香港教育大學
The Education University of Hong Kong

A Project entitled

The Blended Learning approach in Hong Kong secondary school physics education

Submitted by

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Declaration

I, *Dai Chung Hei Jana* , declare that this research report represents my own work under the supervision of *Associate Professor ; Associate Head (Research and Postgraduate Studies) of SES, Dr YEUNG Chi Ho*, and that it has not been submitted previously for examination to any tertiary institution.

Signed

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3rd April 2022

Abstract

Under the effect of the COVID-19, it brings a huge negative influence on our society and daily life. In the meanwhile, how to maintain students' learning motivation and enhance students' academic performance under the impact of class suspension become one of the major education issues in recent years. This study aims to examine the impact of the Blended Learning approach on Hong Kong secondary school physics students' academic performance and learning motivation. This study will adopt the action research approach, recruit twenty to thirty secondary school students to join the project, having a Blended Learning lesson. In that lesson, students will learn the topic of The Light, Colors, and Beyond. And the whole project will take around 30 to 40 minutes to finish. Before and after the Blended Learning lesson, students need to finish a short quiz to study their learning outcome, also students need to complete the questionnaire before and after the course to determine their learning motivation on physics education. It is expected that this study can show the impact of the blended learning approach on students' academic performance and the changes of the teaching approach that can enhance students' learning motivation. This study will facilitate the reform of the Hong Kong physics education system and give more information to in-service and pre-service teachers on designing the most suitable lesson to support students' learning.

Content

List of Table

List of graph

Part 1: Introduction

In the past decade, the development of technology brings huge changes and make improvements to our life included the structure of education. In Hong Kong, there are more and more schools adopting technology in teaching, in a recent research Reichert, Lam, Loh, and Law (2020) surveyed over 20000 Hong Kong primary and secondary school students, 67% of them reported that every day needs to spend less than an hour to use technology for learning in school. Although, using technology to support teaching becomes the main trend in Education, however, how to ensure the technology can enhance students' academic performance or motivate students' study interests. Especially, in the recent year, under the effect of COVID-19, how to apply the technology in the teaching design to maintain the teaching quality is the most significant topic during education. Moreover, most of the research is not focused on Hong Kong Physics education. This project wants to study how the teaching approach supports students' studies and reduced the negative impact caused by COVID-19. This project will facilitate the reform of the Hong Kong physics education system and give more information to in-service and pre-service teachers on designing the most suitable lesson to support students' learning.

Research Questions/Hypotheses

This project will focus on the two research questions, the purpose of these two research hypotheses is to want to study the relationship between the students' learning approach and students' study performance and their learning motivation. To identify the reason behind the study found, in this project, the student learning performance is measured by the test score, and the students' learning motivation is measured by the questionnaire.

1. Will students' physics academic performance be improved by the blended learning approach?

2. Will the blended learning approach motivate students to study physics?

The hypothesis for the research question 1:

- H_1: The physics test scores are improved by the blended learning approach.

The hypothesis for the research question 2:

- H_0: The blended learning approach cannot motivate students to study physics.
- H_1:The blended learning approach can motivate students to study physics.

Part 2: Literature Review

How to improve students' academic performance always is a significant topic in education research. With the rise of technology, many researchers try to study how technology teaching tools can enhance students' study effect. The development of the internet and technology brings a new trend to the education system, many teachers and educators use various technology tools and online resources for teaching, the purpose of the new teaching style is to support students learning.

The Blended Learning approaches

Especially, in recent years the Blended learning approach has become one of the popular study themes in education research and wants to find out the relationship between this new teaching method and students' learning performance and learning motivation. In terms of the meaning of the “blended”, the blended learning approach can be defined as mixing the formal and informal learning methods, for example, applying face to face teaching and online learning activities in the same course. (Hande, 2014) A Blended Learning lesson can include a variety of learning activities, during the learning activities students need to structure new subject knowledge under the technology support. For example, video, learning software, simulations, and so on. The

learning activities supported by technology can provide different types of learning opportunities and support students study new subject knowledge.

Several studies suggested the blended learning approach brings many advantages to students' learning. Akgündüz and Akınoğlu (2017) did a study comparing two groups of students' science test results, they found out that students that adopted the Blended Learning approach had the highest point increase in the pre-test and post-test when compared to the control group which adopts the traditional learning method. This study, it can show that the blended learning method did support students to achieve higher academic performance. When comparing the teaching efficiency between the traditional teaching method and the Blended Learning approach, Blended Learning provided higher teaching efficiency by combining different types of learning activities which are face-to-face learning, self-paced learning, and e-learning. (Alonso, Lopez, Manrique, & Vines, 2005) Since each student is unique, they have different types of learning styles that can let students have the highest efficiency in their learning. (Pashler, McDaniel, Rohrer, & Bjork, 2008) The blended learning approach combined multiple types of learning activities, teacher can select and design the most suitable type of learning activity that can fulfill students' education needs and learning style.

Another factor that can enhance students' academic performance is learning motivation. Renninger and Hidi (2019) pointed out that students' study interests can provide positive support to the development of coordinated valuing and knowledge, which bring positive effects to students' learning outcomes. Therefore, the teacher needs to motivate students in learning, help students to develop students' study interests, and drive them more willing to study physics subjects.

To find out the relationship between the Blended Learning approach and students' learning motivation. Akgündüz and Akınoğlu (2017) studied that the blended learning method can motivate students to learn science more than the traditional teaching method. Since the blended learning approach combined different types of learning activities, it provided a positive study environment for students and develop their study interests. Yılmaz and Malone (2020) suggested that the blended learning environment can reduce students' fear of science and enhance their enjoyment of learning science. Students will be more willing to study new knowledge and drive them to explore more in the science subject.

From the reviewed literature, the blended learning approach can bring a positive impact on students' academic achievement and motivate students to study science. In

the table 1, listed out the advantages of applying the Blended Learning approach to learning. However, none of the research focused on the impact of the blended learning approach apply in Hong Kong secondary school physics education. In this project, it will be targeted at Hong Kong secondary school students and try to study will the blended learning method bring any impact on student's academic success and study motivation in physics subject.

Table 1: The advantage of using Blended Learning approach

Academic performance	Learning Motivation
Support students to achieve higher academic performance (Akgündüz & Akınoğlu, 2017)	Provided a positive study environment for students and develop their study interests (Akgündüz & Akınoğlu, 2017)
Provided higher teaching efficiency (Alonso, Lopez, Manrique, & Vines, 2005)	Can reduce students' fear of science and enhance their enjoyment of learning science (Yılmaz & Malone, 2020)

Part 3: Methodology

This project is adopting the action research approaches, in the following section will describe how the data collection and the design of the experiment are going to be performed.

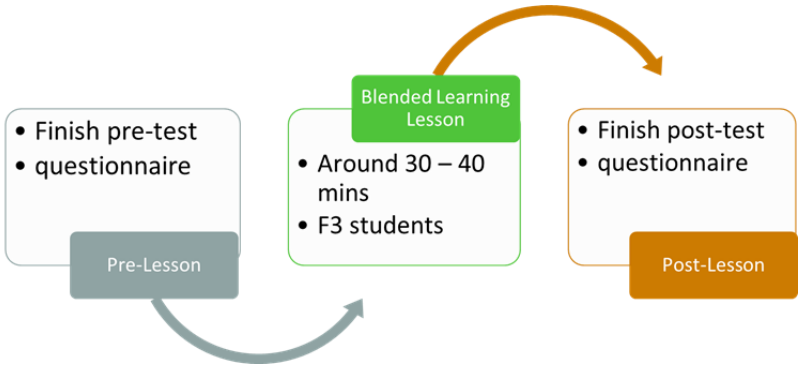
i. Data collection and analysis

This study will collect quantitative data and contact the data analysis to find out whether adopting the blended learning method enhances students' academic performance and learning motivation. This research is targeted Hong Kong secondary school students who are studying physics, in this project, around twenty to thirty students are being recruited to experience the blended learning approach in the physics education.

ii. The experiment design

In this research a physics blended learning lesson will be designed, students need to conduct a pre-test before the lesson and a post-test after the blended learning lesson. The two tests are used to compare students' academic performance. In the graph 1, is show the whole design of the experiment. The blended learning lesson will include a face-to-face lesson and different teaching activities with technology support.

For studying students' study motivation, it will adopt the questionnaire to compare students' learning motivation, the design of the questionnaire is referenced to the Motivated Strategies for Learning Questionnaire (MSLQ). This questionnaire is used the 7-point Likert scale and the questionnaire included 5 aspects, which are self-efficacy, intrinsic value, test anxiety, cognitive strategy use, and self-regulation. (Pintrich & de Groot, 1990) In this project, students need to finish 2 sets of the questionnaire which only included 10 questions and by comparing students' pre and post-lesson performance to study is the Blended Learning approach improved students' learning motivation on physics subject.



Graph 1: The experiment design

Research Activities

No.	Milestones	Months
1	Permit application	1
2	Complete data collection	2
3	Complete data processing	1
4	Complete data analysis	1
5	Complete final report	1

Part 4: The design of the blended learning lesson

In this project, it had designed one physics lesson for the secondary school form 3 students, the design and development of the lesson is the standing stone of the whole project to study how the Blended Learning approach supported students' academic performance. In the following, the development of the lesson and design of the teaching method, and the element of the blended learning approach will be discussed in detailly.

i) The background information of the participate

In this project, the participants were 22 secondary three students, who are aged 14 to 15 from New Asia Middle School are agreed to join this project. Students had not had any formal education on the topic of Color of light before the Blended Learning lesson take place.

This class has implemented the policy of the "Bring your own device (BYOD)", therefore almost all of the students have their own device, they can use during the lesson, also inside the classroom there are e-whiteboard, teacher can use the e-whiteboard to display different information on the internet or other teaching tools during the teaching. Therefore, those students are experienced in using the tablet or other technology devices while they are learning.

ii) The selected of the teaching topic

To develop the Blended Learning lesson for the Form 3 students, the researcher will select the physics topic from the curriculum. According to the Education Bureau (2017), one of the study units for form 3 students is Light, Colors and Beyond, under this topic students need to study the relationship between the color light and colored objects. In this chapter, teacher will discuss the formation of the white light from the three primary colors and how the colored objects appear in colored and white light.

iii) The procedure of the blended learning lesson

The whole blended learning lesson can be separated into three stages. In the first stages, to determine students' prior subject knowledge and learning motivation, students are required to finish an online pre-test which only takes students around 10 to 15 minutes to finish the pre-test. The format of the test is multiple questions, students need to finish 12 questions and one set of questionnaires about the learning motivation. The researcher needs to ensure all students have finished the pre-test and submitted the result before entering the second stage of the blended learning lesson.

In the second stage, the researcher conduct the blended learning lesson in Hong Kong local secondary school. The lesson mainly involved 3 sessions which are the Engagement, Development, and Conclusion. In the following, the design and procedure of the lesson will be discussed.

In the Engagement session, the major purpose is to motivate students' study interests and recall students' prior knowledge. The activation of students' prior knowledge is one of the key parts of the engagement session, the prior knowledge plays an important role on support students to structure new knowledge. As Wetzels, Kester and van Merriënboer (2011) found out that the activation strategy can support students to link up the learners' prior knowledge to a certain topic that shows out can bring beneficial effects on students' study. To activate students' prior knowledge, teacher used a daily example to motivate students on this learning topic, the picture of the rainbow was displayed to the students and activated students' prior knowledge – the dispersion. Students can sport out that when the white light passes through the prism can be separated into 7 colors of light. Then teacher will raise the question, how people can form the white light? The follow-up question is the linkage of prior knowledge and the new learning topic. The purpose of the first part of the lesson is to motivate

students to study this topic and use the questioning skills to stimulate students to think about the relationship between white light and color.

In the next part of the teaching, teacher used a virtual laboratory to conduct a learning activity that can let students use the simulator to find out which three kinds of light can form the white light. According to Bonk and Graham (2005), the Blended Learning approach involved two types of learning environments, the face-to-face lesson provided by the traditional teaching method, the computer-mediated learning environment emphasized students' self-placed learning. Mixing those two kinds of learning environments is one of the key points of the blended learning approach, with the development of technology, students can conduct various learning activities through online learning and support students' education. Therefore, the choice of virtual laboratories becomes the key element in designing the blended leering approach for science subject.

During the project, one of the learning activities is students need to use their own devices to access the online simulation to conduct the online experiment, through these learning activities, students require to figure out the

three prime colors and the formation of the subtractive primary color. In these learning activities, students can conduct the knowledge construction in their own place and through hands-on experience students. The aim of this activity is to enhance student study interest and this type of activity is more student-centered which can cause students to have deeper thinking and memory on discovering new knowledge. Also, students need to finish the worksheet and answer teacher's questions than the teacher can ensure students could master related key learning point.

For the second learning objective, teacher will use a video to design a game called "color game" to let students study what the colored object looks like under different colored light. Students need to identify different color cards (black, white, red, green, and blue) under the red light after watching the video, students can check their answers at the end of the video. This learning activity is allowed students to use the video to discover what the color object looks like under colored light. Also, students need to use their knowledge and science skills to explain the relationship between colored objects and colored light, during the learning activity students need to complete the worksheet as well.

At the end of the lesson, teacher provided a conclusion by a concept map, it can support students organize the relationship between different concepts and the two learning objectivities. Also, the daily example can strengthen their understanding of this topic and find out how to apply subject knowledge in their daily life. After the conclusion of the lesson, students need to finish the post-test, which is as same as the pre-test, the pre-test also can work as an assessment of learning, the result of a short quiz can reflect students' academic performance and the questionnaire can show their learning motivation of this study topic.

iv) The design of the pre-test and post-test question

In the whole project, teacher gave two tests, the pre-test, and the post-test to the students, those two tests provided important information and data to the project on analyzing is the Blended Learning approach benefited students' academic performance. In the test, there are 12 questions, which can be separated into three types, each question type is used to measure different kinds of subject knowledge. In table 2 there are show the different types of the question and the related question number, for the detailed questions used in the project can go reference appendix 1: the pre-test and post-test question.

Table 2: The question types of the Pre-test and Post-test question	
The type of question	Question number
1. Learning objectivities 1 – The formation of the white light and the three primary colors	1-5
2. Learning Objectivities 2 – Relationship between the color light and colored objects	6-10
3. Challenge question	11,12

The first type of question has concluded with five questions, those five questions are used to assess students' first learning objectives which are about the formation of the white light and three primary colors. The first two questions are measured are students can identify the primary colors and which 7 colors can be speared by the white light. Question 3 to 5 are asked students to select the correct combination to form specific color. Students were required more than memorize the theory or concept only but needed to know how to apply knowledge to solve the problem.

The second type of question has included five questions as well, in this part of the quiz students are main being tested on their subject knowledge of the relationship between the color light and colored object. Most of the question are

asked students try to answer how the colored object look like under different colored light.

As the third types of question are challenge question, there are two questions. These two questions are mainly are advanced questions, they require students not just asked to recall facts and basic concepts, they need to apply their knowledge and concept to solve the problem. For question 11, it told students there are objects placed under the green light and the object looks black in color, students need to select which color would not be the object's original color. In this question, students need to judge which kinds of color will become black in color when under the green light, however, the correct answer is asking students to select which color would not be the object original color that needs students to apply their reverse thinking skills when they are doing this types of question. For Question 12, there will provide a color table, students need to select which box will become black in color when under the yellow light. This question is targeted at the formation of the primary colors and the subtractive primary colors, students need a clear concept between the primary color and subtractive primary colors, also the major difficult point is the object with subtractive primary colors are reflecting two wavelengths of light. Therefore,

when students are finishing question 12, students need to figure out each object will reflect a different wavelength of light, students need to critique which object would not reflect the red light and green light and make the object look black in color when under the yellow light.

v) The design of the Learning motivation questionnaire

To measure students' learning motivation on study physics subject, in this project students were need finished 2 questionnaires before and after the lesson. The questionnaire is referenced to the Motivated Strategies for Learning Questionnaire (MSLQ). Ten questions are being asked and five variables are being measured to study the level change of students' learning motivation before and after the Blended Learning lesson. In the questionnaire, students need to read the different statements and rate the statement on a 7-point scale which they can use 1 to represent the statement is not at all true of me and 7 to represent the statement is very true of me. The table 3, it is listed out which two questions are used to measure students' learning motivation aspect, also the question of the questionnaire is attached in appendix 2.

Table 3: The related questions on tested area	
Variable	Question number
Test anxiety	1,2
Intrinsic Value	3,4
Self-efficacy	5,6
Cognitive strategy use	7,8
Self- regulation	9,10

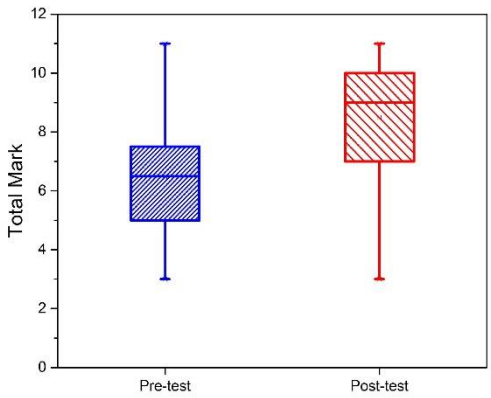
This lesson design appears the blended learning approach when the researcher developing different learning activities are tried to use suitable computer-mediated or e-learning tools in the lesson. The whole lesson is mixed into two major types of the learning environment in the single lesson, including the traditional teaching method (face-to-face lesson) and virtual learning environment which is supported by a different type of online study resources. By designing a blended learning physics lesson for the local secondary school, it was depended on the Hong Kong local education need and supported students achieve higher academic achievement. Also, the teaching materials that were used in the project are attached in appendix 3 and 4.

Part 5: Finding

In the whole project, through the pre-test and post-test and two questionnaires collect quantitative data. In the following part, it will report the related data on the analysis of the effectiveness of the Blended Learning Approach in supporting students' academic performance and the learning motivation in studying physics subjects.

The academic performance on physics subject

First of all, the overall students' academic performance in the Blended Learning Lesson. In this project, the pre-test and post-test were used to measure students' academic performance. The table 4 shows that the mean score of the pre-test is 6.54 and the mean score of the post-test is 8.54 out of 12, the percentage of the correction was increased from 54.5% to 71.2%, and the overall students have 2 scores of improvement on physics subject knowledge. In the t-test, the p-value of the students' overall academic performance is 0.001 which proved that there was a significant change in students' physics knowledge after the Blended Learning lesson. This significant improvement can support the hypothesis of the Blended Learning approach can improve



Graph 2: The overall students' academic performance

students' physics test scores and help students achieve higher academic performance.

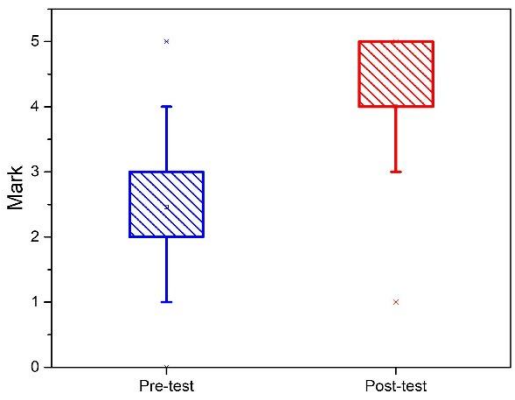
Table 4: The students' mean score of different types question in the test

Type	Pre-test	Post-test	Percentage change	T-test	p-value
Total score	6.5455	8.5455	+30.6%	4.099	0.001
Type 1	2.5455	4.0000	+57.1%	-5.405	0.000
Type 2	2.7273	3.0455	+11.7%	-1.022	0.318
Type 3	1.2727	1.4545	+14.3%	-1.000	0.329

In order to study students' study performance and progress through the whole Blended Learning lesson, students' test scores for each learning objective will be analysed.

i) Students' academic performance on learning objectivities 1

For learning objectivities 1, which is the concept of the formation of white light and primary colors, this subject knowledge was measured by questions 1 to 5 in the test. The mean score of the pre-test is 2.54 and the post-test is 4.0 out of 5, and the p-value of



Graph 3: Students' academic performance on learning objectivities 1

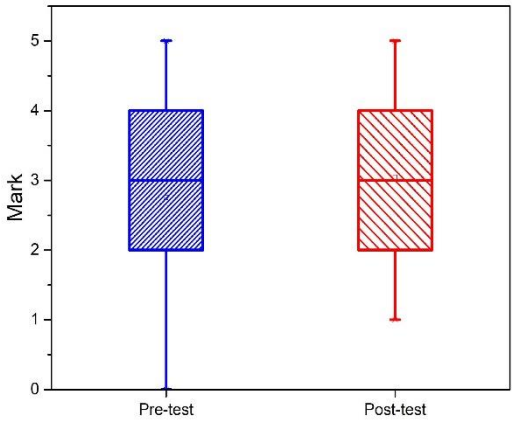
the t-test is 0 (in Table 4). This information told us that the significant improvement of the subject knowledge for the learning objectivities 1 was benefited from the Blended Learning approach.

In the project, students were using the virtual laboratory to do a small experiment to study the subject knowledge of learning objectivities 1. In the Blended Learning approach using technology support is one of the important factors to help students structure new knowledge. Therefore, in the project, students were asked to use the online resources to experiment and they need to find out the formation of white light and primary color by themselves. According to Wieman, Adams, and Perkins (2008) point out that students using the simulations can let students explore new science concepts, and thought the hands-on tasks can improve students' understanding. In the learning activity, students were asked to use the simulations to discover the formation of colored and white light, after the experiment they need to report the discovery to the teacher. Since using the simulations can provide hands-on experience for students to learn new knowledge by themselves, therefore they have a deeper understanding of the related concept rather than just learning from the teacher explanation. The benefit of using the virtual laboratory on studying physics

knowledge can be reflected in the collected data. The significant improvement in subject knowledge proved that the Blended Learning approach did can support students to achieve higher academic success in physics subject.

ii) Students' academic performance on learning objectivities 2

The learning objectivities 2 wants students to understand how the colored objects appear in colored and white light. In the test, there are also five questions to assess their subject knowledge. The mean score of the pre-test is 2.73 and the post-test is 3.04 out of 5. Also, the p-value of the T-test is 0.318 (in Table 4). It cannot give out that the change of the score has a strong relationship between the blended learning approach and the score improvement of the learning objectivities 2. However, there is a key point that can be found from the data, the range of the post-test is smaller than the range of the pre-test. This information can report that after the Blended Learning lesson more students can master the basic knowledge of the relationship between the colored object and colored light. Therefore, it can still know that



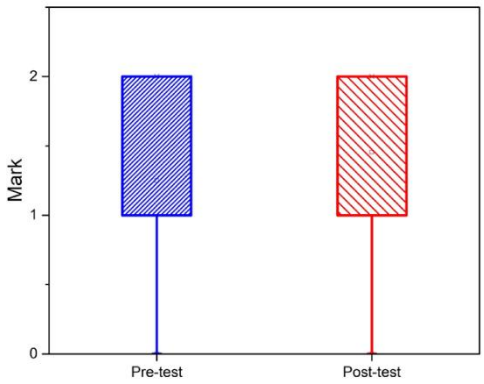
Graph 4: Students' academic performance on learning objectivities 2

the Blended Learning approach can support students in structuring new knowledge.

To understand the improvement is not significant may relate to a problem of students' lack of prior knowledge. This project was conducted under the special arrangement from the project school, before this lesson, students had not yet studied the topic of wavelength. But for learning objectivities 2, it needs students to understand which kind of wavelength will colored object reflect. Under the lack of support from prior knowledge, I may cause students to face difficulties in learning the learning objectivities 2. There may be one of the reasons students did not have great performance on this type of questions.

iii) Students' academic performance on challenge question

In the test there are 3 types of questions, the first type of question is designed to assess students' subject knowledge of the learning objectivities 1 and 2. The last type of question is the advanced question, students need to apply learned knowledge and concept to



Graph 5: Students' academic performance on challenge question

analyze under different situation how the colored object appear in colored light, also students need to find the formation of colored light. The mean score for pre and post-test is 1.27 and 1.45, the p-value is 0.329 (in Table 4). The small improvement did not have a strong relationship with the Blended Learning approach. Since advanced questions are combined with the knowledge of learning 1 and 2, the problem of lack of prior knowledge of wavelength may affect the result of students' performance on the advanced question. Therefore, it may cause the improvement in type 3 questions were not significant.

This project by using the pre-test and post-test to study students' academic performance after the Blended Learning lesson. From the data collected, it can give a clear conclusion on the Blended Learning approach can improve students' academic performance in physics subjects and support students in achieving higher academic success.

The Learning Motivation on physics subject

In the meantime, this project adapted the Motivated Strategies for Learning Questionnaire (MSLQ) to measure students' learning motivation on physics subjects and redesigned this questionnaire to include 10 questions and studied 5 aspects. In the following part, it will explore which aspect is motivated by the blended learning approach. In the table 5, it is listed out that the mean score and percentage change in each aspect.

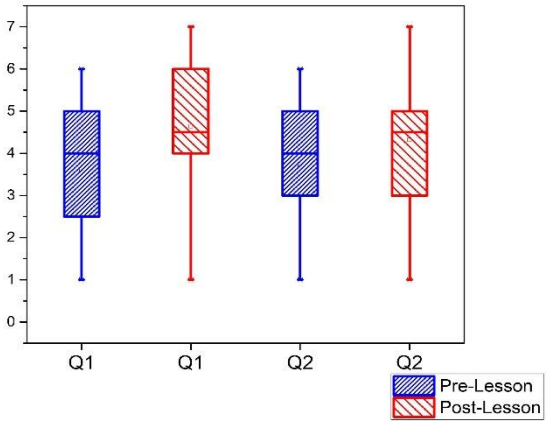
Table 5: The mean score of pre and post-lesson on different aspect

Aspect	Pre-lesson	Post-lesson	Percentage change	T-test	p-value
Test anxiety	7.7273	8.9545	+15.9%	-2.752	0.012
Intrinsic value	10.7273	10.9091	+1.69%	-0.476	0.639
Self-efficacy	9.7727	10.8636	+11.2%	-2.424	0.025
Cognitive strategy use	10.6364	11.0909	+4.27%	-1.267	0.219
Self-regulation	9.9545	10.9549	+10.0%	-2.171	0.042

1. *Test anxiety*

The first aspect is the test anxiety, mainly is wanting to find out if the feeling of the exam or test affected study interest or causes them to feel fear when they are studying the specific subject.

Comparing the mean score of pre-lesson and post-lesson is 7.7273 and 8.9549, increased by around 15.9% and the p-value of the t-test is 0.012.(in Table 5) From this information, it can show that students had reported that after the Blended Learning lesson enhanced students' test anxiety feeling.



Graph 6: Test anxiety

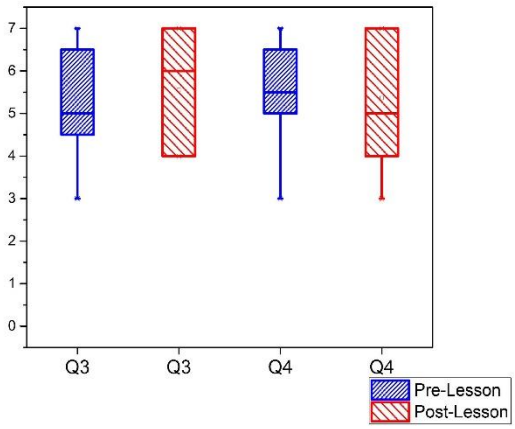
However, the main factor that causes the outcome of enhancing students' test anxiety may not be related to the Blended Learning design. Since under the effect of COVID-19, the lesson time of the project school was reduced, therefore students need to finish the pre and post-test in a short time, and this arrangement may lead students to have misunderstood of having blended learning lessons mean they need to have finish 2 quizzes. Students need to finish many works within a short period, which must cause they to feel stressed, which causes students to have a high level of test anxiety.

2. *Intrinsic value*

The intrinsic value is about students could be engaged in learning certain tasks by their learning interest, but not because of anticipated

consequences. (Spinath, Spinath, Harlaar, & Plomin, 2006) If students with a high level of intrinsic value, students are more willing to study new knowledge and drive them to focus on their learning.

Through the response from the students' questionnaire, it can notice the improvement of students' intrinsic value is slight. The mean score of the pre and post-lesson is 10.7273 and 10.9091, the p-value of the T-test is 0.639 and it cannot show out there is a strong relationship between the improvement and the blended learning approach. However, when taking a look at question 3, which asks students are they love what they have learned in this project, in this question majority of students reported they enjoy their lesson, the mean score of the pre and post-lesson is 5.27 and 5.54, also the range of the students' respond of the post-lesson is smaller than the pre-lesson, it can be reflected the majority of students agreed they love what they have learned in the Blended Learning lesson. This data can become evidence on the Blended Learning



Graph 7: Intrinsic value

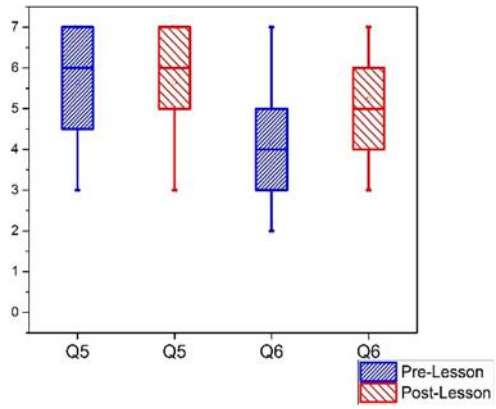
lesson can enhance students' enjoyment of studying physics and enjoyment is one of the important factors on drive students learning.

One of the main reasons that cause the outcome of the level of intrinsic value lower after the Blended Learning lesson may be related to the students' test anxiety. Since question 4 was asked students, if students can learn value from mistakes even, they perform not well in the exam, however, when students under the misunderstanding of Blended Learning lesson containing 2 tests, a high level of test anxiety may make students more sensitive to the keyword on "Exam" and "not well". Therefore, when students were answering question 4 may cause students to have some bad feelings and lead them cannot have great performance on the aspect of intrinsic value. The lower score of question causes the non-significant relationship between the intrinsic value and the Blended Learning approach.

3. Self-Efficacy

Question 5 and 6 in the questionnaire are used to measure students' self-Efficacy on study physics subjects. According to Jackson (2002), Self-Efficacy is related to students' belief and depend on their belief to set up

an action plan that can help them to achieve their goal. Studying will Blended Learning help students strengthen their education belief and drive their study. From the data collected, the pre and post-lesson mean score is 9.7727 and 10.8636, and there is around 11.2% improvement. The p-value of the t-test is 0.025 (in Table 5), which told us that the improvement of self-efficacy was strongly related to the Blended Learning lesson.



Graph 8: Self-efficacy

The collected data that the Blended Learning approach cand help students strengthen their education belief, which they want to perform well in physics subject and this education belief drive student to focus on their learning physics. As Pajares (1996) point out that student with high self-efficacy help they stay calm while they are handling difficulties in education. Therefore, students with high self-efficacy can keep the focus on their education problems and generate solution plans to cope with their difficulties. In this way, the Blended learning approach can strengthen students' learning belief on study physics, drive them to cope with different

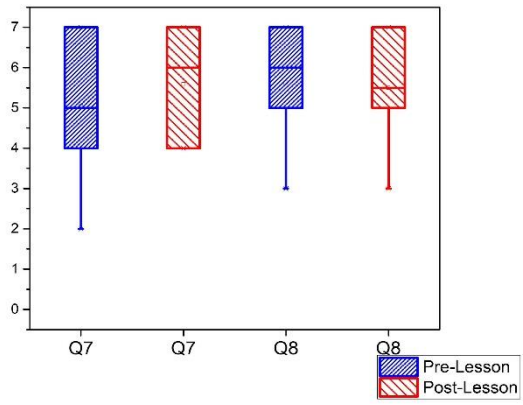
kinds of learning problems in their academic life, which can support students in setting up long time learning goals and have a long journey of studying physics.

4. Cognitive strategy use

While students are learning, students need to use different kinds of the study strategy. The use of the learning strategy can affect students' study effectiveness. According to Hilpert, Stempien, van der Hoeven Kraft, and Husman (2013) pointed out that the learning strategy which can show is students' planning, monitoring, and regulating their learning. If students can select the most suitable cognitive strategy that can support students maintaining the highest learning efficacity and enhance their academic performance. Moreover, there are two main types of cognitive strategy, which are deep and surface learning strategies. As Murayama, Pekrun, Lichtenfeld, and vom Hofe (2013) stated applying a deep learning strategy can help students conduct semantic understanding of knowledge, which provides students a deeper understanding and help students achieve later academic success. Since the deep learning strategy does not just ask

students to memorize knowledge only, students need to study the meaning behind the theory.

In the questionnaire, questions 7 and 8 are used to measure students which cognitive strategy was used when learning new knowledge. The mean score of the pre and post-lesson is 10.6364 and 11.0909, and the p-value of the t-test is 0.219. (in Table 5) This data shows that the improvement of the cognitive strategy was not significant to the Blended Learning approach.



Graph 9: Cognitive strategy use

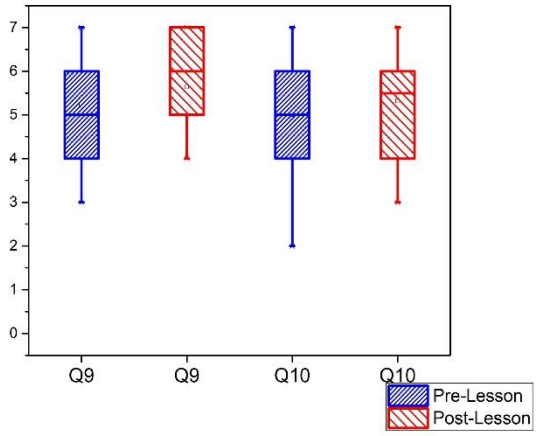
Although the result was not significant, it did not mean the Blended Learning approach cannot let students to conduct deep learning. When focusing on question 7, the responses from students can be noticed that while students were studying a new topic, students tend to adapt old learning materials to support them study new knowledge. To compare students, performance between the pre and post-lesson, the mean score of question 7 was increased by around 11%. Using the old learning material

in studying can support students' structure of new knowledge through prior knowledge support. This is one of the deep learning strategies that can help students organize the relationship between different concepts. However, for question 8, it could be found that there are slightly decreased 0.4% of the mean score, this question was asking students will them asking themselves questions that can be monitoring their study progress. Overall, form these two questions shown out that students did use deep learning strategy in studying physics, but the choice of cognitive strategy was uniform. Therefore, it may cause a non-significant relationship between the Blended Learning approach and improvement of cognitive strategy use.

5. Self-Regulation

Self-regulation was one of the strong factors of learning motivation in students' academic life. In the questionnaire, there are also included two questions to analyze the level of students' self-regulation before and after the Blended Learning lesson, and studying the change in students' self-regulation can let us figure out if the Blended Learning approach can drive students to learn physics subject.

From the data collected, the mean score of the pre and post-lesson of this item is 9.9545 and 10.9549, the percentage change to the related questions 9 and 10 is around 10.0% and 8.7%. The p-value of the T-test is 0.042, and it can prove that the improvement of students' regulation was strongly supported by the Blended Learning lesson.



Graph 10: Self-regulation

This project can help us understand that the Blended learning approach can enhance students' self-regulation. According to Zimmerman and Schunk (2011) point out that students with strong self-regulation in their study, will set up their personal learning goals and reflect on their learning progress regularly. In this way, self-regulated students are more proactive in their studies, they want to maintain high learning effectiveness and achieve their personal learning goals. The improvement in students' self-regulation means students after this lesson, were motivated on studying physics subjects, they are dedicated to learning new knowledge and carrying out their education beliefs. Having a clean learning goal can

drive students to focus on their studies and want to discover different ways to support themselves achieved the learning goal. As Zimmerman and Schunk (2011) stated that self-regulation is more than an individualized learning style, it makes students conduct self-initiated learning. Students will keep monitoring their study progress and adjusting their study method which can keep them having high learning effectivities in education. After all, the information can tell us that the Blend Learning approach can strengthen students' self-regulation and this can drive students to pay attention to the physics subject and keep monitoring their academic performance and ensure they can achieve their personal study goals.

All in all, this project adapted the questionnaire, which referenced the MSLQ questionnaire can provide valued information for us to study students learning motivation in physics subjects. Although, after the Blended Learning approach, not all five aspects can be enhanced by this learning approach. However, two aspects had a significant improvement, which are self-efficacy and self-regulation. These two aspects are powerful on drive students to carry out their education beliefs and enhance their study effectiveness, in that way students are willing to study physics subjects. Especially, under the effect of COVID-19, these two aspects are

important to motivate their learning. As Save the Children Hong Kong (2020) found out that over 66% of respondents reported that while conducting online learning, it was hard to stay focused and 54.8% of junior secondary respondents think that one of the difficulties of learning at home can't be bothered or not motivated. This research shows the learning difficulties for students while under the effect of COVID-19. Self-regulation and self-efficacy become a powerful way to motivate students to study at their place, and the Blended Learning approach can enhance students' enjoyment and ensure students have high learning effectiveness on study physics subject.

Part 6: Discussion

Through this project, we can have a better understanding of applying the Blended Learning Approach in physics subject, and in this project collected students' data, which can help us to analyse the effect on students' academic performance and learning motivation in physics subject. However, in this project, there are some limitations that may affect the outcome of the project. In the following part, it will discuss the limitation of this project.

First of all, the sample size of the project. Due to COVID-19, many schools adopted half-day schooling or special timetable during the time of project conduct. Therefore, when communicating with the participant's school, it is difficult to arrange the lesson time for the researcher to conduct the teaching experiment. In this project, only recruited 22 students joined the experiment. Also, since limited participants, this project did not separate participants into two groups and conduct a controlled experiment, and compare the effectiveness of Blended Learning and normal lesson. In this way, this project cannot give out a clear conclusion on the effectiveness of the Blended Learning approach and traditional teaching methods. To improve the work of this project, it can recruit more students to join the experiment and separate them into two groups and compare students' academic performance and learning motivation that having Blended Learning approach and traditional teaching methods.

The second limitation is the students' background. Before the project, the researcher did not have enough information about students' backgrounds, in this class, some students have special education needs. With this problem, students with special education needs may need more help while they are studying physics knowledge. Also, the teacher needs to do some special design or provide learning support to students. However, before conducting the experiment researcher did not have this information, the experiment may not provide well-learning support to students with special education needs and may affect the data collected through the experiment. In order to ensure all students have positive learning support, before designing the project, need to have enough information on students' backgrounds and needs.

Moreover, the lack of prior knowledge support. In this project, the Blended Learning Lesson has two main learning objectivities, but for the second learning objective when students learn the relationship between the colored object and colored light, they need to understand what kinds of wavelength the colored is reflected. However, before students had the Blended Learning lesson, students did not learn the topic of wavelength yet. This problem cause students may face some difficulties in studying the knowledge about the learning objectivities, and this problem leads to the problem of cannot giving a significant improvement in students' academic performance of learning objectivities

after taking the Blended Learning lesson. In the future, teacher may arrange the Blended Learning lesson after learning the topic of wavelength.

Last but not least, is the problem of technology support. In this project, the participants are experienced in using devices while lesson time. But it was the first time for students to use the virtual laboratory or simulations to do the experiment. During the project, some students have shown that they are not familiar with the function of the simulator and they need to seek help from the teacher. This factor caused students to need more time to study. To improve the project, it can provide an information sheet to students, and students can follow the guideline and finish the experiment.

Although, this project has some limitations and may affect the result of the project. In the future, if there are opportunities to conduct the project again, it can consider the limitation of this project and improve the whole project design.

The further development of this project

Since this project was conducted during the outbreak of COVID-19, it causes many difficulties for students to study new knowledge. To further improve this project, it can build up a learning platform, for example using google classroom, students can log in

to this learning platform on their own devices. The Blended Learning approach still is new for students, students are lack experience in how to apply different kinds of technological learning tools to support them to learn new knowledge. Therefore, if the teacher can build up a learning platform for students to assess the teaching material will be easier for students to follow the teaching. In this way, students can follow the guideline or introduction to conducting learning in their place at any time and anywhere.

Moreover, this platform can be set up for the different levels of learning material, students can select the one that is most suitable for them to use while they are teaching. On the other hand, teacher can use it to monitor students' study progress, so that teacher can give timely feedback to students and adjust their learning plans.

This project shows that the Blended Learning approach can benefit students' academic performance and learning motivation in physics subjects. This result is valued to pre-service and in-service teachers. When teachers teaching physics subjects can consider adopting the Blended Learning approach and provided a better learning experience to students and help them to achieve academic success.

Part 7: Conclusion

In this project, the main target is to study is the Blended Learning approach can improve students' academic performance and enhance students' learning motivation in physics subjects. The data collected in the project supported that the Blended Learning approach did benefit students' academic performance and help students achieve higher academic success. Since the Blended Learning approach combined different kinds of learning activities and supports technology, it can fulfill different learning styles of students, and ensure students maintain high learning effectiveness during the lesson. In studying students learning motivation for physics subjects, although the collected data only can show significant improvement in students' self-efficacy and self-regulation. However, these two aspects can strengthen students' education beliefs that can drive them more willing to study and monitor their learning progress in physics subjects. The positive study environment created by the Blended Learning approach can enhance students' enjoyment of physics subjects, which can motivate students having further development on study physics.

To conclude, in this project can found out that the Blended Learning approach can improve students' physics academic performance and motivate students to learn physics.

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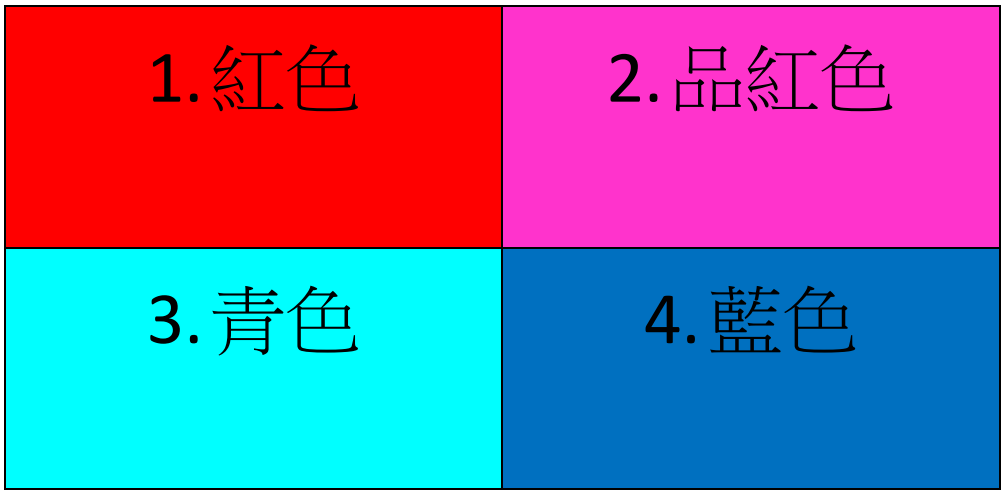
Appendix 1: Pre-test and Post-test questions

1. 以下那個組合是光的三原色？
   - 紅、橙、黃
   - 紅、綠、藍
   - 紅、黃、藍
   - 黃、綠、藍
2. 白光可以分成紅、橙、黃、綠、藍、靛、紫的色光。
   - 正確
   - 錯誤
3. 為了產生青色的光，應該混合那幾種顏色的光？
   - 紅和黃
   - 黃和藍
   - 綠和藍
   - 紅和綠
4. 為了產生品紅色的光，應該混合那幾種顏色的光？
   - 紅和藍
   - 黃和藍
   - 綠和藍
   - 紅和綠
5. 為了產生黃色的光，應該混合那幾種顏色的光？
   - 紅和藍
   - 青和黃
   - 綠和藍
   - 紅和綠
6. 若把一件白色的物件放在橙光下，該物件會顯示甚麼顏色？
   - 紅
   - 橙
   - 黃
   - 白
7. 若把一件紅色的物件放在藍光下，該物件會顯示甚麼顏色？
   - 黑
   - 白
   - 紅
   - 品紅

8. 若把一件黑色的物件放在紫光下，該物件會顯示甚麼顏色？
   - 黑
   - 白
   - 紫
   - 藍
9. 若把一件黃色的物件放在藍光下，該物件會顯示甚麼顏色？
   - 黃
   - 藍
   - 綠
   - 黑
10. 我們看到一件物件顯紅色是因為它只吸收紅色的光。
   - 正確
   - 錯誤
11. 有一個物體，若在綠光照射下看它時，物體呈黑色，則這個物體不可能為何種顏色？
   - 紅色
   - 藍色
   - 白色
   - 黑色
12. 下圖的圖案在黃光的照射下，那一個格子會變成黑色？



   - 1
   - 2
   - 3
   - 4

Appendix 2: Motivated Strategies for Learning Questionnaire

請根據您在本課程中的行為對以下項目進行評分。 您的評分應該是 7 分制，其中 1= 完全不符合我的情況到 7= 非常符合我的情況。

1. 我在考試時非常緊張，以至於我不記得我學到的知識 （測試焦慮）

2. 考試時我有一種不安的感覺（測試焦慮）

3. 我喜歡我在這堂課上學到的東西 （內在價值）

4. 即使我在考試中表現不佳，我也會嘗試從錯誤中吸取教訓 （內在價值）

5. 我希望在這門課上取得很好的成績 （自我效能）

6. 與這個班的其他學生相比，我認為我的表現更好 （自我效能）

7. 我用從舊作業和課本中學到的東西來做新作業 （認知策略的使用）

8. 閱讀時，我嘗試將我正在閱讀的內容與我已經知道的內容聯繫起來。(認知策略的使用)

9. 即使我不喜歡上課，我也努力學習取得好成績 (自律)

10. 我問自己問題以確保我知道我一直在學習的材料 (自律)

Appendix 3: Student worksheet

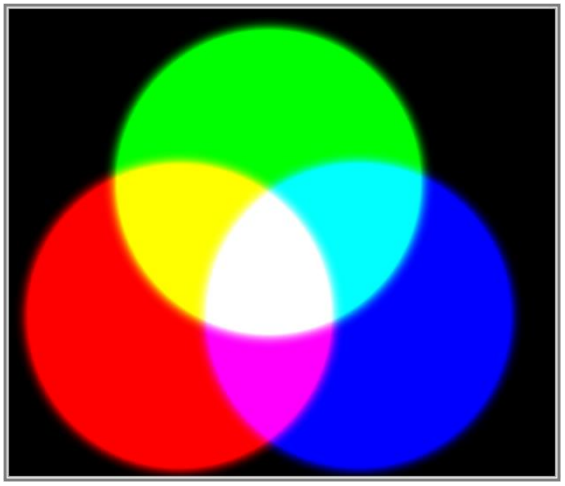
學號：_____ 日期：_____

物理科：顏色和光

白光如何組成

- 白光也可以分成不同的色光， 包括：紅、橙、黃、綠、藍、靛、紫

光的三原色



✧ 最基本的三原色：紅，藍，綠

- ✧ 綠＋藍→青色
- ✧ 紅＋綠→黃色
- ✧ 紅＋藍→品紅色

顏色遊戲：

在遊戲中有 5 張顏色的卡牌：紅色，藍色，綠色，黑色，白色。你要在紅光的照射下分辨出卡牌的顏色。

顏色卡牌	紅色	藍色	綠色	黑色	白色
卡號					
實際卡號					

物件的顏色：

- 某些物件能顯示出特定顏色，因為它會將這種顏色反射到我們的眼睛，並吸收其他顏色的光。

- 白色的物件會反射／吸收所有顏色的光
- 黑色的物件則會反射／吸收所有顏色的光

學號：_____ 日期：_____

物理科：顏色和光

白光如何組成

- 白光也可以分成不同的色光， 包括：_____

  _____

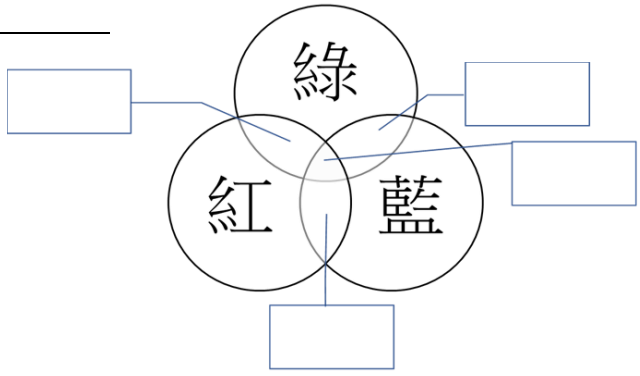
光的三原色

✧ 最基本的三原色：_____

✧ _____＋_____→青色

✧ _____＋_____→黃色

✧ _____＋_____→品紅色



顏色遊戲：

在遊戲中有 5 張顏色的卡牌：紅色，藍色，綠色，黑色，白色。你要在紅光的照射下分辨出卡牌的顏色。

顏色卡牌	紅色	藍色	綠色	黑色	白色
卡號					
實際卡號					

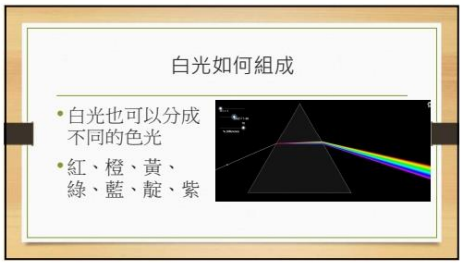
物件的顏色：

- 物件能顯示出特定顏色，因為它會將這種顏色_____到我們的眼睛，並_____其他顏色的光。
- 白色的物件會 反射／吸收 所有顏色的光
- 黑色的物件則會 反射／吸收 所有顏色的光

Appendix 4: The teaching PowerPoint

1

2



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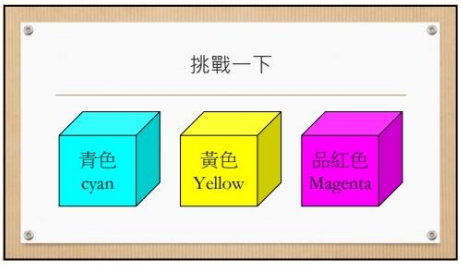

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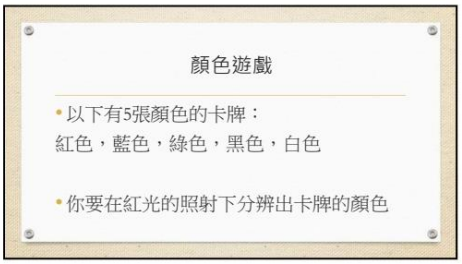

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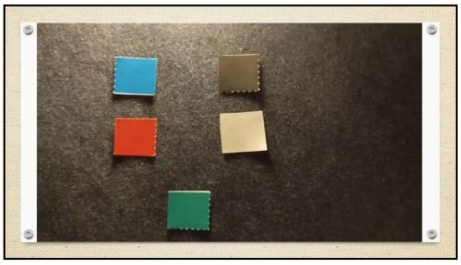

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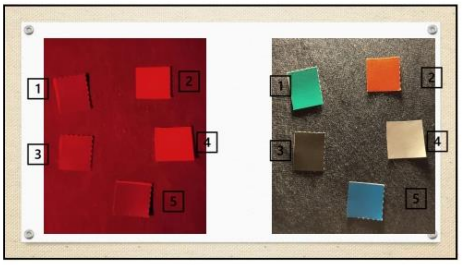

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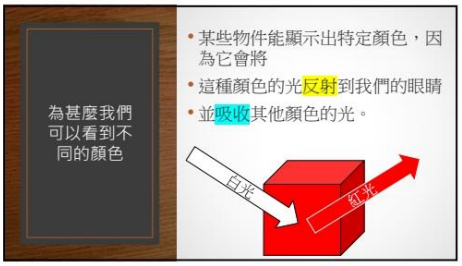

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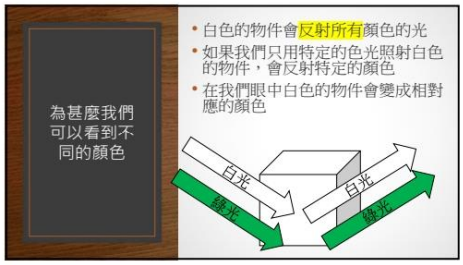

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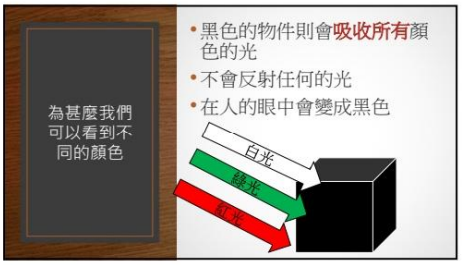

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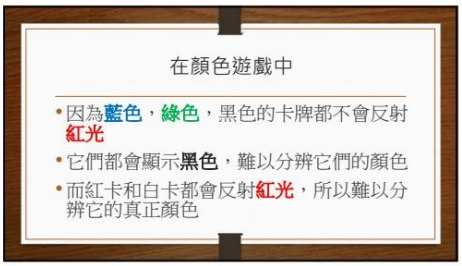

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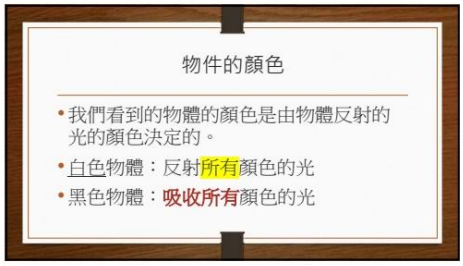

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