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A Cognitive Linguistic Approach to Piano Sight-Reading Instruction

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ABSTRACT

This study investigates the design, development, and evaluation of a novel instructional module for piano sight-reading, grounded in the principles of Cognitive Linguistics and utilizing the Design and Development Research (DDR) framework. Aiming to address persistent shortcomings in traditional sight-reading pedagogy for children aged 7–11, the research integrates Cognitive Linguistics (CL) concepts—including embodied cognition, schema theory, and metaphorical thinking—with Piaget established developmental and Vygotsky sociocultural educational theories. The DDR process comprised a comprehensive needs analysis involving interviews with piano teachers and surveys with students, informing the module's conceptualization. Iterative module development incorporated expert feedback and pilot testing to ensure theoretical rigor and practical usability. The module was then implemented in an experimental group, with outcomes compared against a control group receiving conventional instruction. Quantitative data from pre- and post-tests indicated statistically significant improvements in sight-reading accuracy and musical understanding among the experimental group, while qualitative feedback highlighted enhanced student engagement and confidence. The resulting teaching module provides educators with a practical teaching tool that can reduce the instructional gaps that often occur in traditional piano lessons.The study demonstrates that a CL-informed, DDR-based approach can substantially improve young learners' sight-reading skills and attitudes. Findings offer theoretical and practical implications for piano pedagogy and support the adoption of interdisciplinary, cognitively informed instructional design in music education.

Keywords: Cognitive Linguistics; Piano Sight-Reading; Embodied Cognition; Music Education

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1. Introduction

1.1. Opening and Problem Statement

Learning the piano is often a starting point for musical study. Its keyboard offers a clear visual layout of notes, and the instrument can play both melodies and harmonies simultaneously, providing a full picture of the music. This makes it a popular choice for developing musical understanding. Among the essential skills piano students should learn, sight-reading — the ability to play music accurately the first time seeing it — is crucial for musical independence[1]. Pianists who can sight-read well can learn new pieces faster, participate more easily in group music-making, and explore a wider variety of musical styles on their own[2].

However, despite its value, sight-reading is often neglected in piano lessons[3]. Many students struggle to develop this skill because instruction can lack a clear, step-by-step approach[4]. Teaching methods passed down over time may not be based on current research about learning and often fail to adequately address the complex thinking skills sight-reading requires[5]. Additionally, asking students to sight-read music that is too difficult for their current level can cause frustration and prevent them from learning effective reading strategies. There appears to be a significant gap between what researchers understand about the mental processes of sight-reading and how it is commonly taught in practice[6]. While studies have identified key cognitive elements like quick note identification, rhythm processing, and hand-eye coordination[7], many piano teachers lack specific, structured methods to help students build these skills effectively.

1.2. Introducing Cognitive Linguistics as a Theoretical Framework

To tackle the ongoing problems with teaching piano sight-reading, this study draws on ideas from Cognitive Linguistics (CL). CL provides a useful way to think about music cognition — simply put, how our minds process, understand, and learn music — particularly when it comes to learning sight-reading. CL differs from some earlier views of thinking, such as early computational models that treated the mind mainly as a system for processing abstract symbols. Instead, CL stresses that meaning and understanding come directly from our physical bodies and how we experience the world around us[8].

Several key ideas from CL are especially relevant to learning music and sight-reading. One is embodied cognition, which suggests that our thinking processes are fundamentally linked to our physical experiences and interactions[9]. For music, this means that physically engaging with the instrument — the feel of the keys, the movements required – is crucial for truly understanding and performing, rather than just mentally decoding notes on a page. Another helpful idea is conceptual metaphor theory[8]. This theory explains how we understand abstract things (like musical pitch) by relating them to more concrete physical experiences (like space — thinking of pitches as "high" or "low"). This kind of metaphorical thinking helps pianists quickly interpret musical notation.

Additionally, schema theory suggests we organize knowledge into mental patterns or 'schemas' based on repeated experiences. In sight-reading, building up these musical schemas — recognizing common rhythmic figures, melodic shapes, and chord patterns — allows for faster and smoother playing. Finally, CL often looks at systems like musical notation as being similar to language[10]. From this viewpoint, learning to sight-read involves understanding music's 'grammar' (how harmony and rhythm work) and 'vocabulary' (common patterns), using mental skills similar to those needed for language learning. This study, therefore, uses CL's insights about embodiment, mental schemas, and metaphorical thinking to explore how sight-reading is learned and how it can be taught more effectively.

1.3. The Design and Development Research (DDR) Framework and Interdisciplinary Approach

To bring the ideas from Cognitive Linguistics into real teaching practice, this study used the Design and Development Research (DDR) approach. DDR is a hands-on way to create and test teaching tools, like sight-reading module, directly in classroom environments[11]. It involves a cycle of planning, building, trying out, and evaluating the module. This structured process helps ensure the module actually addresses the difficulties students face with sight-reading.

Study combined Cognitive Linguistics with proven ideas from music teaching and educational psychology. In

particular, we considered Jean Piaget's work on how children's thinking develops[12]. This helped us match the module's activities to the thinking skills of young learners aged 7–11. We also incorporated Lev Vygotsky's sociocultural theory[13]. His idea of the Zone of Proximal Development (ZPD) shows how important guided help (scaffolding) and learning together can be[14]. So, our module includes features like step-by-step support and group activities to help students learn effectively within their ZPD.

The overall aim was to build a piano sight-reading module that is both well-supported by theory and truly works in practice. We believe blending Cognitive Linguistics, the practical DDR steps, Piaget's developmental insights, and Vygotsky's social learning concepts helps achieve this goal.

1.4. Research Aims and Paper Structure

This research focuses on creating and testing a new way to teach piano sight-reading to young children (ages 7–11). We developed a teaching module using the Design and Development Research (DDR) process. The core ideas behind the module's design come from Cognitive Linguistics, which helps us understand how learners perceive and process musical notation in relation to performing it.

Specifically, the research aims are:

1. To design and build a piano sight-reading teaching module for 7–11 year olds. This module integrates concepts from Cognitive Linguistics alongside relevant ideas from Piaget (on cognitive development) and Vygotsky (on social learning), all structured within the DDR framework.
2. To evaluate whether this new module actually helps young learners improve their piano sight-reading skills in a real classroom. We will compare their progress against students taught using more traditional methods.
3. To analyze how specific concepts from Cognitive Linguistics can offer fresh perspectives on teaching and learning piano sight-reading, suggesting practical applications for music educators.

The remainder of this paper is structured as follows. Section 2 reviews the relevant literature and theoretical underpinnings. Section 3 details the materials and methods employed in the study. Section 4 presents the empirical findings from each research phase. Finally, Section 5 discusses the results, considers the study's implications and limitations, and offers concluding remarks.

2. Materials and Methods

2.1. Research Design

This study employed a Design and Development Research (DDR) framework to develop and evaluate a Cognitive Linguistics-informed instructional module for piano sight-reading. DDR is a cyclical and iterative research approach aimed at creating and refining educational interventions in real-world settings[11]. A mixed-methods approach was integrated within the DDR framework, utilizing both quantitative and qualitative data to comprehensively assess the module's effectiveness and implementation process[15]. Specifically, a quasi-experimental design with a pre-test and post-test control group was adopted to compare the sight-reading improvement of students who received the Cognitive Linguistics-informed instruction (experimental group) with those who received traditional instruction (control group). The selection of DDR was justified by its suitability for developing complex educational interventions that require iterative refinement based on empirical evidence and contextual feedback, aligning perfectly with the goal of creating an effective and practical piano sight-reading module[16].

2.2. Participants

2.2.1. Teacher Participants

Piano teachers were recruited to participate in different phases of the DDR process. For the Needs Analysis phase, a quantitative survey was distributed to 100 piano teachers across Jiangsu Province, China, and qualitative data were gathered from focus group discussions with 5 purposively selected piano experts. During the Design and Development phases, the module was refined based on feedback from a panel of 8 experts in music education, pedagogy, and cognitive psychology. For the main Implementation and Evaluation phase, 5 experienced piano teachers were selected to implement the instructional module with their students. All participating teachers held recognized music qualifications and had a minimum of five years of teaching experience with children aged 7–11. The demographic profile of the five teachers involved in the final implementation is detailed in **Table 1**.

Table 1. Demographic Profile of Teacher Participants.

Variable	Category	Frequency	Percentage
Gender	Male	2	40%
	Female	3	60%
Teaching Experience	1–5 years	2	40%
	6–10 years	1	20%
	11–15 years	1	20%
	16+ years	1	20%
Highest Qualification	Bachelor's Degree	1	20%
	Master's Degree	1	20%
	Doctorate Degree	3	60%

2.2.2. Student Participants

The target student population for this study comprised children aged 7–11 years, identified as beginner to intermediate level piano students from mainland China. Purposive sampling was used to select experienced piano teachers, and from their classes, a total of 60 students participated in the main Evaluation phase. Stratified random sampling was utilized to ensure a representative sample across different age groups and proficiency levels. Participants were randomly assigned to an experimental group (n = 30), which received the Cognitive Linguistics-informed module, or a control group (n = 30), which received traditional piano sight-reading instruction. An additional 20 students participated in a preliminary pilot study during the development phase. The demographic profile of the 60 students in the main study is presented in **Table 2**.

Table 2. Demographic Profile of Student Participants.

Variable	Category	Frequency	Percentage
Gender	Male	36	60%
	Female	24	40%
Age Group	7 years	15	25%
	8 years	12	20%
	9 years	12	20%
	10 years	12	20%
	11 years	9	15%
Skill Level	Beginner	36	60%
	Intermediate	24	40%
	Advanced	0	0%

2.3. Instructional Module Development

2.3.1. Needs Analysis Phase

Before building the module, we first conducted a comprehensive needs analysis to investigate how piano sight-reading is usually taught and where the main difficulties lie. This mixed-methods phase involved a quantitative survey of 100 piano teachers and in-depth focus group discussions with 5 piano pedagogy experts. From these data, several key issues emerged. Teachers consistently reported a lack of systematic, step-by-step methods and noted that instruction often overlooks the cognitive skills required for sight-reading. A strong theme was the desire for engaging, evidence-based resources built on a solid understanding of how children learn music. These specific, empirically identified needs became the essential groundwork for designing our teaching module.

2.3.2. Design and Development Phase

Creating the teaching module was a cyclical effort, moving through the Design, Development, Implementation, and Evaluation stages typical of DDR [11]. Our approach was strongly shaped by Cognitive Linguistics, especially the ideas of embodied cognition (learning through physical experience) and schema theory (building mental shortcuts for recognizing patterns), which we introduced earlie [8].

During the initial Design stage, we put these CL ideas into practice. Rhythm exercises, for instance, used physical movements like clapping or tapping. This helped students connect the abstract idea of time in music to something they could physically feel, reflecting embodied principles.

Schema theory helped us decide the order of topics. We started with basic musical patterns and gradually introduced more complex ones, aiming to help students build up mental frameworks (schemas) for recognizing musical elements quickly during sight-reading.

The next stage, Development, was all about improving the initial design through iterative feedback. We conducted a formal expert review process with a panel of eight specialists in music teaching, cognitive psychology, and piano pedagogy. They examined the module's content, teaching methods, and how well it reflected CL concepts using a detailed questionnaire. We also ran a pilot study with 2 teachers and 20 students to gain practical insights into the module's usability, student engagement, and preliminary effectiveness. We carefully used all this feedback—from the expert review and the pilot test—to make iterative adjustments.

We carefully used all this feedback to make adjustments. We revised the module's content, tweaked activities, and refined how we checked student understanding. Our aim was to create a module that was not only practical and educationally effective but also stayed true to its Cognitive Linguistics roots.

The finished module contained three main units: Rhythm, Melody, and Harmony. These were planned to be taught over 12 weeks, with one 45-minute lesson each week. Every lesson laid out clear learning goals, offered various activities designed to keep students involved, and included ways to track progress.

Crucially, we also wove in ideas from developmental psychology. We made sure the musical tasks were appropriate for the thinking skills of 7-to-11-year-olds[12]. We also applied Vygotsky's theories by including scaffolding techniques (giving support that gradually fades) and setting up collaborative activities[13]. This was designed to help students learn from each other and tackle challenges within their 'Zone of Proximal Development' (ZPD), where they can succeed with guidance[14].The research procedure framework guiding this research is illustrated in **Figure 1**.

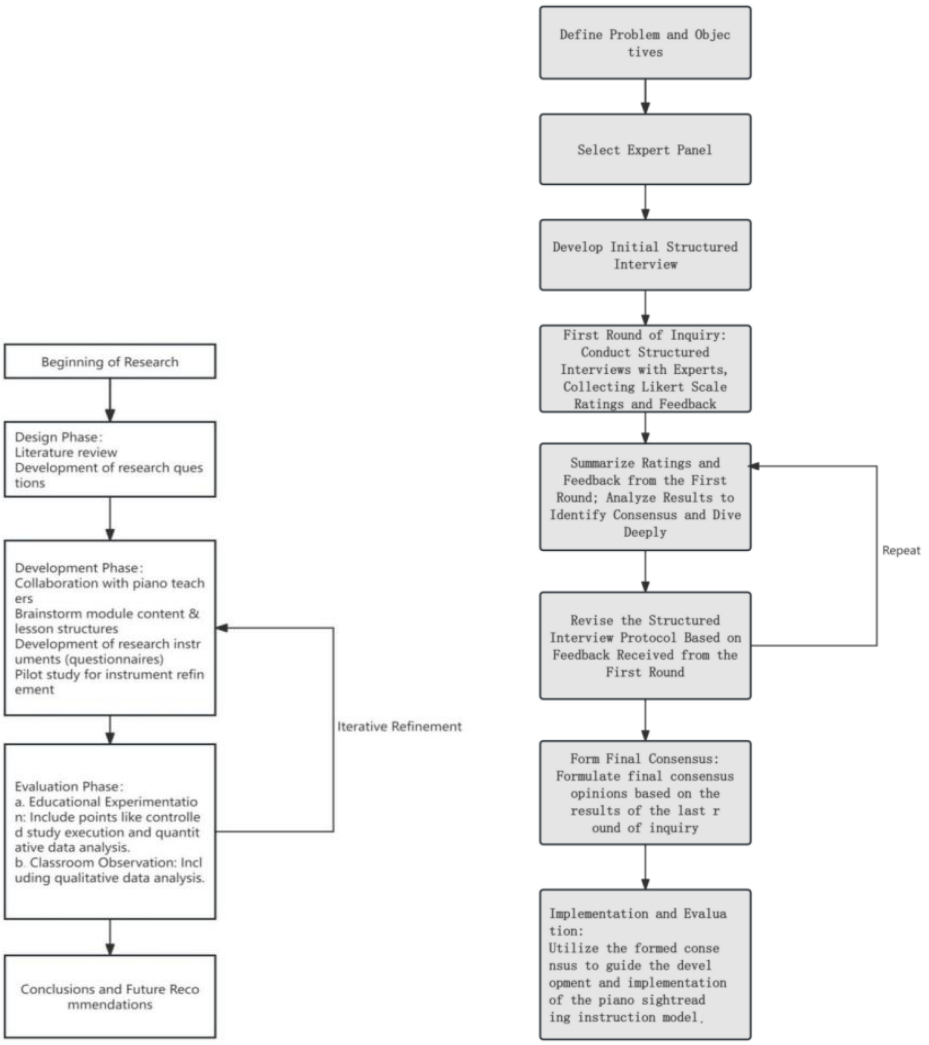
2.4. Data Collection Instruments

Multiple data collection instruments were utilized to gather both quantitative and qualitative data throughout the study. Semi-structured teacher interviews were conducted during the Needs Analysis phase to explore teachers' perspectives on sight-reading instruction and gather qualitative feedback on the module's implementation and effectiveness in the Evaluation phase. Student questionnaires employing Likert scales were administered pre- and post-module to measure changes in students' attitudes towards sight-reading and their self-efficacy in sight-reading. Standardized sight-reading pre-tests and post-tests were used to quantitatively assess students' sight-reading performance before and after the intervention. These tests consisted of graded musical excerpts appropriate for the students' proficiency levels, and scoring was based on a rubric assessing accuracy of rhythm, pitch, and musical expression. Student feedback forms were administered at the end of each unit to collect both qualitative (open-ended questions) and quantitative (Likert scale ratings) data on student engagement, perceived learning, and module usability. Expert review questionnaires, designed for the FDM, were used to gather expert ratings and qualitative comments on the module's design and content. Validity and reliability of the instruments were ensured through several measures. Expert review by music education specialists and Cognitive Linguistics scholars established content and face validity. Pilot testing of instruments with a representative sample of participants ensured clarity and appropriateness. Cronbach's alpha was calculated for Likert-scale questionnaires to assess internal consistency reliability, demonstrating acceptable reliability scores ($\alpha > 0.70$).

2.5. Data Analysis

Both quantitative and qualitative data were analyzed to evaluate the effectiveness of the Cognitive Linguistics-informed instructional module. Quantitative data from pre-tests, post-tests, and student questionnaires were analyzed using descriptive statistics (means, standard deviations) and inferential statistics using SPSS software[17]. Paired samples t-tests were conducted to examine within-group changes in sight-reading scores and student attitudes from pre-test to post-test for both the experimental and control groups. Independent samples t-tests were used to compare post-test scores and attitude changes between the experimental and control groups. A mixed-design ANOVA was employed to analyze the interaction effect of group (experimental vs. control) and time (pre-test vs. post-test) on sight-reading performance. Qualitative data from teacher interviews and open-ended

questions in student feedback forms were analyzed using thematic analysis[18]. This involved a systematic process of coding the data, identifying recurring patterns and themes, and interpreting the meaning of these themes in relation to the research questions[19]. Mixed-methods integration was achieved by triangulating quantitative findings with qualitative insights to provide a more comprehensive and nuanced understanding of the module's impact. For instance, qualitative data from teacher interviews and student feedback forms were used to explain and contextualize the quantitative findings regarding student sight-reading improvement and engagement. This integrated approach allowed for a richer and more robust evaluation of the Cognitive Linguistics-informed instructional module[15].



(**a**) (**b**)

Figure 1. Research Procedure Framework: (**a**)The overall Design and Development Research (DDR) process; (**b**)The Fuzzy Delphi Method (FDM) procedure used for expert review.

3. Results

3.1. Findings from Needs Analysis Phase

The Needs Analysis phase, conducted through semi-structured interviews with ten piano teachers and surveys with 80 students, revealed significant challenges and unmet needs in current piano sight-reading education in Jiangsu Province, China. Teachers consistently reported that sight-reading was a challenging skill for their students to acquire, often leading to frustration and avoidance. A primary concern was the lack of systematic and engaging instructional ma-

terials specifically designed for sight-reading development. Many teachers relied on fragmented approaches, incorporating sight-reading exercises sporadically rather than as a structured component of their curriculum. Furthermore, teachers expressed a desire for pedagogical strategies that moved beyond rote learning and incorporated cognitive approaches to enhance students' understanding of musical structures and patterns relevant to sight-reading. Student surveys corroborated these findings, indicating that students often perceived sight-reading as difficult and unenjoyable, with many feeling unprepared and lacking confidence when faced with new musical scores. Students also expressed a preference for more interactive and game-based learning activities to make sight-reading practice more engaging. These findings highlighted a clear gap between the recognized importance of sight-reading and the effectiveness of current teaching practices, underscoring the need for a more systematic, cognitively informed, and engaging instructional approach, which directly informed the development of the DDR module.

3.2. DDR Module Development and Refinement

The development of the Cognitive Linguistics-informed DDR module was an iterative process, guided by the findings of the Needs Analysis and incorporating expert feedback and pilot testing. The initial design of the module was grounded in Cognitive Linguistics principles, specifically embodied cognition and schema theory. Activities were designed to engage students' embodied experiences of music through movement and physical representations of musical concepts, aiming to make abstract musical notation more concrete and accessible[8]. Schema theory informed the structured progression of the module, starting with fundamental rhythmic and melodic patterns and gradually building towards more complex harmonic structures, facilitating the development of robust musical schemas for efficient sight-reading.

Expert review using the Fuzzy Delphi Method (FDM) involved five experts in music education and Cognitive Linguistics evaluating the module's design and content. Key feedback themes emerging from the FDM process included: (a) strong endorsement of the pedagogical approaches, particularly the integration of Cognitive Linguistics principles and the emphasis on active learning; (b) positive feedback on the practical applicability of the module, noting its clear structure and user-friendly materials; (c) suggestions for further enhancing skill development through more explicit strategy instruction and varied musical examples; and (d) recommendations for refining assessment tasks to better align with learning objectives. Based on this expert feedback, revisions were made to clarify lesson instructions, incorporate more diverse musical examples, and refine assessment rubrics.

The pilot study implementation with ten students and two teachers provided valuable insights into the module's strengths and weaknesses in a real classroom setting. Observed strengths included high student engagement with the interactive activities, positive teacher feedback on the module's structure and clarity, and preliminary indications of improved sight-reading performance. Identified weaknesses included the need for more explicit scaffolding for students struggling with specific rhythmic or melodic patterns and the need for adjustments to the pacing of certain lessons. Based on the pilot study findings, final refinements were made to the module, including incorporating additional scaffolding strategies, adjusting lesson pacing, and providing supplementary materials for differentiated instruction. These iterative development and refinement processes ensured that the final DDR module was not only theoretically grounded in Cognitive Linguistics but also practically effective and user-friendly for both teachers and students.

3.3. Research Phase Results: Experimental Group

3.3.1. Pre-Test Results

Prior to the implementation of the Cognitive Linguistics-informed module, the experimental group (n = 30) completed a standardized sight-reading pre-test to assess their baseline proficiency. Descriptive statistical analysis of the total pre-test scores, presented in **Table 3**, revealed a mean score of 52.77 (SD = 6.29), with scores ranging from 42 to 66 out of a possible 100 points. These baseline scores indicated that the participants exhibited sight-reading skills ranging from beginner to low-intermediate levels. Observed weaknesses in their pre-test performances commonly included rhythmic inaccuracies, challenges in melodic pattern recognition, and a limited degree of musical expressiveness in their sight-reading interpretations. These pre-intervention results established a clear baseline of sight-reading proficiency for the experimental group against which to measure the impact of the subsequent instructional module.

Table 3. Pre-Test scores of participants.

Student ID	Rhythm (25)	Melody (25)	Harmony (25)	Coordination (25)	Total (100)
S1	17	15	18	11	61
S2	15	12	10	12	49
S3	10	13	11	8	42
S4	13	11	10	10	44
S5	14	13	11	12	50
S6	11	12	16	10	49
S7	16	14	12	13	55
S8	12	10	13	15	50
S9	13	12	10	11	46
S10	11	14	11	13	49
S11	12	10	10	11	43
S12	16	15	18	14	63
S13	11	10	13	12	46
S14	15	11	14	11	51
S15	18	14	16	15	63
S16	10	13	13	12	48
S17	16	11	17	10	54
S18	15	12	13	15	55
S19	13	11	15	14	53
S20	15	17	14	14	60
S21	11	10	13	11	45
S22	17	15	16	18	66
S23	13	17	15	14	59
S24	11	16	14	15	56
S25	15	11	13	16	55
S26	11	15	16	14	56
S27	13	15	10	11	49
S28	12	14	14	13	53
S29	16	15	11	14	56
S30	15	14	15	13	57

3.3.2. Unit Feedback Forms

Throughout the implementation of the DDR module, students in the experimental group completed feedback forms after each unit (Rhythm, Melody, Harmony) to provide insights into their learning experiences. Summarized feedback scores indicated generally positive student perceptions across all three units. Throughout the implementation of the DDR module, students in the experimental group completed feedback forms after each unit (Rhythm and Timing, Melodic Recognition, Harmonic Understanding) to provide insights into their learning experiences. Summarized feedback scores, as detailed in **Table 4**, indicated generally positive student perceptions across all three units. Specifically, for Unit 1 (Rhythm and Timing), the average student rating for confidence in rhythmic sight-reading was 4.0 out of 5, enjoyment of the unit activities averaged 4.3, and perceived difficulty was rated 3.2. For Unit 2 (Melodic Recognition), average confidence ratings slightly decreased to 3.9, while enjoyment remained high at 4.1, and perceived difficulty marginally increased to 3.4. Unit 3 (Harmonic Understanding) showed a further slight decrease in average confidence to 3.8, with enjoyment at 4.0, and perceived difficulty increasing to 3.7. Qualitative comments from student feedback forms consistently highlighted students' enjoyment of the interactive and game-based activities, their increased understanding of musical concepts through the embodied activities, and their growing confidence in approaching sight-reading tasks. For example, students frequently mentioned that the rhythmic movement activities helped them "feel the rhythm in their body" and that the melodic pattern recognition exercises made "reading notes easier." These feedback forms provided valuable qualitative data supporting the module's engagement and perceived effectiveness from the students' perspective. Post-Test scores of participants are shown in **Table 5**, summary of unit feedback averages is shown in **Table 6**.

Table 4. Unit 1–3 average feedback scores.

Feedback Category	**Average Rating (1–5)**
Confidence in Reading New Rhythms	4.0
Perceived Progress in Maintaining Steady Tempo	4.3
Enjoyment of Clapping/Tapping Exercises	3.2
Feedback Category	**Average Rating (1–5)**
Confidence in Interval Identification	3.9
Perceived Progress in Maintaining Steady Tempo	4.1
Enjoyment of Clapping/Tapping Exercises	3.5
Feedback Category	**Average Rating (1–5)**
Confidence in Reading New Rhythms	3.8
Perceived Progress in Maintaining Steady Tempo	3.9
Enjoyment of Clapping/Tapping Exercises	3.7

Table 5. Post-Test scores of participants.

Student ID	**Rhythm (25)**	**Melody (25)**	**Harmony (25)**	**Coordination (25)**	**Total (100)**
S1	20	18	17	18	73
S2	22	20	19	20	81
S3	18	16	15	17	66
S4	21	19	18	19	77
S5	23	21	20	21	85
S6	19	17	16	17	69
S7	24	22	21	22	89
S8	20	18	17	18	73
S9	21	19	18	19	77
S10	19	17	16	17	69
S11	18	17	19	21	75
S12	22	24	23	20	89
S13	18	17	14	21	70
S14	21	16	18	14	69
S15	18	20	22	21	81
S16	17	19	17	20	73
S17	21	20	19	19	79
S18	19	17	20	21	77
S19	20	20	21	19	80
S20	19	20	21	18	78
S21	18	17	19	20	74
S22	18	17	19	17	71
S23	20	22	21	20	83
S24	17	18	20	21	76
S25	18	19	17	20	74
S26	20	18	22	23	83
S27	19	21	22	20	82
S28	17	19	18	18	72
S29	20	21	22	20	83
S30	19	20	22	21	82

Table 6. Summary of unit feedback averages.

Unit	**Confidence (1–5)**	**Enjoyment (1–5)**	**Perceived Difficulty (1–5)**
Unit 1 (Rhythm and Timing)	4.0	4.3	3.2
Unit 2 (Melodic Recognition)	3.9	4.1	3.5
Unit 3 (Harmonic Understanding)	3.8	3.9	3.7

3.3.3. Post-Test Results

Following the completion of the DDR module, the experimental group (n = 30) undertook a standardized sight-reading post-test. Descriptive statistics for the post-test scores, as presented in **Table 5**, demonstrated a substantial improvement. The mean post-test score for the experimental group was 78.63 (SD = 6.53), with total scores ranging from 66 to 89 out of a possible 100 points. This represents a significant increase from the pre-test mean score of 52.77, indicating a marked enhancement in sight-reading proficiency after participating in the Cognitive Linguistics-informed instructional module. These elevated post-test scores, in con-

junction with the positive student feedback previously summarized, strongly suggest that the DDR module was demonstrably effective in enhancing the sight-reading abilities of the experimental group.

3.4. Research Phase Results: Control Group and Comparative Analysis

The control group (n = 30), receiving traditional piano instruction, also completed pre- and post-test. The control group's pre-test scores (M = 52.40, SD = 4.30) showed a similar baseline proficiency to the experimental group. However, their post-test improvement was considerably smaller. Descriptive statistics for the post-test scores show a mean score of 60.17 (SD = 4.33), with total scores ranging from 54 to 70. While this indicates some improvement from their pre-test baseline, the magnitude of this improvement is notably less than that observed in the experimental group.The smaller gains in the control group suggest that traditional sight-reading instruction, as implemented in this study, resulted in less substantial progress in sight-reading ability compared to the Cognitive Linguistics-informed DDR module. Pre-Test scores of control group participants are shown in **Table 7**, the Post-Test scores of control group participants are shown in **Table 8**.

Table 7. Pre-Test scores of control group participants.

Student ID	Rhythm (25)	Melody (25)	Harmony (25)	Coordination (25)	Total (100)
C1	12	14	15	11	52
C2	10	11	13	15	49
C3	15	13	12	12	52
C4	12	11	11	14	48
C5	13	12	16	11	52
C6	14	14	13	13	54
C7	13	15	12	10	50
C8	14	11	16	10	51
C9	11	14	15	15	55
C10	13	12	16	13	54
C11	11	12	16	11	50
C12	13	11	12	16	52
C13	14	10	11	13	48
C14	13	17	11	13	54
C15	11	15	13	15	54
C16	12	11	11	15	49
C17	15	13	14	13	55
C18	13	14	12	14	53
C19	14	17	15	15	61
C20	13	11	13	12	49
C21	17	16	14	15	62
C22	13	17	13	15	58
C23	11	13	10	11	45
C24	12	17	16	16	61
C25	10	11	10	13	44
C26	12	13	14	15	54
C27	14	13	10	12	49
C28	15	12	13	12	52
C29	11	14	12	13	50
C30	14	13	13	15	55

Table 8. Post-Test scores of control group participants.

Student ID	Rhythm (25)	Melody (25)	Harmony (25)	Coordination (25)	Total (100)
C1	14	15	16	14	59
C2	13	15	14	13	55
C3	17	15	13	14	59
C4	14	12	14	14	54
C5	15	18	14	18	65
C6	17	16	15	15	63
C7	14	12	16	13	55
C8	15	16	14	16	61
C9	15	13	15	17	60

Table 8. *Cont.*

Student ID	Rhythm (25)	Melody (25)	Harmony (25)	Coordination (25)	Total (100)
C10	15	14	13	14	56
C11	15	13	17	13	58
C12	14	13	14	15	56
C13	16	15	17	18	66
C14	15	13	14	13	55
C15	14	16	14	15	59
C16	16	15	17	17	65
C17	14	17	15	14	60
C18	16	14	13	17	60
C19	18	17	18	15	68
C20	13	15	14	16	58
C21	15	18	17	16	66
C22	17	15	16	17	65
C23	14	14	15	13	56
C24	18	17	18	17	70
C25	13	15	15	14	57
C26	14	17	15	17	63
C27	14	14	13	15	56
C28	16	15	17	13	61
C29	16	14	13	15	58
C30	17	15	16	14	62

4. Discussion

4.1. Effectiveness of the DDR-Based Sight-Reading Module

The primary objective of this research was to design, develop, and rigorously evaluate the effectiveness of a novel instructional module for piano sight-reading, grounded in the Design and Development Research (DDR) framework and informed by principles of Cognitive Linguistics. The findings, comprehensively presented in sction 3, offer compelling and convergent evidence supporting the efficacy of the DDR-based sight-reading module in significantly enhancing the sight-reading abilities of young piano learners. This section will delve into a detailed discussion of these findings, examining both the quantitative and qualitative data to provide a nuanced understanding of the module's impact and its demonstrable advantages over traditional instructional approaches.

4.1.1. Quantitative Evidence of Effectiveness

The quantitative data derived from the pre-test and post-test assessments provide robust statistical evidence for the effectiveness of the DDR-based sight-reading module. A paired samples t-test analysis revealed a statistically significant improvement in sight-reading scores within the experimental group. Specifically, the mean post-test score for the experimental group (M = 78.63, SD = 6.53) was substantially and significantly higher than their mean pre-test score (M = 52.77, SD = 6.29), with $t(29) = -19.73$, $p < 0.001$. This substantial increase, representing an average gain of over 25 points, underscores the practical significance of the module's impact.

Furthermore, an independent samples t-test revealed a statistically significant difference in post-test scores between the two groups, with the experimental group exhibiting significantly higher scores (M = 78.63, SD = 6.53) compared to the control group (M = 60.17, SD = 4.33), with $t(50.40) = -12.91$, $p < 0.001$.

This statistically significant between-group difference unequivocally establishes the superior effectiveness of the DDR-based sight-reading module in enhancing sight-reading ability when compared to traditional piano teaching methodologies that do not incorporate explicit and systematic sight-reading training. Moreover, a mixed-design ANOVA, examining the interaction effect between group (experimental vs. control) and time (pre-test vs. post-test), further corroborated these findings. The significant interaction effect indicated that the experimental group demonstrated a significantly greater gain in sight-reading scores from pre-test to post-test compared to the control group, reinforcing the unique contribution of the DDR module to sight-reading development.

These quantitative findings are not only statistically robust but also align with and extend the existing body of research in music education. Prior studies have consistently emphasized the critical role of structured and systematic

approaches in the development of effective sight-reading skills[20]. The DDR-based module, with its carefully sequenced units focusing on rhythm, melody, and harmony, and its incorporation of spaced repetition and immediate feedback, embodies these principles of structured instruction. Furthermore, the demonstrable success of the DDR framework in this study resonates with broader research highlighting the efficacy of DDR methodologies in developing and refining educational interventions across diverse domains. The quantitative evidence, therefore, firmly establishes the DDR-based sight-reading module as a demonstrably effective and significantly superior approach to fostering piano sight-reading ability in young learners compared to traditional methods.

4.1.2. Qualitative Evidence and Student Perceptions

While the quantitative data provides compelling statistical evidence of the DDR module's effectiveness, the qualitative data, derived from student feedback forms administered after each unit, offers invaluable insights into the students' subjective experiences, perceptions of their learning, and engagement with the module.

A consistent theme emerging from the student feedback was the high level of enjoyment and engagement experienced throughout the DDR module. The average enjoyment ratings consistently exceeded 4.0 on a 5-point Likert scale across all three units (Rhythm, Melody, and Harmony). This consistently high level of enjoyment is further substantiated by qualitative comments from the feedback forms. For example, in response to questions about their favorite activities in the Rhythm unit, students frequently mentioned the clapping and tapping exercises, with comments such as, "I really liked clapping the rhythms, it was like a game!" and "Tapping with the metronome was fun, it made me feel like a real musician!". Similarly, in the Melody unit, students expressed enthusiasm for the interval training exercises and melodic pattern recognition tasks, with comments like, "Finding the intervals was like solving a puzzle, it was really interesting" and "I liked singing the melodies before playing them, it helped me hear the music in my head". Even in the more challenging Harmony unit, students reported positive engagement with the chord-based activities, with comments such as, "Learning about chords was hard, but it was also really cool to see how they fit together" and "Playing the chord progressions made me feel like I was playing real music".

These qualitative comments vividly illustrate that the DDR module successfully fostered a positive and engaging learning environment, effectively addressing a key challenge identified in the Needs Analysis phase – namely, the issue of student motivation and engagement in sight-reading practice. The incorporation of gamified elements, interactive activities, and varied instructional strategies within the module appears to have significantly enhanced student interest and active participation, transforming sight-reading practice from a potentially tedious task into an enjoyable and stimulating learning experience.

Furthermore, student feedback consistently indicated a perceived sense of progress and increased confidence in their sight-reading abilities as they progressed through the DDR module. While average confidence ratings showed a slight decrease across the units, likely reflecting the increasing complexity of the musical concepts introduced, they remained consistently above 3.8, indicating a generally positive and improving sense of self-efficacy. Qualitative comments further illuminate this perceived progress and growing confidence. In the Rhythm unit feedback, students noted, "I feel much better at keeping a steady beat now" and "I can read rhythms much faster than before". In the Melody unit, comments included, "I can recognize intervals much easier now" and "Reading melodies is not as scary as it used to be". And in the Harmony unit, students reported, "I am starting to understand chords better" and "I feel more confident about reading music with chords now".

These qualitative expressions of perceived progress and increased confidence are particularly significant, as they suggest that the DDR module not only improved students' objective sight-reading skills, as evidenced by the quantitative data, but also positively impacted their self-perceptions and attitudes towards sight-reading. The module appears to have effectively demystified the process of sight-reading, making it feel less daunting and more achievable for young learners. This reduction in anxiety and increase in confidence is a crucial outcome, as it can foster a more positive and proactive approach to music learning in general and encourage students to engage more willingly with new and challenging musical material. In conclusion, the qualitative evidence, in conjunction with the robust quantitative findings, provides a comprehensive and compelling picture of the

DDR-based sight-reading module as a highly effective and engaging instructional approach that demonstrably enhances piano sight-reading ability and fosters positive learning experiences in young students.

4.2. Cognitive Linguistics Interpretation of Findings

The demonstrable effectiveness of the DDR-based sight-reading module, as evidenced by both quantitative and qualitative data, gains deeper resonance and theoretical grounding when interpreted through the framework of Cognitive Linguistics. Cognitive Linguistics, with its central tenets of embodied cognition, experiential grounding of meaning, and the conceptualization of language as a dynamic cognitive system, provides a powerful lens through which to understand the mechanisms underlying the module's success. This section will explore the study's findings through several key Cognitive Linguistics perspectives, illuminating how the module's design principles effectively leveraged cognitive processes to enhance piano sight-reading ability.

4.2.1. Music Sight-Reading as Language Learning through Cognitive Linguistics Lens

A foundational premise within Cognitive Linguistics is the understanding of language not as a purely abstract, rule-based system, but as an embodied and experiential phenomenon deeply rooted in human cognition [8,10]. From this perspective, learning music notation and sight-reading can be fruitfully conceptualized as analogous to learning a new language. Just as spoken and written languages are symbolic systems for representing and communicating meaning, musical notation serves as a symbolic system for representing and communicating musical ideas, emotions, and structures. This analogy is not merely metaphorical; Cognitive Linguistics posits that the cognitive mechanisms underlying language processing and music processing share significant overlap, both drawing upon fundamental cognitive capacities such as pattern recognition, categorization, and schema formation [21].

The DDR module, informed by this Cognitive Linguistics perspective, was intentionally designed to facilitate the "language acquisition" process of music sight-reading by explicitly addressing the "grammar" and "vocabulary" of musical notation. In this context, the "grammar" of music can be understood as the underlying structural principles and organizational rules that govern musical syntax. This encompasses elements such as rhythm, meter, harmony, and form – the rules that dictate how musical elements are combined and structured to create coherent musical expressions. The DDR module directly addressed these grammatical aspects through dedicated units on rhythm and harmony. The Rhythm unit systematically introduced rhythmic patterns, time signatures, and rhythmic notation, providing students with a foundational understanding of musical time and its representation in notation. The Harmony unit, similarly, focused on chord structures, harmonic progressions, and harmonic analysis, equipping students with the grammatical tools to understand the underlying harmonic framework of musical pieces. By explicitly teaching these "grammatical" elements, the module aimed to move students beyond simply decoding individual notes and towards understanding the structural logic and organizational principles of musical notation.

The "vocabulary" of music, in this analogy, can be seen as the recurring musical patterns, melodic contours, harmonic idioms, and stylistic conventions that constitute the building blocks of musical expression. This "vocabulary" includes melodic intervals, scales, arpeggios, chord voicings, and common musical phrases – the recurring units of musical meaning that composers utilize to create musical works. The DDR module's Melody unit was specifically designed to build this musical "vocabulary." Through interval training exercises, melodic pattern recognition tasks, and exposure to diverse melodic examples, the module aimed to develop students' ability to recognize and decode common melodic patterns and units of musical meaning. By focusing on both melodic and harmonic "vocabulary," the module aimed to equip students with the building blocks necessary to fluently "read" and interpret musical scores.

By explicitly focusing on both the "grammar" and "vocabulary" of music notation, the DDR module facilitated a more holistic and meaningful approach to sight-reading instruction. Instead of treating sight-reading as a purely perceptual-motor skill of decoding individual notes, the module encouraged students to engage with music notation as a meaningful symbolic system, akin to a language. This approach aligns with Cognitive Linguistics' emphasis on understanding language as a system of meaningful patterns and schemas, rather than a mere collection of isolated sym-

bols. The improved sight-reading performance observed in the experimental group can be attributed, in part, to their developing ability to "read" music as a meaningful language, to recognize musical patterns and structures, and to anticipate musical events based on their developing understanding of musical "grammar" and "vocabulary." This Cognitive Linguistics-informed approach, therefore, provides a robust theoretical framework for understanding the module's effectiveness in enhancing piano sight-reading ability by fostering a deeper, more structural understanding of musical notation as a language.

4.2.2. Embodied Cognition and Movement-Based Activities

A cornerstone of Cognitive Linguistics, and particularly relevant to the design of the DDR module, is the theory of embodied cognition. Embodied cognition challenges the traditional Cartesian dualism that separates mind and body, arguing instead that cognition is fundamentally shaped by bodily experience, sensorimotor interactions with the environment, and the physical constraints of the human body. From this perspective, abstract concepts are not simply disembodied mental representations, but are grounded in and shaped by our bodily experiences and sensorimotor schemas. In the context of music learning, embodied cognition suggests that musical understanding is not solely a cognitive or intellectual process, but is deeply intertwined with our bodily engagement with music, including movement, gesture, and sensory experiences [22,23].

The DDR module strategically incorporated movement-based activities throughout its units, explicitly aligning with the principles of embodied cognition. Activities such as clapping rhythms, tapping beats, conducting time signatures, and stepping intervals were intentionally integrated to help students internalize abstract musical concepts by grounding them in concrete physical and sensory experiences. Rhythmic concepts, often perceived as abstract and challenging for young learners, were made more tangible and accessible through physical actions like clapping and tapping. These activities allowed students to experience rhythm not just as a visual notation on the page, but as a felt, embodied experience, engaging their kinesthetic and tactile senses. Similarly, melodic intervals, representing abstract pitch relationships, were embodied through stepping exercises, allowing students to physically "feel" the distance between notes in a spatial and proprioceptive manner. Conducting patterns for different time signatures engaged students' whole bodies in representing the metric structure of music, further embodying abstract musical concepts through movement.

The positive student feedback regarding the effectiveness and enjoyment of these movement-based activities provides empirical support for the embodied cognition approach. Students frequently commented on their enjoyment of the clapping and tapping exercises in the Rhythm unit, with comments such as "rhythmic movement activities helped me feel the rhythm in my body" and "clapping made rhythm easier to understand". These comments directly reflect the principles of embodied cognition, indicating that the movement-based activities facilitated a deeper, more intuitive understanding of rhythmic concepts by engaging students' sensorimotor systems and creating embodied representations of musical structures. By grounding abstract musical notation in concrete bodily experiences, the DDR module made sight-reading more meaningful and accessible, contributing to improved learning outcomes. This finding aligns with a growing body of research in music cognition and education that emphasizes the importance of embodied learning and sensorimotor engagement in musical skill acquisition. The success of the movement-based activities in the DDR module underscores the pedagogical value of incorporating embodied learning principles into music education, particularly in the domain of sight-reading, where abstract notation needs to be connected to concrete musical experience.

4.2.3. Schema Theory and Development of Musical Schemas

Another central concept within Cognitive Linguistics that provides a valuable framework for interpreting the findings of this study is schema theory. Schema theory posits that knowledge is organized in the mind in the form of schemas, which are structured mental frameworks or knowledge packages representing typical concepts, situations, or events [24]. Schemas are not static representations, but are dynamic and flexible cognitive structures that are constantly being refined and updated based on experience. In the context of music, musical schemas represent our organized knowledge of musical patterns, structures, and conventions, including rhythmic patterns, melodic contours, harmonic progressions, and musical forms [25]. These schemas enable us to efficiently process, interpret, and anticipate musical information, play-

ing a crucial role in musical perception, comprehension, and performance.

The DDR module was explicitly designed to facilitate the development of musical schemas for rhythm, melody, and harmony. The structured and progressive nature of the module, moving from simpler to more complex musical patterns and structures, was intentionally sequenced to support the gradual building and refinement of these schemas. The Rhythm unit, for example, focused on establishing schemas for basic rhythmic patterns, time signatures, and rhythmic notation. By repeatedly exposing students to common rhythmic patterns and providing opportunities to practice recognizing and performing them, the module aimed to help students develop robust rhythmic schemas. The Melody unit built upon these rhythmic schemas and introduced melodic schemas for intervals, melodic contours, and melodic phrases. Interval training exercises, melodic dictation tasks, and melodic pattern recognition activities were designed to help students develop schemas for recognizing and processing melodic units. The Harmony unit further expanded these schemas to encompass chord structures, harmonic progressions, and harmonic functions. Chord identification exercises, harmonic analysis tasks, and chord progression practice aimed to facilitate the development of harmonic schemas.

The improved sight-reading performance observed in the experimental group can be interpreted as reflecting the acquisition and application of these musical schemas. As students progressed through the module, they developed increasingly sophisticated schemas for recognizing and processing musical patterns in notation. These schemas enabled them to efficiently decode musical scores, anticipate upcoming musical events, and perform sight-reading tasks with greater fluency and accuracy. For instance, once students developed a robust schema for common chord progressions like I-IV-V-I, they could more readily recognize and perform these progressions in sight-reading, rather than having to decode each chord individually in isolation. Similarly, developing schemas for common melodic intervals and patterns allowed students to chunk melodic information and process melodic lines more efficiently. The DDR module's emphasis on pattern recognition, schema development, and structured progression, therefore, aligns directly with Cognitive Linguistics principles and provides a compelling theoretical framework for understanding the observed improvements in sight-reading ability. This finding is consistent with extensive research in cognitive psychology and music education that highlights the critical role of schema development in expertise and skill acquisition across various domains, including music.

4.2.4. Conceptual Metaphor

While not explicitly a central design feature of the DDR module or a primary focus of the study's methodology, the Cognitive Linguistics concept of conceptual metaphor warrants brief consideration in the context of music learning and teaching. Conceptual metaphors are systematic mappings from one conceptual domain (the source domain) to another (the target domain), allowing us to understand abstract or less familiar concepts in terms of more concrete, embodied, and familiar ones [8]. Conceptual metaphors are pervasive in language and thought, shaping how we conceptualize and reason about the world. In music, numerous conceptual metaphors are deeply ingrained in our language and musical understanding, including "high" notes being spatially "up" and "low" notes being spatially "down" (the pitch-height metaphor), musical phrases being understood as "journeys" with beginnings, middles, and ends (the music-as-motion metaphor), and musical tension and release being conceptualized in terms of physical tension and release (the affect-as-force metaphor).

While the DDR module did not explicitly leverage conceptual metaphors in its instructional design, it is plausible that these implicit metaphorical mappings contribute to students' understanding of musical notation and structure. For example, the spatial metaphor of "high" and "low" pitches, deeply embedded in Western musical notation and language, likely facilitates students' understanding of pitch relationships on the musical staff. The visual representation of notes on the staff, with higher pitches positioned higher on the page, directly reflects this spatial metaphor. Similarly, the understanding of musical phrases as having directionality and contour, potentially influenced by the music-as-motion metaphor, may contribute to students' ability to anticipate melodic shapes and phrase structures in sight-reading.

Future research could explore the explicit use of conceptual metaphors in music education and investigate their potential to enhance sight-reading instruction. Instructional materials could be designed to explicitly draw upon and leverage common musical metaphors to make abstract musical

concepts more accessible and intuitive for learners. For instance, teachers could use spatial language to describe pitch relationships, motion verbs to describe melodic contours, and force dynamics to describe musical tension and release. Further investigation into the role of conceptual metaphor in music learning could provide valuable insights for refining pedagogical approaches and enhancing students' musical understanding and sight-reading abilities. While the current study did not directly investigate this aspect, it represents a promising direction for future research within the Cognitive Linguistics framework applied to music education.

4.3. Integration of Piaget and Vygotsky's Theories

The design of the DDR module also incorporated principles from Piaget's theory of cognitive development and Vygotsky's sociocultural theory, providing a broader developmental and sociocultural context for understanding the module's effectiveness.

4.3.1. Piaget's Cognitive Development Theory

Piaget's theory of cognitive development posits that children progress through distinct stages of cognitive development, each characterized by different modes of thinking. The DDR module's design aligned with Piaget's stages, particularly for the target age group of 7–11 years, who are typically in the concrete operational stage. During this stage, children develop logical thinking skills and can perform concrete operations, such as classification and seriation, but still struggle with abstract concepts. The module's progression from concrete operations (rhythm, simple melodies) to more abstract concepts (harmony, modulations) was designed to be developmentally appropriate for this age group. The Rhythm unit, focusing on concrete rhythmic patterns and physical activities like clapping and tapping, provided a foundation in concrete operations. The Melody unit built upon this foundation, introducing melodic intervals and patterns that are still relatively concrete. The Harmony unit, introducing more abstract concepts like chord structures and modulations, was sequenced later in the module, allowing students to gradually transition to more abstract musical thinking. By aligning the module's content and activities with the cognitive capabilities of children in the concrete operational stage, the DDR module ensured developmental appropriateness, contributing to its effectiveness in facilitating sight-reading skill acquisition.

4.3.2. Vygotsky's Sociocultural Theory

Vygotsky's sociocultural theory emphasizes the role of social interaction and cultural context in cognitive development, particularly through the concept of the Zone of Proximal Development (ZPD). The DDR module incorporated Vygotsky's principles of scaffolding and social learning by emphasizing teacher guidance, peer interaction, and collaborative activities. Teacher guidance was integral to the module, with teachers providing demonstrations, explanations, and feedback to support students' learning within their ZPDs. Peer interaction was facilitated through activities like the "Rhythm Detective" pairs exercise and collaborative sight-reading tasks, allowing students to learn from each other and scaffold each other's learning within their respective ZPDs. Student feedback highlighted the effectiveness of peer learning and teacher support, indicating that these sociocultural elements of the module contributed to its success. By creating a socially supportive and interactive learning environment, the DDR module facilitated learning within the ZPD, enabling students to achieve more than they could independently and fostering their sight-reading development. This integration of Vygotsky's sociocultural principles, alongside Piaget's developmental considerations and Cognitive Linguistics principles, contributed to the holistic and effective design of the DDR-based sight-reading module.

5. Conclusions

5.1. Summary of Key Findings

This study embarked on an interdisciplinary endeavor to design, develop, and evaluate a novel piano sight-reading instructional module grounded in the Design and Development Research (DDR) framework and informed by the theoretical principles of Cognitive Linguistics. The empirical findings, meticulously detailed in the preceding sections, unequivocally demonstrate the effectiveness of the DDR-based sight-reading module in significantly enhancing piano sight-reading skills among young learners. Quantitative analyses revealed statistically significant improvements in sight-reading scores for students who received instruction through the module compared to both their pre-intervention

performance and a control group receiving traditional instruction. Furthermore, qualitative data, gathered through student feedback, highlighted the module's success in fostering student engagement, enjoyment, and a perceived increase in confidence and reduced anxiety related to sight-reading. Beyond the demonstrable practical efficacy of the module, the study also underscores the significant value of Cognitive Linguistics as a robust theoretical framework for understanding and enhancing music learning processes. The integration of Cognitive Linguistics principles within the DDR framework, complemented by considerations from Piaget's cognitive development theory and Vygotsky's sociocultural theory, provided a holistic and effective approach to music education, demonstrating the synergistic potential of these interdisciplinary perspectives.

5.2. Strengths and Limitations of the DDR Framework and Study

The DDR framework and the study itself possess both notable strengths and inherent limitations that should be considered when interpreting the findings and considering future research.

5.2.1. Strengths of the DDR Framework

The Design and Development Research (DDR) framework proved to be a particularly valuable methodology for this study. Its systematic and iterative nature allowed for the development and refinement of the instructional module through multiple cycles of design, development, implementation, and evaluation. This iterative process, incorporating expert feedback through the Fuzzy Delphi Method and pilot testing in real classroom settings, ensured that the final module was not only theoretically grounded but also practically applicable and user-friendly. The DDR framework's emphasis on real-world relevance and practical applicability is a significant strength, as it ensures that the developed intervention is designed to address authentic educational needs and challenges. Furthermore, the mixed-methods evaluation approach, integral to DDR, provided a comprehensive understanding of the module's effectiveness, combining quantitative measures of student performance with qualitative insights into student perceptions and learning experiences. This mixed-methods approach allowed for a richer and more nuanced evaluation than would have been possible with a purely quantitative or qualitative approach alone. The DDR framework, therefore, provided a robust and systematic methodology for developing and evaluating the Cognitive Linguistics-informed sight-reading module, contributing to the rigor and validity of the study's findings.

5.2.2. Limitations of the Study

Despite its strengths, this study also has limitations that should be acknowledged. One limitation is the sample size. While 60 student participants in the evaluation phase is a reasonable sample size for a classroom-based intervention study, a larger sample size could have increased the statistical power and generalizability of the quantitative findings. The specific population of Chinese students aged 7-11 also limits the generalizability of the findings to other cultural contexts and age groups. While the principles of Cognitive Linguistics and developmental theories are likely to be broadly applicable, cultural and age-related factors may influence the effectiveness of specific instructional strategies. The duration of the intervention, three weeks, is another limitation. While significant improvements were observed within this timeframe, a longer-term longitudinal study would be needed to assess the sustained impact of the DDR module on students' sight-reading abilities and musical development over time. Finally, the potential for teacher bias or Hawthorne effect cannot be entirely ruled out. Teachers in the experimental group were aware of the study's purpose and may have inadvertently influenced student outcomes through their enthusiasm or expectations. The Hawthorne effect, where participants' behavior changes simply due to being observed, could also have played a role. Future research could address these limitations by employing larger and more diverse samples, conducting longitudinal studies, and incorporating more rigorous controls to minimize potential biases.

5.3. Implications for Music Education and Future Research

The findings of this study have significant implications for music education, particularly piano pedagogy, and suggest several promising directions for future research.

5.3.1. Practical Implications for Piano Pedagogy

The practical implications of this study for piano teachers and music educators are substantial. The findings strongly

advocate for the adoption of Cognitive Linguistics-informed, systematic sight-reading instruction methods, such as the DDR module developed in this study[26]. Traditional piano teaching methods, often relying on rote learning and incidental sight-reading practice, may not be sufficient to develop fluent and confident sight-readers. The DDR module provides a practical and effective alternative, offering a structured and engaging approach to sight-reading instruction that is grounded in cognitive and developmental principles. Piano teachers are encouraged to incorporate embodied cognition principles, schema development strategies, and social learning activities into their sight-reading pedagogy. Movement-based activities, pattern recognition exercises, and collaborative learning tasks can enhance student engagement, understanding, and skill acquisition. The DDR module, or adaptations of it, can serve as a valuable resource for piano teachers seeking to improve their students' sight-reading abilities in a systematic and student-centered manner. Furthermore, the study highlights the importance of ongoing professional development for music educators, equipping them with the knowledge and skills to implement innovative, research-based pedagogical approaches like the Cognitive Linguistics-informed DDR module.

5.3.2. Future Research Directions

This study opens up several promising avenues for future research. Longitudinal studies are needed to assess the long-term impact of the DDR module on students' sight-reading abilities, musical development, and overall musical engagement. Such studies could track students' progress over several years to determine the sustained benefits of early, systematic sight-reading instruction. Applying the DDR-Cognitive Linguistics approach to other musical instruments and age groups is another fruitful direction for future research. The principles of embodied cognition, schema development, and social learning are likely to be applicable across various musical instruments and learner populations. Adapting and evaluating the DDR module for instruments other than piano, and for older or younger learners, could broaden its impact and applicability. Further exploration of specific Cognitive Linguistics concepts in sight-reading education is also warranted[27]. For example, future research could investigate the explicit use of conceptual metaphors in music instruction and their potential to enhance understanding and skill acquisition. Finally, investigating the role of technology in enhancing DDR-Cognitive Linguistics based sight-reading instruction is a timely and relevant direction for future research. Technology-enhanced learning tools, providing real-time feedback, adaptive learning pathways, and gamified practice environments, could further amplify the effectiveness and engagement of Cognitive Linguistics-informed sight-reading instruction. Exploring the integration of such technologies with the DDR framework could lead to even more innovative and impactful pedagogical approaches in music education.

5.4. Contribution to the Field

This research makes several notable contributions to the fields of music education and linguistic studies. Firstly, it presents a novel interdisciplinary approach by explicitly combining Cognitive Linguistics theory with established music pedagogy practices within a rigorous DDR framework. This integration offers a fresh perspective on music learning, viewing it through the lens of embodied cognition, schema development, and language-like cognitive processes as described by Cognitive Linguistics. Secondly, the study provides empirical evidence supporting the effectiveness of a Cognitive Linguistics-informed DDR module for piano sight-reading instruction. The statistically significant improvements in sight-reading skills, coupled with positive student perceptions, offer tangible validation for the application of Cognitive Linguistics principles in practical music education settings. Thirdly, the research contributes theoretical insights into the application of Cognitive Linguistics to music learning more broadly. By demonstrating how concepts such as embodied cognition, schema theory, and conceptual metaphor can illuminate the processes of music skill acquisition, this study paves the way for further exploration of Cognitive Linguistics in diverse areas of music education and research.

5.5. Final Statement and Future Outlook

In conclusion, this study firmly establishes the profound relevance of Cognitive Linguistics for understanding and ultimately improving music education. By conceptualizing music learning as a cognitive and embodied process akin to language acquisition, Cognitive Linguistics offers valuable insights into how instructional design can be optimized to

facilitate skill development and enhance musical understanding. The DDR-Cognitive Linguistics model, as exemplified by the sight-reading module developed and evaluated in this research, holds significant potential for transforming piano sight-reading instruction and fostering enhanced musical literacy among young learners. Looking forward, the continued development and application of interdisciplinary approaches, integrating Cognitive Linguistics with other relevant fields such as neuroscience, educational psychology, and technology, promises to unlock further innovations in music education and contribute to a richer and more effective musical learning experience for all. The future of music education lies, in part, in embracing the interdisciplinary insights offered by fields like Cognitive Linguistics to create more cognitively informed and pedagogically sound instructional practices.

Author Contributions

Conceptualization, R.R. and N.M.N.; methodology, R.R.; validation, R.R., N.M.N. and M.S.A.; formal analysis, R.R.; investigation, R.R.; resources, N.M.N. and M.S.A.; data curation, R.R.; writing—original draft preparation, R.R.; writing—review and editing, R.R., N.M.N. and M.S.A.; visualization, R.R.; supervision, N.M.N. and M.S.A.; project administration, N.M.N. and M.S.A. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

Ethical review and approval were waived for this study due to the research involving standard educational practices and instructional strategies within a conventional learning environment. The procedures posed no more than minimal risk to the participants, and informed consent was obtained from the legal guardians of all participants prior to the study.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study. Written informed consent has been obtained from the legal guardian(s) of all participants to publish this paper.

Data Availability Statement

The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy and ethical restrictions.

Conflicts of Interest

The authors declare no conflict of interest.

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