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Student's Cognitive Ability in Different Learning Environments-Asynchronous Online Learning vs Face-to-face Learning

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ABSTRACT

The purpose of this study is to explore how the different studying environments affect student's memory. During the time of Covid-19, online learning has never been popular around the world. Compared to in-person learning, online learning gives students a chance to do distance learning and effectively prevent the spread of viruses. However, college students reported that the limited attention span is one of the disadvantages of online learning [1]. We explicitly focused on student's memories in different learning environments. Students from online group and in-person group will do a short word memory test and the results show that students from in-person group have a higher average correct rate. Therefore, we conclude that face-to-face instruction will help students develop more solid memories.

Keywords: *distance learning, in-person, memory*

1. INTRODUCTION

Since the beginning of 2020, Covid-19 has become the most popular topic around the world. Many schools, in order to avoid the widespread virus across the different areas, begin to transfer the face-to-face classes to the online classes. This makes online learning ever welcoming. Singh & Thurman defined online learning as "learning experiences in synchronous or asynchronous environments using different devices (e.g., mobile phones, laptops, etc.) with internet access [2]. In these environments, students can be anywhere (independent) to learn and interact with instructors and other students". The independence to learn make students study in anywhere they want. McBrien et al. said that the online classes give the chances to distance education where students could access higher education without leaving their home [3]. However, the learning results for synchronous or asynchronous online environments varies. For asynchronous online learning, students usually watch a pre-recorded lecture and cannot get faculties' feedback in time. Furthermore, research also shows that one of the weakness of online learning is distraction which would affect student's memory performance [4]. Regarding the problems brought by online learning, many researchers begin to explore the difference between traditional face-to-face instruction mode and online learning. Previous research done on

college students showed that lecture format did affect student's memory performance, and the live lecture would enhance student's memory. Varao-Sousa & Kingstone gave college students mind wander probes, memory test, interest rating and motivation rating to tell the difference between online learning group and face-to-face learning group [5]. Students in the face-to-face group reported that they have stronger motivation, higher interesting rate, less time in mind wandering. They also outperform the online group in the memory test. Based on that evidence, we would like to explore if younger kids who are in elementary school will also show that they have better memory performance in live classes.

2. PRESENT STUDY

Our study mainly focuses on the different learning environment results in different memory performance among Chinese elementary students. A short instruction would be given to student through in-person mode and online mode. Then a short quiz tested student's memory on those materials in the instruction would be given by the researchers.

3. HYPOTHESIS

Our question is "Will students who receive online learning instruction perform worse than students who receive in-person learning instruction". Our hypothesis is

that students in the in-person group will outperform students in the online group. Based on many previous studies done on college students, the accuracy in memory test for students who watch live lectures is significantly higher than that for students who watch the video lecture [5]. Therefore, we hypothesize that children in the in-person group will have better performance in memorizing the new words. Furthermore, based on the first hypothesis, we also hypothesized that students in the in-person group will better extend their knowledge into other subjects. They are more likely to actually understand the meaning of the word instead of only remembering certain pictures.

4. METHOD

4.1 Participants

Participants in the study were 28 students in Beijing collected from reading panels between the ages of 4 and 11 (Mean = 7.82 years, SD = 2.13 years) who were randomly divided between two groups (online vs. in-person). There are 14 people in the online group including 9 are male students and five female students. There are 14 in the in-person group including 8 female students and 6 male students.

4.2 Procedure

Students from both groups will first receive a short instruction of 6 French words. The reason we use French words is that most Chinese students have previous Chinese and English learning experience. In order to prevent their previous learning experience from affecting their memory tests' results, we teach students French. Then after the short lecture, students will be immediately given a short word matching test from the researcher. Some of the students will receive another short word test after the first test. The second test is to make sure students understand the meaning of the words instead of only memorizing the pictures. For all the tests, as students from a pretty young age, there is no time limit to complete those tests.

4.3 Short French lecture

For the in-person group, a 5-minute live lecture was given by a researcher under the supervision of participants' parents which included instruction of 6 French words using both a written version of the word next to a picture. Video of in-person instruction is that the researcher in the classroom would hold a picture of each French word at a time and say the word out loud. Then after the first round of teaching those 6 French words, the researchers will review the words again. Some students would like to repeat the words when the researchers are teaching which is not a usual case in the online learning environment. In order to keep the variables as few as

possible, researchers asked students to try not to repeat the words. The whole process will be recorded as a video which is shown to the participants in the online group. Students in the online group will watch the video individually with their parents and researcher only.

Figure 1: French word matching test

4.4 Word Matching Test

This test includes the six French words that were previously taught in the lecture. As shown in Figure 1, each word has their corresponding picture. Students need to draw a line to match the picture with its corresponding French word.

4.5 Extra Matching Test:

This test is given randomly in both groups. Some students after they finish the first test will receive another short test to ensure that they understand the meaning of the word instead of just being able to relate the word to the certain picture. There are only three French words left in the second test, as younger students have a hard time concentrating on learning for a long time. As shown in Figure 2, we replaced the original rabbit, fish and cat with different pictures that still indicate the same meaning.
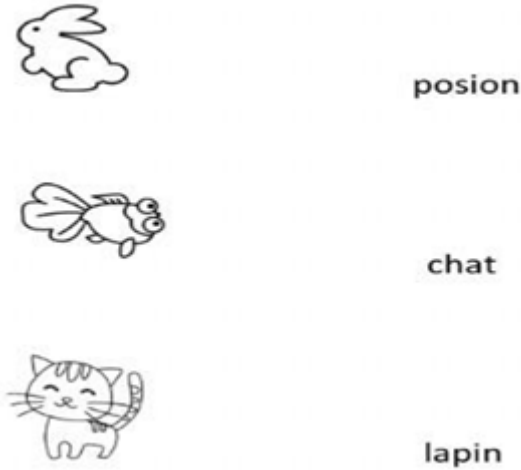
Figure 2: Extra matching test

5. RESULT

Figure 3 shows the average correct rate for online and in-person groups, it is easy to tell there are more students get full scores in the inperson group. Then it is important to see if the score in inperson group is significantly different than that of online group.

The Shapiro-Wilk normality test for two different groups shows that the two groups' correct rates are nor normally distributed. Therefore, we applied mann-whitney u test to analyze our data. The average correct rate is 60.71% for online group, and the average correct for in-person group is 87%. A mann-whitney u test revealed that the average score was significantly higher among in-person group (M =0.87) than among online groups (M = 0.61, W = 151.5, p < 0.05). We can be 95% confident that the ture difference between these means is CI=[3.597549e-05 4.999787e-01].

We also ran a u test to ensure age isn't significantly different from these two groups. As our age range is between 4 and 11 which is a huge gap, it is possible that the huge age gap will be added as another new variable. In order to show we have controlled the age in both two groups, a U test is done. A mann-whitney u test revealed that the average age was not significantly higher among online group (M =7.57) than among inperson groups (M = 8.07, W = 111, p = 0.806). We can be 95% confident that the ture difference between these means is CI = [-1.000002, 2.000036].

Figure 3: it shows the performance of online and in-person group. The x axis only means that there are 14 people in online group and another14 people in inperson group. The data here is unpaired.

For the second small test, there were 5 people in the online group and 10 people in the inperson group doing the test. Only one person from the in-person group didn't get it all right. It shows a ceiling effect in the group of data. More careful and detailed research should be conducted to test this hypothesis.

6. CONCLUSION

Our results aligned with the previous research. Children who have face-to-face classes get higher average scores on memory tests. However, for our second hypothesis, as there is a ceiling effect shown in both groups, more detailed research should be developed to test if students could extend their knowledge to other subjects.

6.1. Limitation

There are several limitations for our research. First, the limited number of participants and stimuli in the test could cause problems in our research. More participants should be collected in order to minimize the bias. Due to the pandemic, there is a big obstacle for researchers to collect data. Therefore, in the future, there should be more participants to be collected into both groups. Also, for our instruction, there are only six stimuli for test one and the test is given immediately after students receive the instruction. In this case, only short memory is tested. If the study wants to be more comprehensive, there should be a follow-up test in the end of the week.

Second, there is a ceiling effect in both our tests. From the first test, we could see that many participants in the in-person groups get full scores. This could indicate the test is not super hard and in order to better show their memory performance, more words should be taught during the instruction. For the second test, there is also a ceiling effect that prevents us from testing our hypothesis. Moreover, in the second test, instead of only using three words- rabbit, fish, cat, all the words should have their pictures replaced. Testing only for three words cannot not fully explain how students truly memorize the words. They could get the answer right by accident if there are not enough stimuli. Time limits should also be set to increase the difficulty level for those two tests.

Third, even though we have a good control in the age between online and in-person groups. We didn't control the gender between these two groups. In order to rule out a potential factor that could influence the final results, the number of males and females should also be controlled.

Fourth, in designing our tasks to test student's memory performance, this is the first time to use matching French words as the task. No previous research used this before, so it lacks validity. Wisconsin Card Sorting Test (WCST), Montreal Cognitive Assessment Test (MoCAT) which are already tested by other researchers and used in many other studies could be used in order to test student's memory performance.

6.2. Future direction

Using technology in the teaching environment would be more and more popular around the world. Even without Covid-19, online learning has already been mature in many different learning websites. The pandemic plays a role in perpetuating online learning. When everything is back to normal, the learning environment will be kept. Not all studies indicate the effectiveness of online learning is not as good as the traditional formats. Some study found that there is strong evidence showing online learning is as least as effective as the traditional format which is face to face instruction. Nguyen suggests that researchers who thought there is no

difference between these two instruction modes should think further [6]. Others suggest that blended learning should be considered in the future. Research indicates that blended learning will have a more significant growth than simply online learning [7]. Therefore, the combination of face-to-face instruction and online learning could also become popular in the future. Therefore, instead of only testing a student's memory under two different learning environments, learning effectiveness in a blended learning environment should be considered. People could still question and test the difference between online and traditional learning, however with the development of technology, online learning could be part of a student's daily study life. In this case, learning about how to improve students' cognitive ability in the blended environment would be necessary. Furthermore, especially in the medical and biological field, virtual reality could also be applied as one the studying environment. Students could have a chance to see a 3D model which could better enhance their memories. Some researches provide solid support the use of VR cognitive training application would help patients with stroke [8]. It is possible that VR be used in the teaching field as well. The effectiveness of students learning in the VR environment could be studied later.

Moreover, the social factors could also be studied in both studying environments could also be a promising direction. Different gender, ethnicity, race, social class could play a big role in affecting a student's academic success. For instance, the potential question could be in the online learning environment, how could race play a role in affecting a students' academic result. Will some stereotypes of minority students negatively affect students' memory performance which lead them to lower scores? Roksa & Whitley shows that African American students have less motivation in achieving their academic success than their white peers, as the faculties don't pay much attention in encouraging minority students [9]. Therefore, studying how the social factors affect memory performance will be interesting to look at.

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