

# Impact of Different Course Contents on Working Memory of Elementary School Students

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**Abstract.** Students tend to have poor learning efficiency when distracted by numerous internal and external factors in class. And there were many evidences demonstrate that students' attention plays a significant role in teaching. Therefore, this study aims to probe into working memory of elementary school students by administering three different courses, including math, physical education (PE), and athletics training courses, to three experimental groups. It compares the impact of the three courses on students' attention. In this study, purposive sampling was implemented to select 36 fifth graders from an elementary school in Taichung City, who were divided into three experimental groups. The data were analyzed based on the correctness of students' responses to attention tasks. The experimental test was employed using display duration of 0.3 and 0.4 seconds, respectively. A Wilcoxon matched-pairs signed-ranks test and Kruskal-Wallis one-way analysis of variance by ranks were conducted to identify the significance of the difference between the experimental groups ( $\alpha = .05$ ). When a substantial difference existed between experimental groups, the researcher implemented a post hoc comparison using a Mann-Whitney U test. The experimental results show that all three groups scored strikingly higher on the post-tests than on the pretests, reaching a significant difference ( $p < .05$ ). Moreover, the researcher compared the post-test results and discovered that there was a vast difference between the group receiving the PE course and the one receiving the athletics training course ( $p < .05$ ). When the experimental test was given using a time interval of 0.3 seconds, the difference among the three groups was not statistically significant ( $p > .05$ ). The conclusions of this study were as follows: (1) the implementation of different courses has a significant and impact on the working memory of higher-grade elementary school students; (2) different course contents may influence working memory of students; (3) regular athletic training is helpful in enhancing student attention.

**Keywords:** attention, training course, working memory, elementary school students.

# 1 Introduction

## 1.1 Research Background

The attention mechanism plays a very important role in the learning process. School children are often affected by internal and external factors while attending classes. It has to be pointed out that the human attention system is a very complicated process. Attention implies “withdrawal from some things in order to deal effectively with other items of greater importance” [1]. A Taiwan local scholar [2] pointed out that “attention” has three different dimensions:

1. Selectivity: Selective focus on certain aspects of the environment while ignoring other facets.
2. Persistence: Continued focus on certain aspects based on personal choice without being distracted or affected by other stimuli.
3. Attention shift: Shift of focus from one object of attention to another as required.

We still have a very limited understanding of the complex structure and functions of the brain. Attention plays a key role for the functioning of the brain, while attention deficit negatively affects learning and intellectual abilities and behavioral control [3]. The childhood represents a key stage in the acquisition of knowledge and new information. It is also a major stage of cognitive development. A fully developed cognition is a basic requirement for learning and provides the necessary resources for learning activities [4].

Attention is also a very important processing mechanism of visual information. Key processes such as identification, learning, and memorization all require a high level of attention. Students are often affected by internal and external factors while they attend classes, which in turn have an adverse effect on learning outcomes. When an individual focuses his/her attention on selected stimuli, he/she is able to gain a clear perception and has the proverbial “Sharp eyes and keen ears”. On the other hand, he/she takes no notice of stimuli and clues that are not in the focus of attention. Instructors should place special emphasis on the impact of attention during the teaching process and consider the internal and external factors that affect attention in order to aid students in the learning process. This study therefore analyzes the focused visual attention of elementary school students and compares their attention levels before and after classes. It also attempts to determine the immediate impact of their exposure to different curricula on their visual attention levels.

## 1.2 Research Objectives and Problems

Based on theoretical foundation developed in the previous section, the purpose of this study is an analysis of the focused visual attention of elementary school students and their involvement in different curricula (general curricula such as math, physical education in addition to track and field varsity team training) in addition to a comparison of the different attention levels before and after their participation in different

curricula. This should help us gain a better understanding of the impact of different curricula such as math, PE, and track and field varsity team training on the student concentration levels.

### 1.3 Explanation of Key Terms

1. General Curriculum- Math. According to the Nine-year Integrated Curriculum Guidelines, the goals of the math curriculum should include the instruction of the following new topics: observation and practice, conceptual learning, new calculation methods, and solution of application problems
2. General Curriculum –Physical Education Educators have to provide a suitable environment and teaching materials for physical education curricula and employ appropriate teaching methods based on the psychology of learning, the physical and mental attributes, and unique needs of the students. Educators also have to provide the best possible guidance through purposeful, organized, and planned physical activities to achieve the goals of the physical education curriculum [5].
3. Track and Field Varsity Team Training. Track and field training as referred to in this study includes training activities such as jogging, warm-up activities, body-loosening exercises, Mark exercises, interval running, and short sprints twice a week for 40 minutes each time. The training program focuses on simple activities that put no strain on the muscles.
4. Ratio of correct answers. Percentage of accurate responses to target stimuli of the attention assessment test by the participants in the experiment.
5. Display time. The display time intervals which were employed for the experiment were 0.3 sec and 0.4 sec respectively.
6. Symbol length. Memory capacity and duration are the two main characteristics distinguishing short-term memory from other types of memory. Short-term memory has a very limited capacity (only about six items or symbols can be stored at a time). The symbol length was therefore determined as a six-digit sequence of numbers for this experiment [6].

## 2 Research Methods

### 2.1 Test Subjects

We employed purposive sampling techniques to select a sample of 5<sup>th</sup> graders from elementary schools in Taichung City. The selected test subjects were divided into three groups of 12 students each (a total of 36). We obtained written permission from parents or guardians before using the students as test subjects and conducting the experiments.

### 2.2 Research Process

We conducted three different experiments for this study in form of visual attention assessments before and after student involvement in classes. The first experiment

focused on visual attention levels of general school children before and after their involvement in an activity based-curriculum (Physical education), while the second experiment was centered on student involvement in a passive curriculum (Math). Finally, the third experiment focused on visual attention levels before and after their participation in track and field varsity team training.

We created a software program to assess visual attention levels for this study. The test subjects were asked to familiarize themselves with the software operations for approximately 1 minute. During this practice phase, the test subjects had to identify random six-digit number sequences and enter the information into the software system. To measure their visual attention levels, the students were asked to identify a total of 100 number sequences that randomly popped up on the screen within a time span of 10 minutes. The students were exposed to two series of 100 number symbols each that appeared on the screen for 0.3 and 0.4 sec respectively. The ratio of correct answers served as the main data source for the determination of attention levels.

Upon completion of the pre-class experiment, the test subjects immediately attended PE class for 40 minutes. Right after the class another attention test was administered by following the same procedure as for the pre-class assessment.

### **2.3 Data Processing**

The raw data were recorded in the correct format required for the statistical software. The statistical analysis of the raw data obtained from the experiments was performed with SPSS for Windows 12.0 software.

1. A non-parametric related sample test (Wilcoxon signed-rank test) was conducted to determine the difference between the visual attention levels before and after classes within each group. A comparative analysis of the differences of assessment tests that were conducted before and after classes served the purpose of determining the impact of different curricula on student visual attention.
2. A Kruskal-Wallis one-way analysis of variance by ranks was conducted to determine the difference between the pre-class and post-class attention levels of each group and to compare and analyze the impact of different curricula on the visual attention of the students. If statistical significance was indicated ( $\alpha = .05$ ), a further comparative analysis was undertaken using the Mann-Whitney U test.
3. The differences between different display times (0.4 sec and 0.3 sec) were analyzed by using a non-parametric related sample test (Wilcoxon signed-rank test)

## **3 Results and Discussion**

### **3.1 The Effect of Class Involvement on the Visual Attention Levels of Elementary School Students before and After Classes**

Rueda, Rothbart, McCandliss, Saccomanno, and Posner [7] explored the development of the attention network by employing the attention network test. Their samples

included the following age groups: children between 6 and 10 and adults. The results of their research indicate that the alerting network is in a stable state after the age of 10. On the other hand, they were not able to observe any obvious changes in the orienting network. The conflict resolution network enters a stable state after children reach the age of 7. This study is a follow-up of the previous research mentioned above. We focused on the effect of class involvement on visual attention levels of school children. A comparison of the results of the visual attention assessments before and after classes shows that all three groups achieved better scores (higher ratio of correct answers) in the post-class assessment (see Table 1 and 2). However, the groups showed different degrees of improvement based on the type of curriculum. We discovered that indoor classes (Math) were associated with a greater improvement in scores than outdoor classes. This is probably related to the fact that children are less distracted by environmental stimuli than during classes that take place in an open outdoor environment. These results are similar to the findings of other studies. Students are generally more focused in math class than in other classes. A comparison of the two outdoor curricula (PE and track and field training) reveals that members of the track and field varsity team tend to achieve better scores than their counterparts who attend regular PE classes. This is probably related to the fact that members of the varsity team have more physical strength and a better physique than other students. Although they are exposed to the same environmental stimuli as other students, they are less exhausted after their training sessions due to their greater physical strength. Members of the varsity team showed a greater improvement in scores than students who participated in regular PE classes, but their scores were slightly worse than those of students who had attended math classes. We believe that these differences can be attributed to different environmental stimuli in indoor and outdoor areas. To sum up, we firmly believe that the involvement in classes has an immediate positive effect on the visual attention level of elementary school students.

**Table 1.** The results of the Wilcoxon signed-rank test for the ratio of correct answers on assessments before and after classes (display time=0.4sec) are summarized in the table below (Mean  $\pm$  Standard error; Unit: %) \* $P < .05$

Unit: %	Pre-class	Post-class	Improvement	Z value	P value
PE	58.72 $\pm$ 8.1	63.13 $\pm$ 17.87	4.41	-2.237*	.025
Math	71.08 $\pm$ 16.53	77.25 $\pm$ 14.33	6.17	-3.061*	.002
Track and Field	73.25 $\pm$ 13.1	80.60 $\pm$ 9.17	7.35	-2.982*	.003

**Table 2.** The results of the Wilcoxon signed-rank test for the ratio of correct answers on assessments before and after classes (display time=0.3sec) are summarized in the table below (Mean  $\pm$  Standard error; Unit: %)

Unit: %	Pre-class	Post-class	Improvement	Z value	P value
PE	62.53 $\pm$ 15.58	66.71 $\pm$ 15.2	4.18	-2.903*	.004

**Table 2.** (Continued)

Math	68.67 ± 4.25	75.95 ± 11.67	7.28	-2.936*	.003
Track and Field	71.85 ± 14.35	77.97 ± 13.02	6.12	-3.059*	.002

### 3.2 The Effect of the Involvement in Different Classes on the Visual Attention of Elementary School Students

It is evident that visual attention assessments that were conducted before classes for all three groups with display times of 0.3 and 0.4 sec did not show any significant differences, which means that the three groups were homogeneous to begin with. The results of assessment tests that were conducted after the involvement in different curricula (display time = 0.4sec) showed statistically significant differences. A follow-up comparative analysis revealed that students who had been exposed to track and field training scored higher on the attention assessment tests than students who had attended PE class. These results suggest that different curricula have different immediate effects on the visual attention levels of elementary school students.

The results of post-class assessment tests with a display time of 0.3 seconds did not show any significant differences in visual attention levels for all three groups. We therefore shifted our attention to the different degrees of improvement. The post-class tests showed a significant improvement in the ratio of correct answers for all three groups. We went on to subtract the pre-class scores from the post-class scores. Although we did not find statistically significant differences, the results were close to significance. We are therefore still convinced that the involvement in different classes has different immediate effects on the visual attention of school children. Higher attention levels increase the ability of students to detect hints and clues in problems and also lead to a better problem-solving capacity [8].

The results of this study clearly demonstrate that members of the track and field varsity team scored higher in post-training visual attention assessments than students who had attended regular PE classes. This is a very interesting phenomenon since both training and PE classes are activity-based curricula. It is an intriguing question why the participation in these training sessions positively affects visual attention levels. We believe that the main reason for this phenomenon is that long-term athletic training results in greater physical strength compared to students who don't exercise on a regular basis. These students also have a better ability to handle the physical burden of the training curriculum which explains the fact that they score higher on post-class attention assessments and achieve better results than students who participate in regular PE classes. Wu [9] pointed out that table tennis training has a significant impact on the ability of elementary school students to focus their attention. He also suggests that a medium training regimen produces better results than a light training regimen. Exhaustion from exercise, however, leads to significantly lower attention levels [10]. The results of this study are similar to the findings of numerous past studies. We therefore postulate that different curricula influence the visual attention of elementary school students in different ways.

**Table 3.** The results of the Kruskal-Wallis one-way analysis of variance by ranks for the ratio of correct answers on assessments before and after classes (display time=0.4sec) are summarized in the table below (Mean  $\pm$  Standard error; Unit: %)

Unit: %	PE	Math	Track and Field	$\chi^2$ value	P value
Pre-class	58.72 $\pm$ 5.22	71.08 $\pm$ 4.77	73.25 $\pm$ 3.78	4.123	.127
Post-class	63.13 $\pm$ 5.16	77.25 $\pm$ 4.14	80.60 $\pm$ 2.65	6.33*	.042
Improvement	4.40 $\pm$ 1.10	6.16 $\pm$ 1.29	7.35 $\pm$ 1.40	1.38	.265

\* $P < .05$ **Table 4.** The results of the Kruskal-Wallis one-way analysis of variance by ranks for the ratio of correct answers on assessments before and after classes (display time=0.3sec) are summarized in the table below (Mean  $\pm$  Standard error; Unit: %)

Unit: %	PE	Math	Track and Field	$\chi^2$ value	P value
Pre-class	62.53 $\pm$ 4.5	68.67 $\pm$ 4.11	71.85 $\pm$ 4.14	1.585	.453
Post-class	66.71 $\pm$ 4.39	75.95 $\pm$ 1.17	77.97 $\pm$ 2.32	4.427	.109
Improvement	4.18 $\pm$ .80	7.28 $\pm$ .97	6.13 $\pm$ .99	2.90	.070

### 3.3 The Impact of Different Display Times on the Visual Attention of Elementary School Students

Gerardi-Caulton [11] employed spatial conflict task to determine the attention and conflict resolution capacity of children. The results of her research show that reaction times decrease with increasing age, while the accuracy rate rises. The differences between spatially incompatible and spatially compatible trials also become smaller, which in turn indicates a better problem-solving capacity. Rueda, Rothbart, McCandliss, Saccomanno, and Posner emphasize the flexibility of attention development in their study[7]. The brain wave data of their experiments suggest that pre-school children who had received attention training exhibited brain wave patterns in the frontal lobe and parietal lobe area that were more similar to adults than those of children who

**Table 5.** The results of the Wilcoxon signed-rank test for the ratio of correct answers on assessments between different display times are summarized in the table below (Mean  $\pm$  Standard error; Unit: %)

Unit: %	0.4 sec	0.3 sec	Z value	P value
Pre-class (N=36)	67.68 $\pm$ 6.88	67.68 $\pm$ 14.84	-.440	.660
Post-class (N=36)	73.66 $\pm$ 5.82	73.54 $\pm$ 13.91	-.079	.937

didn't receive any training. Shan, Chen, and Su [4] point out in their research that among the attention functions, reaction times are the most sensitive indicator of differences. This is also reflected in the results of this study since we were able to show that identical attention assessment tests with slightly different display times (0.3 sec and 0.4sec) did not produce any significant differences as far as the ratio of correct answers of pre-class and post-class tests are concerned.

## 4 Conclusion

There is general agreement that attention is comprised of three interrelated networks (orienting, alerting, and executive) and that different brain areas are involved in the attention process. The development of these networks and high-level executive functions are also part of the attention network and are closely related to conflict resolution and inhibition skills. If children exhibit low performance in these areas, it is usually reflected in below average school performance. This study seeks to make a contribution to the research in this field by exploring the connection between attention and learning efficiency. Our results indicate that the involvement in classes has a direct impact on the level of attention and focus during the learning process.

The comparison of the participation in different types of curricula focused on the impact of external stimuli on the student's attention levels. We discovered in our research that no significant differences exist between the pre-class test scores of all three groups. This clearly indicates that the initial attention levels of all participants of the experiments which had been divided into three groups were very similar. After the involvement in different classes, however, it was evident that members of the track and field training group achieved significantly better scores than members of the PE group. We have suggested that this is probably related to the fact that members of the varsity team have a better physique due to their continued participation in a regular training and exercise program. They therefore possess a greater amount of attention resources and abilities which can be employed to effectively suppress environmental distractions and are better equipped to engage in physically taxing activities, which in turn explains why they score higher than their counterparts. Finally, we compared the differences between different symbol display times (0.3 and 0.4 sec). By viewing all participants of the experiment as members of the same sample cluster, we were able to demonstrate that different display times (0.3 and 0.4 sec) have no significant impact on the visual attention levels of elementary school students.

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