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Mini Review

Impact of Visual Cues and Feedback on Learning Performance: Different Learning Styles and Cognitive Loads

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Abstract

Learners with different learning styles experience different cognitive loads in response to feedback information. This study investigated the impact of visual feedback and cues on the effectiveness of learning to play on a drum set, and it discusses the impact of the learners' individual learning styles and cognitive loads on their learning outcomes. Sixty drum students were divided into two groups, with one undergoing the traditional training method of reading sheet music and the other training in a visually based environment. The results indicate visual cues and feedback positively influence learning to play on a drum set certain learning environments are suitable for learners with different learning styles and cognitive loads. These findings serve as a reference point for designing and improving learning environments for music students.

Keywords: Media in education, learning style, cognitive load

INTRODUCTION

Learning music involves the teacher's verbal instructions and self-practice. Once the music class is done, the self-practice is the essential approach to enhance the performance. The real-time feedback becomes the crucial factor for self-practice (Allman T et al, 2009). If real-time feedback is obtained during the learning process, the student will make appropriate adjustments and rectifications to improve the next practice session's learning efficiency. There have been extensive studies of the effect of feedback on the performance of various tasks, also known as the knowledge of results. However in traditional teaching methods, the time constraints often result in verbal feedback delays, and reduce the learn performance. This problem of delayed feedback can be addressed by giving real-time visual feedback instead (Arthurs JB, 2007). More studies have investigated the effect of real-time visual feedback for pitch correctness and voice quality during singing performance. However visual feedback brings more information for learners and more cognitive loads. Cognitive load theory refers to an individual's working memory can handle a limited amount of visual and auditory information effectively within a specific period of time (Brandmeyer A, 2011). The mechanism of providing real-time visual feedback might have become what is known in cognitive load theory as an extraneous load, which negatively affects the results of timing practice. Some educational psychologists substantiated that video games can be effective learning tools. The visual information provided by the game interface lets the gamer know how to go about performing. When the actions and timing of the performance are correct, the gamer will receive a corresponding sound effect and a visual feedback for correctness. Otherwise, there will be no sound effect but rather, an indication that an error has been made. In terms of video games, it has been widely acknowledged that can be effectively used as learning aids (Corlu M, 2015). Examined the effect of visual feedback and the results showed no positive influence on learning performance. However, in situations in which a rhythm game is being played, the visual cues provided by the game interface guides the player to perform. It is unclear whether this implies such visual cues can actually help a learner train his/her sense of timing in performance. Except the factor of visual feedback on learning music, some other factors are not discussed and examined thoroughly such as learning environment and personal factors are not investigated commonly on the impact of visual feedback. Yet there is a close relationship between individual learning styles and corresponding learning environments. The students' learning styles should be considered when investigating the impact of the presence or absence of visual information on the music learning outcome (Drake RM, 1957). Based on the above discussions, this study aimed to examine the impact of visual information feedback and cues and learning styles on the cognitive load and the outcomes of training on the drum set.

LITERATURE REVIEW

The effect of visual feedback and cues on music learning performance

Giving effective and appropriate feedback is another important factor to enhance the musical learning. Several studies had examined the application of visual feedback to music learning. Prior literature had confirmed that visual feedback can effectively help learners improve the correctness of their singing pitch. The visual feedback can enhance expressiveness and imitate on (Dunn RS, 1993). It can also effectively improve loudness when practicing on percussion instruments but does not improve percussion timing. It blocks timing-practice instead. This phenomenon may be in line with the cognitive load perspective proposed by Sweller (1988) in that visual feedback distracts a learner and affects his/her concentration, thus hindering his/her correctness when learning percussion timing. Our study examines whether the visual feedback increase one's cognitive load and effect the learning performance.

Cognitive load

Cognitive load theory was developed to enhance the study performance. Prior study focused on the impact of learning contents and teaching methods on the concept attainment and cognitive level of their learners (Fleming ND, 1992). Defined cognitive load as what is created by information that is being processed by a person's working memory. Since working memory has a limited capacity, cognitive load theory suggests that instructional materials should reduce cognitive load and optimize the use of working memory. There are several instrument measurements on cognitive load. In this study, the Pass's (1992) subjective rating scale was then used to measure the cognitive loads that had been recommended by Sweller (2010).

Learning styles

On the psychological perspective, learning styles were focused on the cognitive characteristics of individuals' behaviours. Kolb (2014) defined learning style as the behaviour that a student exhibits when undergoing the four stages of learning (Hong J, 2018). Dunn and Dunn (1993) proposed learning style is a student's usual mode of reaction when responding to stimuli in a learning situation. Moreover, Fleming and Mills (1992) noted that learning style is the way a student receives information when he/she is focused on the learning process. It can be visual, aural, reading/writing-based, or kinaesthetic, and it is mainly used to inspire the learner to think. Arthurs (2007) compared the application of three learning styles to a teaching strategy for nursing students. He found that Fleming and Mills (1992) explanation of learning style was more effective in improving learning efficiency than the other two (Jamil MG, 2019). The learning style theory applied the VARK (visual, aural, read/write, and kinaesthetic) scale in the form of multiple choice questions, which better complied with the response mode of individual behaviours. Since the aim of this study was to investigate the impact of visual information and learning styles on drum set-playing outcomes, the VARK scale by Fleming and Mills (1992) was adopted, and the experimental subjects were divided into those who preferred visual or non-visual feedback.

Musical aptitude tests

Gordon (1989) differentiated human musical abilities into aptitude and achievement. The former is a measure of a learner's potential musical ability—in other words, his/her inner possibility whereas the latter measures the student's learning outcomes, which refers to his/her external and actual performance (Kolb DA, 2014). In the context of music, a person's ability is the demonstration of his/her musical achievement through the continuous development of nature and nurture. Since this study aims to measure the impact of visual feedback and cues on the learner's drumming correctness, which is reflected by mastery of steady beats, we employed a rhythm test for our assessment. There are several methods to test the musical aptitude. One of them is Drake musical aptitude test (Latifi S, 2019). Which is easy to asset the steady tempo and is less costly to carry out, and requires less performance duration, it was then adopted in this study. To measure the students' musical aptitude and the differences in their musical abilities after percussion training, experimental manipulations were accompanied by pre-tests and post-tests.

RESEARCH METHOD

The independent variables in this study consist of learning approach (with/without visual feedback) and learning style (visual/non-visual preference). The dependent variables include the learning outcome, cognitive loads, rank performance, and drumming correctness. The subjects were randomly selected in a university. Those who had no experience on music training class were recruited in this study (Merrienboer V, 2005). There were 60 subjects and grouped into two groups: experimental and control group. The inventory measurements include the VARK learning style which was used to identify ones' learning style, the Dark musical aptitude test which was used to test ones' tempo ability, the cognitive load instrument developed by Pass (1992) was used to measure the cognitive load. At beginning, the subjects were taking the VARK test to classify their learning styles and were clustered into two subgroups: with visual preference and non-visual preference. Thus, there are four subgroups. Each two subgroups in both experimental group and control group (Nouri J, 2016). There were, then, four subgroups in this study. The Drake musical aptitude pre-test was then conducted. Prior to the start of the experiment, the instructor elaborated on the content of the percussion practice, including the experimental practice content, the proper way of holding the drumsticks, and the correct drumming method (Sadakata M, 2008). Information on visual cues and feedback in relation to drumming was explained to the experimental group, while the control group learned about the traditional practice of music reading sheets. The DTX Mania game software was used to provide visual cues and feedback. This is freeware introduced by the Yamaha Corporation that can simulate music rhythm games on the computer. The computer keyboard is used to control game play, or electronic drums can be connected to the computer to play the game. The DTX Mania music score files can be edited using DTX Creator. The experimental design is shown in (Figure 1). Our aim was to investigate the impact of visual information provision and learning style on percussion training using a drum set (Sweller J, 1988). The experimental design involved pre-and post-tests of musical aptitude. For both groups, the same instructor conducted basic percussion training in order to prevent the learning outcomes from being affected by different instructors with varying teaching abilities.

H1: Concerning the Drake musical aptitude test, the post-test results of the experimental group (with visual cue/feedback) is significantly better than its pre-test results. No

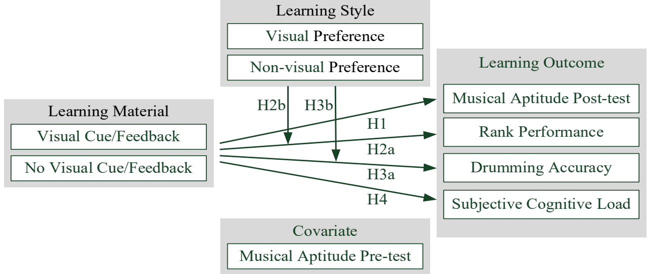

Figure 1. This study proposed the following hypotheses for verification through the results of the teaching experiment.

significant difference will be found in the control group (no visual cue/feedback).

H2a: The rank scores of the experimental group are significantly better than those of the control group.

H2b: For the experimental group, the rank scores of visual preference learners are significantly better than those of non-visual preference learners.

H3a: The drumming correctness of the experimental group is significantly better than that of the control group.

H3b: For the experimental group, the drumming correctness of visual preference learners is significantly better than that of non-visual preference learners.

H4: There are significant differences on cognitive loads among the two groups with different learning styles.

RESULTS

To examine the effects of learning materials and learning styles on the outcomes of music rhythm training, data were analysed using independent samples t-test, paired samples t-test, and one-way ANOVA (Sweller J, 2010). The learning outcomes included data collected by instructor (Drake musical aptitude test), scores from the DTX Mania software (rank scores and drumming correctness), and scales (cognitive loads).

Drake musical aptitude pre-test results

The Drake musical aptitude pre-test results were examined to verify that there was no significant difference between the groups' musical abilities (Sweller J, 1998). One-way ANOVA was carried out to test for differences. The analysis showed that there was no significant difference ($p > 0.05$) in the Drake musical aptitude pre-test results, indicating those subjects' musical abilities prior to undergoing the experimental practice were generally similar.

Drake musical aptitude pre-test and post-test results

Concerning the progress in musical aptitude, the paired samples t-test was used to check for any significant difference before and after the experimental practices. The lower the mean value, the closer the subjects' beats were to the correct beats; that is, the degree of drumming correctness was higher. (Table 1) summarizes the means and standard deviations of Drake musical aptitude test results across different learning materials and learning styles. The results of the paired samples pre-test and post-test analysis indicate that after the experimental practice, the musical abilities of the experimental group subjects showed significant progress ($p < 0.01$ and $p < 0.05$ for the visual and non-visual learners, respectively), thereby supporting H1. For the control group, although the mean post-test scores were lower than those of the pre-test, the p-value did not reach significance. This indicates that the control group

Table 1. Means and standard deviations of Drake musical aptitude.

Learning material	Learning style	Mean of pre-test / Mean of post-test	Sd	Difference between post-test & pre-test
Visual cues / feedback	Visual preference	8.13	4.051	-4.4
		3.73	2.685	
	Non-visual preference	7.87	8.079	-3.133
		4.73	4.284	
No visual cues / feedback	Visual preference	7.6	6.104	-1.4
		6.2	3.55	
	Non-visual preference	8.53	4.749	-1.667
		6.87	4.779	

Table 2. Means and standard deviations of rank scores.

Learning material	Learning style	Mean	Sd
Visual cues / feedback	Visual preference	5.14	1.38
	Non-visual preference	4.62	1.706
No visual cues / feedback	Visual preference	2.71	1.775
	Non-visual preference	2.36	1.724

showed no significant growth in musical abilities subsequent to the experimental practices.

Rank scores

Data on the rank scores and drumming accuracies collected by DTX mania during the practice session were analysed to verify whether any significant differences existed between the experimental and control groups. (Table 2) summarizes the means and standard deviations of rank scores across different learning materials and learning styles. The subjects' rank scores were verified using independent samples t-tests. The rank scores between experimental and control groups were significantly different ($p < 0.01$) after percussion practice on the snare drum. The mean rank score of the experimental group was significantly better than that of the control group (means = 4.88 and 2.53, respectively), such that H2a was supported. The mean rank scores for the visual and non-visual learners in the experimental group were5.14 and 4.62, respectively. The analysis showed that here was a significant difference ($p < 0.01$) in the rank scores between the two categories of learners. H2b was supported. The mean rank scores for the visual and non-visual learners in the control group were 2.71 and 2.36, respectively. In contrast to the experimental group, there was no significant difference between visual and non-visual learners for the control group ($p = 0.123$). Their rank scores were also generally lower than those of the experimental group.

Drumming correctness

The experimental practice consisted of beating crotchets on the snare drum at 80 BPM for one minute. Hence, the sum of all the collected information on drumming correctness would be Perfect + Great + Good + Poor + Miss = 80.Using the DTX Mania method for assessing correctness, the marks for beats graded as Perfect, Great, and Good were added up to obtain the total correctness score. In DTX Mania, Poor and Miss are judged as errors in correctness; hence, the marks for these two grades were excluded from the calculation. (Table 3) summarizes the means and standard deviations of drumming correctness across different learning materials and learning styles. The drumming accuracies of the experimental and control groups were analysed using an independent samples t-test. The means of the former and latter were 76.31 and 60.50, respectively. There was a significant difference ($p < 0.01$) between the drumming accuracies of the two groups, with that of the experimental group being significantly better. Thus, H3a was supported. Next, we compared the drumming accuracies of visual and non-visual learners in the experimental group (means = 77.05 and 75.58, respectively). Results indicated significant differences between the two categories of learners in terms of drumming accuracies ($p < 0.05$). Visual learners in the experimental group had better drumming accuracies than non-visual learners. Thus, H3b was supported. Finally, we compared the drumming accuracies of visual versus non-visual learners in the control group (means = 65.96 and 55.05, respectively). Results indicated a significant difference between the two categories of learners in terms of drumming accuracies ($p < 0.01$). Visual learners in the control group had better drumming correctness than non-visual learners.

Cognitive loads

After the experiment, all the subjects filled out the cognitive load questionnaire. The scale consisted of five questions with answers presented on a 9-point scale (minimum score = 1; maximum score = 9). The aggregate score for the five questions represented the overall cognitive load. (Table 4) summarizes the means and standard deviations of cognitive loads across different learning materials and learning styles (Wu J, 2014). An one-way ANOVA was used to determine if any significant differences in cognitive loads existed among the four subgroups (experimental group with visual preference; experimental group with non-visual preference;

Table 3. Means and standard deviations of drumming correctness.

Learning material	Learning style	Mean	Sd
Visual cues / feedback	Visual preference	77.05	3.728
	Non-visual preference	75.58	5.649
No visual cues / feedback	Visual preference	65.96	13.055
	Non-visual preference	55.05	22.751

Table 4. Means and standard deviations of cognitive loads.

Learning material	Learning style	Mean	Sd
Visual cues / feedback	Visual preference	24.73	5.049
	Non-visual preference	28.53	5.502
No visual cues / feedback	Visual preference	31.67	3.677
	Non-visual preference	33.4	4.222

control group with visual preference; and control group with non-visual preference), as stated in H4. The results indicated that there was a significant difference in the cognitive loads among the groups ($p < 0.001$). Thus, H4 was supported. The cognitive loads of the four subgroups were further analyzed using the LSD multiple comparison test. First, for the experimental group, the cognitive load of visual preference learners was significantly lower than that of the non-visual preference learners ($p < 0.05$). It was also significantly lower than those of both types of learners in the control group (both $p < 0.001$). Second, the cognitive load of non-visual learners in the experimental group was lower than that of visual learners in the control group, although the difference was not significant ($p = 0.071$). Third, looking strictly at non-visual learners, the cognitive load of those in the experimental group was on average lower than that of those in the control group, with the difference being significant ($p <0.05$). Finally, for the control group, although the average cognitive load of the visual learners was lower than that of the non-visual learners, the difference was not significant ($p = 0.313$). A comparison of cognitive loads shows that the overall cognitive load of the experimental group was significantly lower than that of the control group. This indicates that the learning material that uses the traditional practice of reading sheet music (as was the case with the control group) imposes a greater cognitive load on the learners and results in poorer learning outcomes. This study posits that the traditional practice method of reading sheet music exerts a greater extraneous cognitive load, thereby adversely affecting the learning outcomes of the control group.

DISCUSSION AND IMPLICATIONS

Discussion

This study investigated the effect of visual feedback and cues on the learning performance and ones' cognitive load in terms of learning style. The learning performance was measured by a music video game named DTX mania. The cognitive loads were measured by using the VARK measurement. The learning style was classified by the instrument measurement of VARK test. Sixty drum students were divided into two groups which are control and experimental ones. The control group was trained with the traditional method of reading sheet music. The experimental group was trained with the video game of DTX mania. This study examined the effect of visual learning materials on learning performance and cognitive load firstly. Then, the relationship between learning style and learning performance is tested. Moreover, the relationship between ones' visual/non-visual preference and learning material on learning performance is investigated. The results show that visual cues and feedback not only improve the correctness and performance, the musical aptitude post-test scores are also significantly better than the pre-test results. Visual cues inform learners of the correct time to beat the drum, while feedback on drumming correctness prompts learners to make adjustments for beating the drum the next time. The interactivity between these elements is low; hence, they do not generate much cognitive load. Since these elements are closely related to the main content of practice, the learners' working memory space is dedicated to the processing of this information and leads to better learning outcomes. On the other hand, in the traditional learning environment, the sheet on which music and notes printed are static and do not inform learners of their progress. Learners must make use of the existing elements, including musical staves and notes, the tapping sounds of the metronome, and the sounds made by beating the snare drum, to self-determine their drumming accuracies so as to meet the practice requirements. They must also make further adjustments by recalling the practice demonstrated by the instructor or comparing against what they deemed to be the correct way to beat the drum. The entire process produced significant interactivity between the various elements in the learners' minds, which resulted in a greater cognitive load. The working memory space was dedicated to dealing with a cognitive load that was actually not directly related to the actual drumming practice, resulting in poorer learning outcomes. Furthermore, the results of cognitive loads for the two types of learners in the experimental group revealed that those individuals with a visual preference experienced less cognitive load and had better learning outcomes than did those with a non-visual preference. These findings indicate a strong relationship among learning materials, learning styles and cognitive loads. When more visual information is provided, visual learners are better able to process and apply the information than non-visual learners, thereby allowing the former to achieve better outcomes. In contrast, in the traditional method of reading sheet music, the learner's working memory space must process more miscellaneous elements not related to the visual information elements, such as listening carefully to the tapping of the metronome, judging one's own drumming, and making adjustments. Hence, visual preference did not influence learning outcomes. In addition, the learning performance and experience of non-visual learners with visual cues/feedback provision were better than those of visual learners with no visual cues/feedback provision. The former showed more progress in Drake musical aptitude post-test score, higher rank scores and drumming correctness, and lower cognitive load. The results suggest that when visual information is used to facilitate working memory space utilization and efficiency, even non-visual learners could benefit from visualized learning materials.

Implications

The study proposes the following practical implications based on the aforementioned findings. First, since visual cues and feedback can definitely enhance learning effectiveness, music instructors should consider using music software or computer tool to design music sheets for teaching. On the beginning of instruction, the music tool or software can also be used to provide visual cues and feedback to learners in order to obtain better learning outcomes. Second, for the beginners of music rhythm, using the computer game or software as teaching assistance can effectively reduce the students' external cognitive loads and cultivates learning performance (Merrienboer & Sweller, 2005). Third, to enhance learning effectiveness, music students can make use of DTX Mania and DTX Creator to present and prepare music sheets. Considering DTX Mania is a form of game software, music learners can search online and download other unofficial self-made sheet music that is shared by other users to create their own sheet music for practice. Last, cognitive loads vary with the learner's learning styles. For visual learners, visual information can reduce the load on working memory. Therefore, the materials should be designed differently in terms of different learning styles. For example, learners with auditory preferences or with visual preferences need varying learning approaches.

LIMITATIONS

While a rigid experiment was conducted to examine the effects of learning materials and learning styles on music rhythm performance, there are some limitations in this study. First, in this study the subjects were classified into two categories only: those having a visual preference and those having a non-visual preference. However, the VARK learning style includes conditions in which a learner has multiple preferences. For example, learners who with a visual preference, some may have that as a pure preference while others may have a visual-aural or a visual-kinesthetic preference. This study did not discussed in which subjects have multiple learning preferences. In corporating that distinction may affect the experimental results of this study. Second, the standard deviations of the Drake music aptitude test were found to be quite different. This indicates that substantial differences existed in the subjects' Drake music aptitude. DTX Mania cannot provide cues and feedback for drumming strengths. It is recommended that for drum learners, both training of drumming timing and strength are essential for a music learning tool or software. Hence, complete visual information that takes into account on both is suggested.

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DECLARATION OF INTEREST STATEMENT

The authors declare that they have no competing interests.

REFERENCES

1. Allman T, Dhillon RK, Landau MA, Kurniawan SH (2009). Rock Vibe: Rock Band computer games for people with no or limited vision. Proceedings of the 11th international ACM SIGACCESS conference on Computers and accessibility, Pittsburgh, PA. 51-58.
2. Arthurs JB (2007). A juggling act in the classroom: Managing different learning styles. Teach Learn Nurs. 2: 2-7.
3. Brandmeyer A, Timmers R, Sadakata M, Desain P (2011). Learning expressive percussion performance under different visual feedback conditions. Psychol Res. 75: 107-121.
4. Corlu M, Muller C, Desmet F, Leman M (2015). The consequences of additional cognitive load on performing musicians. Psychol Music. 43: 495-510.
5. Drake RM (1957). Manual for the Drake musical aptitude test, Chicago USA Science Research Associates. See J consult Psychol. 26: 48-68.
6. Dunn RS, Dunn KJ (1993). Teaching secondary students through their individual learning styles Practical approaches for grades. J Educ 5: 7-12.
7. Fleming ND, Mills C (1992). Not another inventory rather a catalyst for reflection. Improv Sch.11: 137-149.
8. Hong J, Pi Z, Yang J (2018). Learning declarative and procedural knowledge via video lectures cognitive load and learning effectiveness. Innov educ teach int. 55: 74-81.
9. Jamil MG, Isiaq SO (2019). Teaching technology with technology: approaches to bridging learning and teaching gaps in simulation-based programming education. Int J Educ Technol. 16: 25.
10. Kolb DA (2014). Experiential learning: Experience as the source of learning and development. FT press. 256.
11. Latifi S, Noroozi O, Hatami J, Biemans HJ (2019). How does online peer feedback improve argumentative essay writing and learning. Innov Educ Teach Int. 58: 1-12.
12. Merrienboer V, Sweller J (2005). Cognitive load theory and complex learning recent developments and future directions. Educ Psychol Rev. 17: 147-177.
13. Nouri J (2016). The flipped classroom for active, effective and increased learning especially for low achievers. Int J educ technol high educ. 13: 33.
14. Sadakata M, Hoppe D, Brandmeyer A, Timmers R, Desain P (2008). Real-time visual feedback for learning to perform short rhythms with expressive variations in timing and loudness. J New Music Res. 37: 207-220.
15. Sweller J (1988). Cognitive load during problem solving: Effects on learning. Cogn Sci. 12: 257-285.
16. Sweller J (2010). Element interactivity and intrinsic extraneous and germane cognitive load. Educ Psychol Rev. 22: 123-138.
17. Sweller J, Merrienboer V, Paas FG (1998). Cognitive architecture and instructional design. Educ Psychol Rev. 10: 251-296.
18. Wu J, Chiclana F (2014). Visual information feedback mechanism and attitudinal prioritisation method for group decision making with triangular fuzzy complementary preference relations. Inf Sci Lett. 279: 716-734.