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The Effect of Spatial Intelligence in the Cultivation Process of Children's Piano Sight-Reading Ability (A Pilot Study)

YaNan Hao[1] & Jinky Jane C. Simeon[2]
[1]Academy of Arts and Creative Technology University Malaysia Sabah Jalan UMS, 88400 Kota Kinabalu, Sabah, Shenyang Conservatory of Music,China, [2]Academy of Arts and Creative Technology University Malaysia Sabah, Jalan UMS, 88400 Kota Kinabalu, Sabah
Email: haoyanan@lxlphdsss.cn
Crossponding Author Email: jinkysoo@ums.edu.my

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Abstract

This pilot study aimed to investigate the effectiveness of special training programs based on spatial intelligence theory for improving piano skills in children. The study involved 30 subjects aged 8 – 10 years (n=30), who were divided into experimental and control groups. Both groups used the "Pentagram Teacher" software as an evaluation tool for pre-test and post-test. The experimental group received a 1-month training period designed according to the theory of spatial intelligence.Using t-test (all known as independent samples t-test) to study the difference between Group for Pre-test, Post-test total 2 items, different Group samples for Pre-test all show consistency and there is no difference. The other Group samples show significance ($p<0.05$) for Post-test total 1 item, which means that different Group samples have differences for Post-test. By analyzing the experimental results, there is a positive correlation between the improvement of children's piano visual player ability and the visual player training designed based on the spatial intelligence theory.

Keywords: Sight-Reading, Spatial Intelligence, Affection

Introduction

The term we see used in the vast majority of articles to represent "sight-reading" is "sight-reading", which is a broad term that covers all exercises that involve reading music from the first perspective, including sight-reading, sight-singing, and sight-playing, and the term "sight-playing" specifically refers to " instrumental sight-reading" (Udtaisuk, 2005). Most experts in instrumental performance, music education or artistic research generally agree that sight reading is extremely important in musical activities. Of all the musical talents, sight-reading is one of the most fundamental performance skills that all musicians should master (Spillman, 1990; Crozier, 2000) and an essential skill that all musicians wish to possess.James Lyke (1968) designed a questionnaire inviting piano teachers and music education teachers to rank the importance of 20 keyboard skills. Both groups of teachers agreed that the first importance was sight-reading, the second was coordination, the third was sight-singing, followed by transposition, improvisation, technical development, critical listening, accompaniment and progression.

The Necessity and Complexity of Sight-Reading

Among the sight-reading skills of musical instruments, the piano is more difficult and representative because piano players need to read two lines of music (Wolf, 1976). For pianists, the need for distraction increases when they focus on the notes because they have two lines of notes to read, whereas wind, brass and string instruments have only one line of notes (Bean, 1938; Gudmundsdottir, 2010b). Whilst wind, brass and string instruments still require both hands to play, for the pianist, both hands play, and each hand can play the instrument differently from the other, unlike the flute, which is confined to a specific fingering pattern. In the case of two phrases, the two hands are independent and unified, with one hand being the main melody and the other the accompaniment; or both hands being the main melody.

Because piano sight-reading is so difficult, not all pianists have excellent sight-reading ability, and some talented musical performers have poor sight-reading ability.Ericsson and Lyman (1994) have documented the wide variation in sight-reading ability among professional pianists with extensive musical experience. Musicians with poor sight-reading ability can become excellent performers with careful rehearsal and excellent finger technique and expressiveness, and they often want to find good ways to improve their sight-reading ability.Therefore, for children learning to play the piano, in addition to training their finger skills, sight-reading ability is also an important element that should be developed during the learning process. Many attempts have been made by musicians and psychologists to improve sight-reading ability, including brain nerves, vision and hearing, eye-hand span, cognitive psychology, information processing, and many other aspects.

The Purpose of the Study

The level of sight-reading ability determines whether children's piano learning is lasting and effective to some extent.Therefore, children's piano learning should have a better sight-reading ability.Most piano educators tend to structure their students' courses entirely around the content of existing piano textbooks. Possibly due to limited time, they mainly focus on improving students' playing skills while neglecting the cultivation of sight-reading ability.Teaching methods that focus solely on students' playing skills usually result in many students having proficient finger techniques but lacking excellent sight-reading abilities. For students who are unfamiliar with the staff notation or have difficulty recognizing musical symbols, their confidence may gradually diminish. Rubinstein (2022) criticized the piecemeal learning habit, which involves absorbing individual elements separately rather than understanding them as part of a whole. For instance, it described how some students view a series of notes merely as notes on paper, without considering other identifying factors such as structure, pattern, or finger technique.Ineffective learning skills, slow learning progress, and negative experiences of failure may lead to quitting instrument learning (McPherson, Davidson, and Faulkner, 2012). Especially for children learning the piano, the level of sight-reading ability has largely become the key factor determining whether they can persist in learning the piano.Therefore, this study tries to use special visual reading training to cultivate children's reading ability and master the skills of sight- reading, that is, to have the foundation of music learning, which is the key and the essence of music learning, just like learning words and language. The materials used for training are formed according to the theory of spatial intelligence as the basis of design, aiming to improve children's piano visual reading level through targeted training content.

Theoretical Principle

Howard Gardner, a professor of psychology at Harvard University in the United States, proposed the theory of Multiple Intelligences, which categorises the intellectual abilities and potentials possessed by human beings, and proposes seven main categories of abilities, which he calls "intelligence" (Gardner, 1993). He defined intelligence as "an ability to process certain kinds of information - it has its origins in human biology and human psychology" (Gardner, 2006).

In the theory of multiple intelligences, spatial intelligence is the ability of an individual to perceive and process spatial information. Spatial intelligence is one of the dimensions of the theory of multiple intelligences, which includes the following main characteristics: the ability to perceive and manipulate spatial forms: this includes the ability to accurately perceive and differentiate between the size, shape, colour, and other characteristics of objects and to form a clear mental image of them. The ability to think through visual observations and mental images: the ability to use visual images in thought to analyse, reason and solve problems. Ability to think and create through spatial relationships: the ability to use spatial relationships and forms to depict complex concepts and ideas such as art, design and architecture (Gardner, 2011). Spatial intelligence is recognised as a separate type of intelligence in the theory of multiple intelligences and has a significant impact on an individual's spatial perception, mental imaging and graphic processing abilities. It plays an important role in many occupations and fields.

Spatial-visual intelligence involves a person's ability to recognise and conceptualise visual and spatial information, and those who are better able are able to not only process complex spatial and visual patterns, but also to recognise detailed spatial and visual nuances. This intelligence is a standard component of piano performance. Because formal spatial intelligence can be achieved in music reading and transformational performance, it can also be argued that the use of one's spatial vision is fundamental to piano playing. (Liu, W. C. C., 2010). The present study is a preliminary study of using the principles of spatial intelligence to design sight-reading training materials to enhance the sight-reading ability of children over a period of one month.

Literature Review

Researchers have been constantly searching for methods and strategies that can improve sight-reading skills. These strategies cover musical elements such as rhythm, pitch, singing, and accompaniment, or revolve around psychological categories such as perception and memory, or involve learning theories and forms of learning.

In a dynamic model proposed by Kopiez (2006), a more comprehensive explanation of inter-individual differences in sight-reading achievement includes factors such as expertise, information processing speed, and psychomotor speed.Mishra's (2014) study analysed 92 quasi-experimental studies on sight-reading, evaluating a wide range of sight-reading interventions to reveal the most effective strategies for improving sight-reading ability, categorised as " Auditory Training", "Controlled Reading", "Creative Activities" and "Singing/Scales" had a significant positive impact on sight-reading.Watkins' (1984) study examined the impact of using rhythmic training techniques on sight-reading ability. She studied 22 university music students who were divided into two groups during a ten-week experiment: one group was taught traditional sight-reading accompaniment, and the other group was accompanied by the sight-reading of a recorded soloist. A pre-test and post-test design revealed significantly higher rhythmic accuracy scores for the experimental group. Although the two groups performed similarly in terms of pitch accuracy and expression accuracy, VoWatkins concluded that this treatment was very effective in improving rhythmic accuracy. She suggests that it can be taught in conjunction with actual accompaniments and is particularly applicable to students of different ages.

Zhukov, K. (2014) In order to investigate strategies for sight-reading skill improvement, a methodology for teaching sight-reading to advanced pianists was evaluated by implementing three new training procedures (accompaniment, rhythm, and musical style) and creating a control group with 100 pianists. Pre- and post-sight-reading tests were analysed by customised software and found that all training groups improved by one metric each in rhythm and pitch, and the control group improved in pitch.

The effect of accompaniment on the improvement of sight-reading ability is also something that researchers have endeavoured to confirm, Lehmann and Ericsson (1993), studied 16 pianists and found that students with more experience of accompaniment consistently performed better in sight-reading than those who practised and played mainly solo repertoire. There have also been many researchers who have attempted to improve sight-reading skills through the use of music theory, Gardner (2000), argued that even those with naturally low musical intelligence can be improved through targeted training that utilises other intelligences. Liu (2010), proposed a method for analysing and evaluating the cognitive skills of pianists based on the theory of multiple intelligences. Using Gardner's theory as an organising framework, he provides a new perspective on the analysis of various skills in the piano, examining detailed analyses of piano skills with the aim of helping pianists to construct their own intellectual profiles so that they are better able to identify and solve problems in performance. He argues that this approach is not only applicable to advanced pianists, but can be extended to pianists at other levels and even to other instruments, providing new tools for self-evaluation and teaching.

Chapman's (2023), study, based on Gardner's theory of multiple intelligences, emphasises different musical learning strengths and argues that musical intelligence is largely based on auditory intelligence. Attention was given to the difficulties encountered by piano students in reading and playing music scores synchronously, with the aim of defining and developing an accessible framework of musical intelligence to support the pedagogical practice of piano teachers, particularly in teaching synchronised reading and playing of piano scores. Synchronised reading and playing was found to require strong proprioceptive, kinesthetic and tactile skills, as well as reliable musical spatial intelligence and strong auditory intelligence. Teachers generally recognised that being able to read and play from sheet music was an important part of musical intelligence, but also valued musical literacy and personal and interpersonal intelligence. Pupils demonstrate a variety of musical strengths, some specialising in reading music scores and others in aural learning and imitation, so music education should develop both in a balanced way. Bodily-motor intelligence, the ability to use the body effectively, is essential for playing an instrument, and research by Sloboda and Davidson (1996) has shown that body co-ordination and muscle memory play an important role in sight-reading. Movement techniques such as Dalcroze Eurhythmics can enhance body movement intelligence and sight-reading ability. Since people use a combination of intelligences to solve problems in real life, it means that in piano sight-reading not only musical intelligences play a role, but also other intelligences may be involved, and then the methods of sight-reading training will be expanded to include more dimensions, so as to better achieve the effect of improving piano sight-reading ability (Dong Harmony , 2021).

Based on the theory of multiple intelligences, Wu Fei (2014) explored the correlation of musical, spatial, and kinesthetic intelligences in piano sight-reading and conducted a study on music teacher trainees through a questionnaire. The results showed that these three intelligences were correlated in piano sight-reading, and effective teaching strategies such as reconfiguring curriculum design, learning process and ability assessment were proposed. The study also found that musical intelligence had the highest correlation with kinesthetic intelligence, while spatial intelligence had a slightly lower correlation with kinesthetic intelligence. In order to improve piano sight-reading ability, the development and cultivation of musical, spatial and kinesthetic intelligences should be prioritised, and the curriculum design and learning process should be adjusted in conjunction with the principle of tailoring teaching to the needs of the students.

In summary, researchers have given guidance and reference through different forms of studies, whether they start from musical elements such as rhythm, pitch, accompaniment and singing, or from psychological perspectives such as perceptual, auditory and spatial intelligences, or from music learning theories, learning forms and so on. Although previous literature has explored the perception and production of musical notation, there are few practice materials designed through the theory of spatial intelligence to turn the unfamiliar into the familiar by implanting the notation patterns in advance and storing them through spatial perceptual memory in order to extract the familiar notation patterns when sight-reading.

Method

Participants

Thirty primary school students aged 8-11 years old with an average of 4 years of piano study and varying existing sight-reading abilities. To ensure that each participant enjoyed equal opportunities, grouping was done in a randomised double-blind manner, with 15 cases randomly selected by the researcher out of all participants as the experimental group and the remaining 15 cases as the control group.

Tools

The tools chosen for the pre- and post-tests of sight-reading ability were the software "Pentatonic Teacher" and a midi-capable piano, which was connected to the software's mobile phone device using an adapter cable. Within the software, there are different sections, each of which can be tested individually for sight-reading. When entering the interface of each partition, a corresponding range of notes will be randomly played, mainly including whole notes, half notes and quarter notes, with 50 notes appearing at a time. When the piano is played, the note recognition system starts to activate, and the subject is required to play according to a fixed beat, √ the correct note, and x denotes an incorrect note. When the performance is complete, the software scores the subject according to the number of correct and incorrect notes（Figure1.）, thus determining the subject's level of sight-reading ability.

Figure1.Demonstration of the testing process of the testing software "Pentatonic Teacher".

Design

The process of this study is divided into three phases: pre-test, intervention, and post-test. Both the experimental and control groups will take the pre-test and post-test, while only the experimental group will receive the intervention. The intervention consists of creating a specialised piano sight-reading training course based on spatial intelligence theory. This course is designed to improve the piano sight-reading skills of the children in the experimental group through 1 month of intensive instruction. The control group will follow traditional teaching methods. This preliminary study explores and summarises the improvement in piano sight-reading ability of children in the experimental group after a one-month intervention.

Procedure

The experimental group consisted of three groups, each consisting of five individuals. Each group received weekly specialised training in piano sight-reading techniques. The training sessions were conducted in small groups of five participants each, once a week for two hours, totalling eight hours. The time of the preliminary study intervention was chosen when the participants were on summer holidays, and the training time for Experiment 1 group was from 10:00 a.m. to 12:00 p.m. on Wednesdays, for Experiment 2 group from 2:00 p.m. to 4:00 p.m. on Thursdays: for Experiment 3 group from 10:00 a.m. to 12:00 p.m. on Fridays, with a training time of two hours each time, and a WeChat group was established by the experimental group members, which facilitated the extracurricular exchanges and practice.

Materials

The training materials used in the intervention process were specially designed on the basis of the theory of spatial intelligence, following the spatial layout, spatial arrangement, spatial structure and spatial shape of the notes from point (individual notes) to line (intervals and chords) and then to surface (rhythms and patterns), from shallow to deep and from simple to complex. Through the exercises, an attempt is made to make the participants in the experimental group form different spatial patterns, models, and input the combination and matching of notes into the memory system through the processing and handling of spatial information, so that when faced with the sight-reading material, they can quickly extract the familiar modules. The training material consists of eight units, including the principle of five lines, four intervals, the principle of adding lines, the principle of adding intervals, the spatial model of intervals, the spatial model of chords, the spatial model of rhythms, the structure of music and other major training elements(Figure2,Figure3,Figure4).

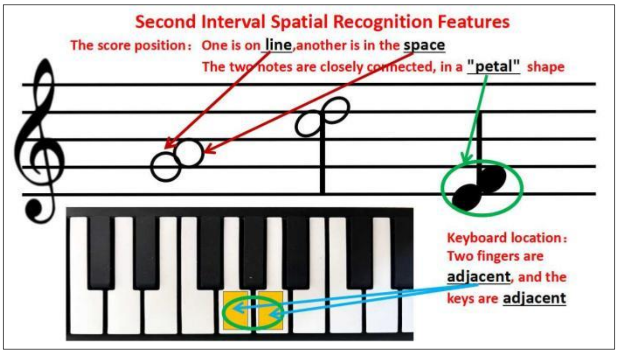

Figure2：Second interval spatial recognition features

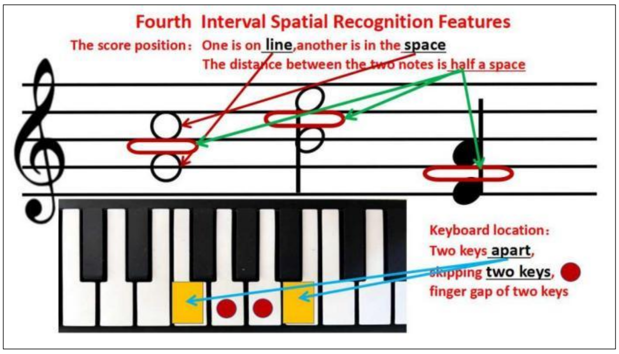

Figure3：Fourth interval spatial recognition features

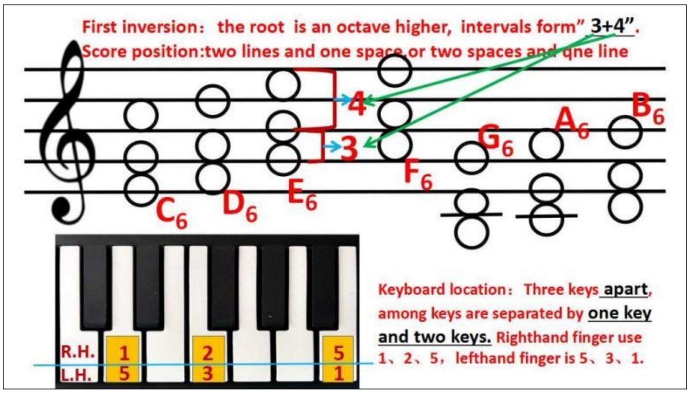

Figure4：First inversion chord spatial recognition features

Result

Using t-test (all known as independent samples t-test) to study the difference between Group for Pre-test, Post-test total 2 items, from the above table can be seen: different Group samples for Pre-test total 1 items will not show significance ($p>0.05$), means that different

Group samples for Pre-test all show consistency and there is no difference. The other Group samples show significance (p<0.05) for Post-test total 1 item, which means that different Group samples have differences for Post-test. Specific analyses show that:

	Group(mean ± standard deviation)		*t*?	*p*?
	Control Group(*n*=15)	Experimental Group(*n*=15)		
Pre-test	36.13±6.89	31.80±9.06	1.475	0.151
Post-test	37.87±7.22	45.33±4.06	-3.490	0.002**
* *p*<0.05 ** *p*<0.01				

Chart1. Results Analysed By t-test

Group for Post-test shows 0.01 level of significance (t=-3.490, p=0.002), as well as a specific comparison of the differences shows that the mean value of Control Group (37.87) is significantly lower than the mean value of Experimental Group (45.33).

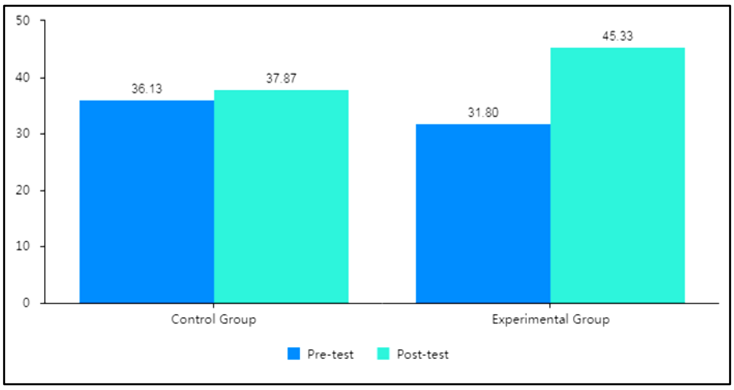

Chart2. Comparison of Group And All Analyses

In conclusion, it can be seen that different Group samples do not show significant differences for Pre-test total 1 item, and the other Group samples show significant differences for Post-test total 1 item.

Group(mean ± standard deviation)	Pre-test	Post-test
Control Group(*n*=15)	36.13±6.89	37.87±7.22
Experimental Group(*n*=15)	31.80±9.06	45.33±4.06
t?	1.475	-3.490
p?	0.151	0.002**
* *p*<0.05 ** *p*<0.01		

Chart3. Results analysed by t-test

Conclusion

In this research, we intervene with training materials based on spatial intelligence and demonstrate a positive correlation between children's piano sight-reading improvement and professional sight-reading training. This implies that children's sight-reading ability can be enhanced by targeted training. The results of the study support the authors' hypothesis.

Consistent with Thomas Wolfe, the main goal of sight-reading is to determine whether what you see is familiar and whether it follows a familiar pattern. By practising the game repeatedly, people can become more proficient at recognising the basic rules. According to the theory of multiple intelligences, individuals can develop the ability to recognise regular patterns of sight-reading by combining spatial visual intelligence, musical intelligence and physical motor skills. Spatial vision plays a crucial role in integrating musical scores into visual representations such as pictures, structures, and models.

While this pilot study revealed important findings, its limitations must be acknowledged. First, due to the timing of the pre-study coinciding with the summer holidays for primary school children, members of the pilot group receiving the intervention were unable to attend every session. As a result, some of the 15 members missed 1-2 intervention training sessions, resulting in a lack of consistent training across the group for all 4 sessions. This inconsistency may have had an impact on the expected results. Second, although the pilot group members' sight-reading skills improved after a month of systematic training, there were also inaccuracies in tempo control.In the future, it will be necessary to adapt the content of the sight-playing training, to increase the duration of the training, to increase the number of participants, and so on.

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