding of developing educational and psychological theories as well as the implementing of those concepts in a thoughtful and suitable manner. On the other hand, these theories present how a mix of cognitive, behavioral, and technical frameworks are within the literature review derived during the years of 2019–2024.

Cognitive Load Theory (CLT) to a great extent implies that the memory of elements that are usually immediately needed is to be limited and the efficiency of learning is to be increased by regulating cognitive processing (Van and Sweller, 2005). That's why the prevention of the working memory overload is a point that finding solutions for the chess players from the mental gaming overload by providing leisure activities such as pattern recognition and information recall is one way (Zhukov and Ginsborg, 2021). Teachers can put the theory in practice by breaking down learning into small pieces that become progressively more difficult to take on as students gain competence (Li, 2023).

Constructivist learning theory, as proposed by Piaget and Vygotsky, posits that knowledge construction requires active engagement with information (Gash, 2014). This theory supports sight-reading pedagogy by encouraging students to actively participate in learning through exploration and self-discovery. Practical applications in sight-reading involve motivating students to work with different music pieces, enhancing memorization and interpretive skills (Sherrill, 2022). Flipped classroom models, characterized by student-centered learning environments, align with constructivist principles, allowing students to engage with theoretical content at their own pace (Pan and He, 2024).

Behaviorism, primarily associated with Pavlov and Skinner, focuses on reinforcement and practice in learning (Vargas, 2017). In sight-reading, behaviorism emphasizes practice and feedback to reinforce learning. Recent research indicates that techniques involving rewards and feedback significantly enhance students' sight-reading skills (Snell and Stringham, 2021). Teachers provide feedback and structured practice routines, fostering the development of sight-reading and broader musical skills.

The TPACK (Technological Pedagogical Content Knowledge) framework

highlights the interaction between technology, pedagogy, and content (Mishra and Koehler, 2006). During the sight-reading lessons, TPACK serves the teachers as a tool that helps to know how to use new technology like augmented reality, digital apps, etc., in creating memorable learning experiences for the students that motivate them for deeper knowledge and since that stimulate their love for learning. Technology provides for individualized learning trajectories, feedback in real time, and hands-on exercises; these are the things that are instrumental to the enhancement of skills like sight-reading (Gazzano, 2019). Adaptive technologies meet different educational needs through providing customized instruments that fit different learning speeds, learning curves, and skill level gaps (Dai, 2019).

Recent breakthroughs in neuroscience have deepened our approach towards the interplay between learning and music in the brain, notably the concept of neural pathways and brain plasticity as the key phenomena involved (Zatorre and Salimpoor, 2013). The learning experience is primarily looking at connecting brain functions that involve pattern comprehension, storing memory, and the switches for executive decisions, which are the important things to have when entering music reading (Li, 2023). Research that investigates how the executive functions are connected to the skill of sight-reading reinforces the use of different cognitive trainings to gauge the efficiency of the discussed cognitive skills.

As a result, the theory dimension of this studied focuses on a multi-dimensional approach methodology of sight-reading that enmeshed behaviorism, cognition, construction, technology, and neuroscience into the practice. Guided improvisation, listening-to-learn, warm-ups, and ear training are educational means that established teachers incorporate and promote so that the students acquire proficient sight-reading techniques that make them triumph in different musical situations.

5. Methods

In order to implement this study comprehensively, it will be carried out in the form of a systematic review study according to the protocol of PRISMA. The examination of the subject matter will cover the period ranging from 2019 to 2024. **Figure 1** below shows a flow diagram of the steps involved in the PRISMA screening process.

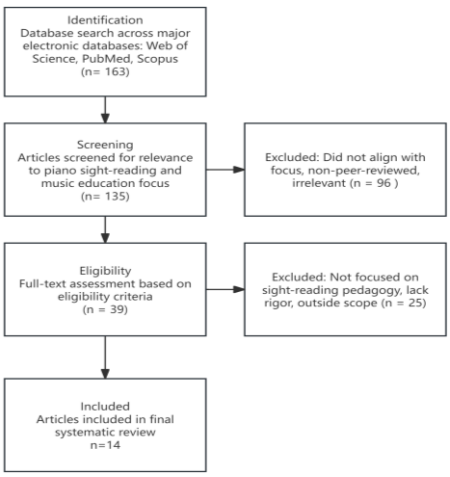

Figure 1. The PRISMA screening process.

5.1. Study identification

It all began with the start of an in-depth search, which was done across three major databases: Web of Science, PubMed, Scopus. The search was based on a set of keywords such as “Piano sight-reading”, “Music education”, “Piano teaching”, “Music pedagogy”, “Sight-reading techniques”, and “Piano learning strategies”. This search strategy was thus designed for the sake of covering all aspects of knowledge on various pedagogic techniques applicable to piano sight-reading.

5.2. Additional sources

These complex and multiple database searches were supplemented by a careful manual survey of the bibliographies in crucial papers, which aimed to ensure comprehensiveness and to search for other essential contributions that might have escaped notice. This stage was of particular importance to the overall thoroughness of the review process.

5.3. Screening process

After the first detection, a well-structured screening mechanism was used. This required a careful deletion of duplicates from the database, which was followed by the evaluation of titles and abstracts in order to determine their relevance to the research topic. Special documentation was taken for the number of duplicates unsubscribed from and the total publications screened. In this phase, studies relevant to piano sight-reading and music education were retained, while those not peer-reviewed or deemed irrelevant were excluded.

5.4. Eligibility assessment

After passing the screening process, full-text articles went through detailed section-wise eligibility assessment using pre-specified exclusion criteria. Articles were rejected if they were a mismatch to the concept of piano sight-reading pedagogy, involved non-peer-reviewed methodologies (e.g., editorials), or were too rudimentary in music education. Primary reasons for rejection included a focus on unrelated topics such as performance anxiety or improvisation, or lack of practical exercises related to sight-reading.

5.5. Inclusion criteria

All the studies included in this systematic review applied defined inclusion criteria, for example:

1) A direct addressment with pedagogic practices, strategies, or techniques of piano sight-reading.

2) Primarily focusing on music education, which has a goal of developing piano sight-reading skills.

3) Participating in piano played in varying sight-reading levels with diverse abilities.

4) Assessing pedagogical methods of improving sight-reading comprehension using cognitive, behavioral, or technical approaches.

5) Empirical studies including qualitative and/or quantitative (mixed-methods)

research, run in peer-reviewed journals published, from 2019 to 2024.

5.6. Study categorization and meta-analysis

The studies cited in the review were grouped into three main categories: cognitive and behavioral interventions for piano sight-reading, strategies for sight-reading assessment, and pedagogical methods. In cases where enough data was available, appropriate studies were included in the meta-analysis. This allowed us to quantitatively examine the ways of teaching piano sight-reading and assess learning outcomes related to improvements in sight-reading skills.

5.7. Data synthesis and reconciliation of conflicting findings

To enhance transparency in the synthesis process, it is important to clarify how conflicting findings were reconciled or weighted. During the synthesis, if studies reported conflicting results on the effectiveness of certain teaching methods, the discrepancies were examined by considering several factors:

1) Study design: Studies with more rigorous methodologies (e.g., randomized controlled trials or longitudinal designs) were given greater weight.

2) Sample size: Larger studies were prioritized as they generally offer more reliable results.

3) Consistency of findings: If a study's findings conflicted with the majority of the literature, it was critically assessed for potential methodological flaws or contextual factors that may have influenced the results. These factors included differences in the populations studied (e.g., age, experience level) and study design.

4) Cognitive, behavioral, or technological approaches: The effects of interventions using cognitive, behavioral, or technological methods were separately assessed to identify if certain approaches yielded significantly different results in terms of sight-reading proficiency.

In cases where findings remained inconclusive or conflicting despite these adjustments, a narrative synthesis was provided. This narrative synthesis explained possible reasons for the discrepancies, such as differences in pedagogical context or methodological limitations.

Such a well-organized and rigorous methodological system provides us with the basis for a review of what piano sight-reading education is like today. It also aids in discovering which strategies work well in classrooms, based on studies and research, and it pinpoints areas where more studies need to be done, thus playing a key role in the field of music education.

6. Results

The systematic review of literature on piano sight-reading and music education encompassed literature search and synthesis of studies published in the period from 2019 to 2024. The following section presents these results of the studies identified during the literature review. These results are organized into their different categories of cognitive and behavioral interventions, sight-reading assessment methods, and incorporation of educational and technical options.

While reviewing the studies, the review highlighted the skills enhancement

achieved through the cognitive and behavioral techniques implemented to improve sight-reading proficiency. The cognitive interventions, based on mental skills' training methods, put forward concentration, memory, and perception as paramount for successful and fast sight-reading. Wong (2019) gives an example of implementing sight-reading practice, which helps to learn and absorb musical patterns faster, leading to faster recognition of phrases and anticipation of the next one. Such exercises are found to assist students in consolidating the core musical ideas. As a result, they are capable of attending to music sheets which they have never seen before with the previous knowledge.

Behavioral interventions, on the other hand, made use of divided practice sessions and feedback to enhance learning. In their work, Snell and Stringham (2021) remarked that strategic practice is key, and exercises that are progressively most difficult should be employed by advancing persons. Such exercise is followed by instant feedback, which allows the exercise to be continuously improved. Sherrill (2022) ratified the effectiveness of constructive feedback by stating that it greatly boosts students' positive learning experiences by providing them with immediate corrections to errors and further building their confidence to sight-read.

Correct assessment strategies are essential for evaluating sight-reading performance and improving sight-reading teaching methods. Some research ensured innovation by incorporating different assessment strategies to accurately measure students' competencies. For instance, Gazzano (2019) invented this tool, which is digital, providing analytics in real-time regarding student performance and insights into areas that students seem to struggle the most. The principles of cognitive load theory support this notion by keeping cognitive extraneous processing in check and thus narrowing the learning capacity to key learning goals.

On the other hand, the peer assessment approach opens the door to a collaborative learning environment in which every individual is a part of the learning process (Dai, 2019). These methods do not only drive self-reflection but also stimulate students to think critically about their peers' skills, facilitating an understanding of the shades in technique. Li (2023) proposed an adaptive test for that matter, which used student responses to adjust the complexity of questions.

The review revealed the educational potential of technology toward sight-reading instruction, which can be used in multiple ways. Today, technological instruments such as AR (Augmented Reality) and digital applications are developing methodologies that motivate students and elevate learning. Zeng et al. (2019) illustrated that AR generates such immersing realities where students are able to see and hear their surroundings, their environments are completed with auditory and visual modality supports. These environments possess the ability to provide contextual feedback, which lies in the interactive and corrective approach.

An increasing focus is now on AI incorporation into music education as an area where it can be quite useful. AI-supported platforms can provide learning opportunities appropriate for different learner needs, including personalized feedback and varied learning paths. Wong (2019) states that the use of these platforms produces a positive impact on the students by keeping them engaged and motivated as the learning process becomes customized to fit each student's learning threshold.

Improving sight-reading skills is central to teaching strategies that focus on

progressive learning and repetitive practice. The literature reviewed provides ample evidence supporting the role of structured practice routines in skill acquisition. Rich (2024) emphasizes a progressive learning approach that allows students to gradually improve their sight-reading abilities by building a solid foundation through mastering basic skills and then moving on to more complex pieces.

Yet, the problem occurs in introducing the new teaching strategies in the classroom with different environment conditions. Accessibility and pricing are increasingly important issues in resource-poor settings, where technology is skyrocketing in use. Engineering of scalable and inexpensive solutions remains the company's top focus to enable the mass availability of these modern learning tools (Dai, 2019).

In addition, while numerous studies centers around time-limited intervention, there is a gap for long-term researches to monitor the prevailing outcome of what have been initiated in sight-reading. Knowing how skills grow and diminish over the years helps us to develop new pedagogies that are more effective in skill retention. More studies could and should also include more cultural and contextual influences that affect sight-reading education, and that, for example, facilitate or impede fitting different learning settings in schools.

The investigation of this systematic review is the documented implication of its multi-aspect nature. Cognitive and behavioral strategies, coupled with innovative evaluation approaches and technology integration, have shown to be promising in achieving educational goals in the music subject area. Through tackling the dire issues and empowering further studies, educators can systematically come up with holistic and practical strategies for students to read music during their musical activities outside the class.

The study finally revealed a complete approach to teaching piano sight-reading, with practical tips for learners. These findings provide educators and curriculum builders with a basis on which they can embark on an implementation of evidence-based strategies for music education. By taking advantage of these skills, it is feasible to nurture musicians who are superb and self-assured when it comes to reading music. In the same way, there will always be a need for throughout research and updates. This will help to address current knowledge gaps and refine educational approaches that respond to the needs of the next generation of musicians.

Table 1 presents an overview of the articles included in the review showing the intervention applied, the research methods used in the study, and the number of participants in each study.

Table 1. Articles included in the review.

Author(s)	Year	Title	Intervention Modality	Research Methodology	Participants
Meijia Li	2024	Research on the Integration Teaching Mode of Traditional Music Elements and College Piano under the Background of Information Technology	Integration of traditional music elements with college piano education using scaffolding pedagogy in the context of information technology	Combination of qualitative and quantitative approaches, including the construction of a mathematical model and validation analysis using datasets (MIR-2K and DSD120) for effectiveness testing	college and university students

Alden H. Snell II, David A. Stringham	2021	Preservice and in-service music educators' perceptions of functional piano skills	Survey study examining perceptions related to the acquisition and use of functional piano skills categorized into technique, repertoire, accompanying and functional skills, sight-reading, and generative creativity	Survey study using a Likert-type scale to assess perceptions of learned and anticipated use of skills among preservice teachers, and learned and actual use among in-service teachers	316 preservice music educators and 295 in-service music educators
Dainora Daugvilaite	2021	Exploring perceptions and experiences of students, parents and teachers on their online instrumental lessons	Transition from face-to-face to online instrumental lessons in a one-to-one setting	Holistic multiple-case study design using semi-structured interviews with both students and teachers to gather qualitative data	(beginner and intermediate levels) aged 8–13 and their parents, as well as five instrumental teachers from the UK
Katie Zhukov, Jane Ginsborg	2021	Time for practice: implications of undergraduate pianists' choices of repertoire	Sight-reading training program for undergraduate pianists	Intervention study with a control group; data collection through participant diaries tracking the repertoire practiced and time spent on practice	24 first-year undergraduate pianists, consisting of 12 in the intervention group and 12 in the control group, from three institutions in the UK and Australia
Hong Zeng, Xingxi He, Honghu Pan	2019	A New Practice Method Based on KNN Model to Improve User Experience for an AR Piano Learning System	Augmented Reality (AR) piano learning system incorporating a K-nearest neighbor (KNN) classifier for identifying and practicing difficult measures at a slower speed	Experimental evaluation comparing a new practice method using AR with a control group using traditional practice methods; performance measured based on playing accuracy	A total of 6 volunteers divided into two groups (experimental and control), with no prior piano experience and aged between 21 to 24 years, all students at Chongqing University
Alan Gazzano	2019	Improving Piano Sight-Reading in Beginners: An Audio-Visual Free App for Self-Practice	Use of a mobile application (Virtual Piano Trainer) for autonomous piano sight-reading practice	Mixed methods (quantitative data from app-based performance metrics and qualitative observations and interviews)	8 beginner piano students, ages 14–29, from the "Ástor Piazzolla" Conservatory in Buenos Aires, Argentina
Suzanne Wong	2019	Let's Play It By-Ear: Learning Piano in a College Setting With an Aural Emphasis	Integrated Aural/Reading vs. All-Reading Approach	Action Research	Community college students in two California colleges
Amanda May Sherrill	2022	Collaborative Piano Skills Within Class Piano Curricula: An Examination of Arizona Collegiate Institutions and Selected Group Piano Textbooks	Collaborative Piano Skills in Class Piano Curriculum	Survey and Interviews	Community college and university instructors of class piano in Arizona
Sun-nyeo Gim	2020	The State of Piano Accompaniment Skills in Preservice Early Childhood Teachers and the Right Direction for the Management of Instrumental Music Courses	Piano Accompaniment Skills in Early Childhood Education	Survey	Preservice early childhood teachers at a 3-year college in Gyeonggi, Korea
Chenyan Dai	2019	Preschool Teachers in Shanghai, China: Pre-Service Piano Skill Development, Perception of Adequacy, and Current Instructional Usage	Piano skill development and usage in preschool teaching	Descriptive statistical analysis, Sequential multiple regression	Preschool teachers in Shanghai who graduated between 2013 and 2018 with at least one year of teaching experience (567 participants)
Megan Elizabeth Rich	2024	Kodály Learning: A Qualitative Case Study Based on the Use of a Blended Curriculum Using the Principles of Zoltán	Blended Kodály-traditional piano curriculum	Qualitative case study	Four students aged 6–8 years old

		Kodály in Beginning Piano Study			
Lin, Yen Yu	2021	A Study on the Teaching Contents and Multi-Sensory Learning Strategies of the "Faber's Basic Piano Adventures"	Multi-sensory learning strategies in piano teaching	Content analysis	31 textbooks
Şenay Savaş Ceyhan	2023	Technical Problems Faced by 15–16-Year-Old Students Who Have Beginning Piano Education and Teacher's Opinions on the Solution of These Problems	Beginning piano technical problem-solving in education	Qualitative case study (Interviews and content analysis)	12 piano educators in Bursa, teaching 15–16-year-old beginner piano students
Moreira e Silva, J. M.	2019	Mental practice in piano teaching: Implementing strategies in the classroom context in the second cycle of basic education	Mental and physical practice in piano	applied research	Nine students

7. Discussion

7.1. Current pedagogical strategies in sight-reading

The studies summarized in this research review accurately describe the current status of piano sight-reading instruction and include relevant notes on the teaching strategies and interventions needed to be effectively implemented in teaching so that students can sight-read fluently. Through the recent literature analysis, one can clearly identify that the need for techniques to enhance sight-reading skills is more than critical for the development of piano player, and different teaching approaches are researched to achieve this aim.

Among the major lessons learned from the review is that cognitive and behavioral training are useful as they help in improving the skills used in piano sight-reading. Research, including Li and Snell's study, has illustrated that blending ordinary music components with the latest technology is one of the best solutions when it comes to mastering sight reading ability. The research of Li (2023) clarifies the instrumental role of augmented reality (AR) in providing a visually-exciting and systematic practice atmosphere to fine-tune the technique of sight-reading. This not only makes the class fun for the students, but they can also easily understand the notes and rhythms of the system due to the energy required to understand the musical system symbols. Yet, the problem occurs in introducing.

The sight-reading process requires the use of cognitive strategies, which comprise visualized processing ability, eye-hand coordination. The study by Zeng et al. (2019) indicates that eye movements in reading the text are coordinated and purposeful, which means that learners can be taught to employ those skills as well. The theory of eye-hand span is a Parncutt-conception of the fact that the mastery of both visual scanning and hand movements coordinating with effective sight reading is the likely key. Through constant expected practice and sophisticated exercise, the effectiveness of the response time to the perception is promoted via the optimal reading accuracy that finally eliminates the gap between the perception and the execution (Zeng et al., 2019).

The theme of the relationship between providing technology in education and teaching methods has become a major issue in contemporary piano schools. Today, educators have an effective means of digital tools, which they can utilize in order to build advanced and experiential learning experiences. For example, Zeng et al. (2019) demonstrates the use of AR along with the KNN model, which significantly contributes to improving the user experience while learning how to play piano. The personalized feedback mechanisms make this possible by providing the students with timely insights into their practices, thus making them better practitioners. This is coherent with the theory that technology is to be used as an enhancement tool rather than a substitute for the traditional processes.

Additionally, Wong's (2019) dissertation employs the auditory approach in piano learning that highlights hearing as a main component in sight-reading development. Taking advantage of the digital media platforms, where immediate auditory feedback is the norm, students can become better at sporting error detection mechanisms; therefore, they can enhance their sight-reading skill. Such integrations bridge auditory and visual learning pathways, making the learning process more holistic and effective.

Incremental learning and repetitive practice, as the pedagogical strategies that focus on sight reading improvement, are the main components. A significant aspect of these articles is the empirical data that suggests that these structured practice routines are extremely beneficial in skill acquisition. The case study conducted by Rich (2024), in which principles of Zoltán Kodály are applied into beginner piano studies, uses the blended curriculum. Here, the learning procedure is synchronous and development is gradual. Such an approach allows these learners to master essential skills that will serve as the building blocks for more complex pieces, which will allow them to become proficient in reading and rehearsing sheet music.

Furthermore, motivation and student involvement, which are other two factors discussed in the literature, should be maintained to achieve success. In Dai (2019), there is a remark about the considerable effect that motivation exerts on the efficiency of sight reading training. Among the strategies that keep the students involved, goal setting and awards assists in achieving their targets ready in a given time frame, while the use of a varied repertoire encourages a longer practice period. The implementation of the collaborative and participatory learning environments (CVEs) allows the learners to have an interactive atmosphere where they can learn from their peers and the shared knowledge (Dai, 2019).

In the literature, the important element is a shift toward student-oriented learning styles. Snell and Stringham's study on preservice and in-service music educators' views emphasizes the necessity of being in line with students' learning needs and preferences (Snell and Stringham, 2019). This is valuable in understanding teaching strategies. Through the development of personalized and responsive teaching methods, instructors can stimulate interest and motivation, two components that can help to guarantee a prosperous sight-reading learning process.

Student-driven learning models, such as those incorporating improvisation and creative exploration, seek out, embrace, and nurture individuals' skills or strengths, which are key to fostering involvement and self-created choices. These approaches develop intrinsic motivation in education and to the extent of granting learners autonomy in their learning process. Through an example, the use of improvisational

tools that foster students' interactions with less familiar musical styles can break the barrier between textual reading and interpretation competencies, thus expanding the overall sight-reading capability.

Emerging tools are becoming more and more transformational in the field of music education. They whisper how to use a new technique in the field of sight-reading training. The implementation of platforms like VR and AI does include learners in experiences that traditional ways are not able to offer. AI-based applications, for instance, can monitor how learners perform during the exercises and therefore provide on-the-spot comments on accuracy and technique, which provide a critical window for the refining of sight-reading skills (Zeng et al., 2019).

Virtual reality environments can imitate real concert locales and enable trainees to practice sight-reading in a situation that mirrors real-life conditions. This potential would be exceptionally useful for rehearsal purposes for allowing students to take part in concerts, where the ability to adapt to situations quickly and reading proficiently are paramount. The dynamic and interactive activities of these innovative technologies make learning more interesting than ever, pick the needs of different learners, and thus, it is less likely that people will forget what they have learned.

7.2. Critical analysis

The reviewed literature reveals significant advancements in understanding piano sight-reading pedagogy; however, several discrepancies and limitations deserve critical examination to contextualize the findings effectively.

One critical discrepancy lies in the differential effectiveness of behavioral and cognitive approaches. Cognitive interventions, such as those emphasizing eye-hand coordination, memory enhancement, and perceptual skill-building, have shown promise in improving the technical and analytical aspects of sight-reading (Wong, 2019; Zeng et al., 2019). These methods provide students with the tools to process and interpret music more efficiently. However, their reliance on individual engagement and intrinsic motivation can limit their applicability to diverse student populations, particularly those who lack foundational skills or demonstrate limited cognitive adaptability.

In contrast, behavioral strategies, such as regimented practice routines and immediate feedback mechanisms, yield more consistent improvements in sight-reading accuracy and fluency across varying skill levels (Sherrill, 2022; Snell and Stringham, 2021). These approaches leverage repetition and structured reinforcement to build muscle memory and fluency. However, they may oversimplify the complex cognitive processes involved in music reading, potentially limiting their ability to cultivate higher-order musical thinking and creativity.

Another limitation is the cultural variability in educational contexts, which influences the implementation and effectiveness of pedagogical methods. Many studies reviewed are rooted in Western educational frameworks, emphasizing individualistic learning and structured practice. These approaches may not align with collectivist cultures that prioritize collaborative learning and oral tradition in music education. For instance, the Kodály method, while effective in Western contexts, may require significant adaptation to resonate with cultural norms in Asian or African

educational settings.

Additionally, access to technology, which is increasingly central to modern sight-reading pedagogy, varies significantly across regions. While advanced tools like augmented reality (AR) and artificial intelligence (AI) platforms offer innovative solutions, their high cost and infrastructure requirements often render them inaccessible in resource-poor settings (Dai, 2019). The reliance on these technologies without adequate consideration of local resources risks exacerbating educational inequities.

The short-term focus of most interventions represents another critical limitation. Many studies assess the immediate effects of pedagogical strategies without examining their sustainability or long-term impact on students' sight-reading proficiency (Zhukov and Ginsborg, 2021). This limitation is particularly pronounced in the context of technology-driven interventions, which often lack longitudinal data to support claims of enduring benefits. Understanding the trajectory of skill acquisition and retention over time is essential for developing robust, evidence-based teaching models.

7.3. Challenges in implementing technological innovations

Although the encouragement methods for sight-reading teaching have realized great progress, certain difficulties remain, making it a problem for these new teaching methods to be fully introduced. There is one big hurdle—the accessibility and also affordability of high-level technological equipment. A great number of educational institutions, especially those that have scarce resources at their disposal, are likely to find it tough to incorporate such technologies as VR and AI into their curriculum. Because of that, learning opportunities across the board will be imbalanced (Dai, 2019).

There is also a need to emphasize on training educators to avoid problems in adopting and effectively utilizing new technologies. Educators ought to be familiar with the right methods that will aid in the application of the tools in the right way. Transitioning to this extent involves continuous training and guidance (Li, 2023). The technology-enhanced learning environment needs to project a new perspective of traditional assessment attempts of sight-reading skills to be more reflectively.

A significant routine entails ensuring equilibrium of technological innovations coming in to replace traditional pedagogy practices. Even though technology aids in the personalized learning of students, it is vital to keep basic aspects of musicality, interpretation, as well as emotional expression that are the pillars of music education. The educators should aim to do this by integrating technology in the area that complements while not eliminate the humanistic factor in the musical learning.

This systematic review reveals that there is still more to discover regarding the long terms effects, especially on different pedagogical interventions' impact on sight reading proficiency. Long-time studies that concentrate on skill-building over more than just short periods of time will give us great advantage in processing sustainability and effectiveness of various educational transformations. Also, with this study looking at cognitive processes recipient receivers as well as pedagogical methods, research has to be done in order to improve learning outcomes (Zhukov and Ginsborg, 2021).

Further studies should highlight the possibilities of cross-disciplinary investigations for a more definitive understanding in international applicability of sight-reading interventions. While acknowledging several musical educational traditions and contexts would improve our understanding of this, it is necessary for students and teachers of sight-reading techniques to collect and analyze the results to find out what works universally and what culture specific methods offer.

7.4. Practical implications

On a practical side, educators are advised to cultivate an adaptable mindset that is always open to new ways for engaging students, enabling them to develop a deeper appreciation for music that lasts. Collaboration is the key among the educators, researchers, and technology specialists that can facilitate the rise of the field and make sure that the new tools are on tap, and most importantly, they are relevant to the changes in the music education (Zeng et al., 2019).

To integrate augmented reality (AR) tools effectively into piano sight-reading pedagogy, educators can follow a step-by-step approach: (1) Select an AR-enabled application that supports interactive music notation visualization and real-time feedback, such as AR Piano Learning systems. (2) Introduce the tool in a guided session, where students learn to navigate its features and understand how it enhances their practice. (3) Design practice modules using AR tools to focus on specific skills like note recognition, rhythm accuracy, or hand-eye coordination. For example, students can use the AR app to slow down difficult passages while maintaining the original score's visual fidelity. (4) Regularly monitor progress through the app's performance analytics, using insights to tailor practice sessions to address students' weaknesses.

In flipped classroom models, educators can start by creating or curating video tutorials and online resources that explain key sight-reading concepts, such as rhythm patterns or melodic intervals. (1) Assign these resources as pre-class homework, ensuring students engage with the material at their own pace. (2) Use in-class time for hands-on activities like sight-reading new pieces, collaborative peer reviews, or improvisational exercises to reinforce learning. (3) Incorporate technology such as AI-driven platforms to provide instant feedback during in-class practice, allowing students to refine their technique in real time. (4) Conclude each session with a reflection activity, where students evaluate their progress and set goals for future practice. These practical frameworks ensure that AR tools and flipped classrooms not only modernize sight-reading instruction but also foster deeper engagement and personalized learning experiences.

7.5. Future research directions

Future research should prioritize longitudinal studies to evaluate the sustained impact of cognitive, behavioral, and technological strategies on piano sight-reading proficiency. These studies can provide critical insights into how skills develop, plateau, or decline over time, offering a deeper understanding of the factors that contribute to long-term retention and mastery. In particular, the persistence of improvements achieved through cognitive, behavioral, and technological

interventions must be explored to ensure that these strategies foster lasting musical proficiency.

Additionally, research should focus on adapting and scaling these pedagogical methods to diverse educational settings, especially resource-limited environments. By tailoring interventions to local contexts, such as using cost-effective technologies or culturally relevant teaching approaches, researchers and educators can make sight-reading education accessible and effective across varied socio-economic and cultural landscapes.

Furthermore, comparative studies across different cultural and institutional contexts would help identify universally effective strategies and culturally specific adaptations, ensuring that sight-reading pedagogy is inclusive, equitable, and globally relevant. By addressing these gaps, future research can guide the development of sustainable, scalable teaching models that benefit diverse learner populations.

In summary, the discussion demonstrates the necessity of developing a holistic, student-oriented way of teaching sight-reading in piano. Using a view that incorporates emerging tools, scrutinizes practical barriers, and elucidates future research directions, teachers get to improve the process of sight-reading instruction, sending excellent students to a new level.

8. Conclusion

The piano sight-reading pedagogy systematic review reveals the key concepts regarding the current methods and interventions in sight-reading piano skills that are most successful. The essay revealed various educational ideas, including cognitive and behavioral strategies, using technology, and carefully designed structures for practice. Through this extensive evaluation, we can draw a conclusion regarding the key findings of the study, and there comes a direction for future piano education.

Sight-reading is a basic skill that all music students must possess, the goal being that they can form the required dexterity and flexibility. The capacity to sight-read well represents musicians with the advantage to learn new pieces very fast, to interact in group performances, and to develop their musicality in general. Sight-reading skills are an important element for the future music learning process. Teaching and enhancing these skills results in making students literate and skilled musicians who can face a wide array of musical tasks successfully.

After the analysis, the review focused on the importance of integrating cognitive and behavioral operations in the process of promoting sight-reading accuracy. The studies, for example, those done by Zeng et al. (2019), reinforce the idea that eye hand coordination and visual processing skills are crucial. Indeed, these cognitive processes are essential for effective sight-reading. The latter may be achieved by means of games targeting them, which is likely to attribute to sight-reading improvement.

This research has a big potential to make a difference to the students' sight-reading progression by introducing the cognitive strategies and applying them in the classroom. Exercises like the one that focuses on the eye-hand span can use in the fulfillment of the students' synchronization of their visual input with the hand movements. As one component of such proficient sight-reading. Educators who make use of the aforementioned strategies in regular practice will be in the legislatory to

produce a musical environment that enables space for aptitude and creation of a music reading environment.

In fact, the introduction of technology as a new instrument in piano education has become a serious breakthrough in the learning techniques. Involving the use of digital tools like the AR and AI, these features allow us to personalize students' learning experiences and enrich their classroom activities. Consequently, Li (2023) and Wong (2019) signal technology as a source of real-time feedback, immersive learning environments, and the power to simulate performance scenarios, which are their necessary components and actually lead to an improvement in reading skills.

To take advantage of technological capabilities, teachers can provide students with highly usable and attractive tools to practice sight-reading. AR applications, for example, enable students to picture music registration simultaneously, virtually sparing their brains from the high-load routing of information, an enhancement to automatization. AI-powered platforms can examine learners' results and give them instant replies whether they have an accurate performance and technique or not. Such feedback communication plays a vital role in their building to uncover shortfalls and therefore adapt their practice accordingly.

The organized practice itself, as well as the appropriate teaching methods, is the basis of acquiring the art of sight-reading. The survey tells us the value of learning approaches that are systematic, step-by-step procedural and based on themeular concept. Through the setting of clear objectives, the employment of a wide repertoire, and the utilization of regular practice, teachers can, for example, draw an outline for the development of students' sight-reading abilities gradually.

Incremental learning, for example, is a method where the students first learn the rudiments of the subject before moving to the actual complex pieces. This will hone a well-rounded understanding of students in which the learned skills can easily be revolutionized in a random situation or a new sheet. In addition, it will be necessary to embed motivation devices, like goal achievement and reward systems, with the purpose keep student on the move toward their goal (Dai, 2019).

The outcomes of this systematic review point towards various issues for the future research and practice in teaching sight-reading in piano classes. There should continue the exploration of the long-term consequences of particular pedagogic strategies since determining their efficacy and long-term usage is necessary. Research on various educational settings, as well as culturally diverse methodologies, will make our vision crystal clear as regards the part that is universal and applicable, and that which is specific to a certain culture in terms of sight-reading techniques.

Moreover, technology progresses so rapidly that it gives hope for new educational tools in music education. The forthcoming study could possibly look into the application of newer technologies, such as virtual reality and machine learning, to take sight-reading instruction beyond the basic level. Working side by side of educators has just been 'okay' for education. Collaboration among researchers and technology developers even more will be fundamental to the future of the modern education system whereby learners will be studying with the help of educational tools that are modern and relevant.

To sum up, the systematic review identifies sight reading as a multidimensional factor, and the holistic approach to the piano sight-reading pedagogy is of great

indoorkiousness. By marrying cognitive and behavioral strategies, the use of technology and designing practice into the system, it becomes possible to enrich the learning environment by enabling the development of sight-reading ability.

Educators need to give students effective sight-reading demonstrations and adopt a learner-centered approach that gives specific feedback, sets boundaries for exploring new learning experiences and motivating features. Music educators combine traditional musical techniques with contemporary innovations, and students will become leaders in an ever-evolving musical environment.

This study provides an excellent basis for further research and application of its learnings in the field of piano teaching. Engaging with effective pedagogy and modernizing through technology, such as online classrooms, guarantees the sustainability of music education, and its relevance is maintained all over the planet.

Conflict of interest: The authors declare no conflict of interest.

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