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Research Topic: Paper Map instruction versus Digital Map instruction: The impact of students' score change on HKDSE typed question and student's attitude

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Declaration

I, Tang Lai Ying declare that this research report represents my own work under the supervision of the Lecturer of the the Department of Social Sciences, Dr. WONG Kwan Lam, Gwendolyn, and that it has not been submitted previously for examination to any tertiary institution.

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Date: 22th April, 2021

Abstract

Map reading has been perceived as a big challenge in Geography Education for the schools because the performance of the map reading section in Hong Kong public examination remains low throughout eight years. Simultaneously, many educators and geographers suggested using geospatial technology in geography lessons. Therefore, the research aimed to compare Google Map and Paper Map, examining the impact of students' correctness rate and students' attitude towards maps. The study found a marginal difference in terms of the score improvement between two different instructional tools. Students taught with Google Maps displayed slightly higher score change than the paper map. Two different tools were appropriate to teach various map skills areas. For students' perception, they held more positive feelings towards Google Map and preferred it as the teaching material rather than the conventional map. However, teachers should be aware of the discrepancy between the teaching effectiveness and students' attitude because the research found no significant correlation between students' achievement and attitude.

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Introduction

Reviewing the Hong Kong Examinations and Assessment Authority Subject Examination Report and Question Papers from 2012 to 2019, the candidates' performance displayed poorer skills on the map reading. In the multiple-choice section, candidates generally could not get the mark from the map reading question. Throughout eight years, the accuracy of those questions was only 56 percent. (Appendix 1) Since the Hong Kong Diploma of Secondary Education Examination in Geography has been introduced nine years ago, students' ability in map reading is assumed to be improved with more practice papers, and teachers are expected to be more experienced in teaching HKDSE map reading questions. However, the improvement of the candidates' performance is less significant.

To foster teaching and learning, many educators and geographers suggested using geospatial technology in geography lessons. (Keiper,1999; Patterson et al., 2003, Wiegand, 2003; Shin, 2006). The reason for effective learning is because geospatial technology has plenty of geographical information (i.e. population of the area), the function of zooming, overlaying, and dissolving. When it comes to HKDSE map reading questions, which are conducted in a paper-based format, would the benefit of a digital map overwhelm the paper map? It is valuable to investigate the effectiveness of digital maps in teaching the HKDSE curriculum when the value of a paper map is disregarded by some educators. Therefore, this research aimed to compare the score difference of HKDSE typed questions by using paper map teaching and digital map teaching. Since there are several map reading skills required in the HKDSE, this research focused on the contour line reading skills to recognize the relief and calculate the gradient. The reason for selecting contour line reading skills because the correctness rate was low on average. Student's attitudes on different map tools were examined for teachers to design student-oriented lessons.

Background

Hong Kong Examinations and Assessment Authority publishes a Hong Kong Examinations and Assessment Authority Subject Examination Report and Question Papers annually with comprehensive data of students' performance, marking schemes, and commends. (HKEAA, 2012). Candidates performed poorer in the map reading skills than the concept-dominated questions, with merely 56 percent correctness in map reading multiple-choice questions from 2012 to 2019. There has been a little decline in students' accuracy rate since 2015. (Figure 1) By reviewing the exam report, students faced a big challenge in measuring the area of the given place and the average gradient of the slope. (Appendix 1)

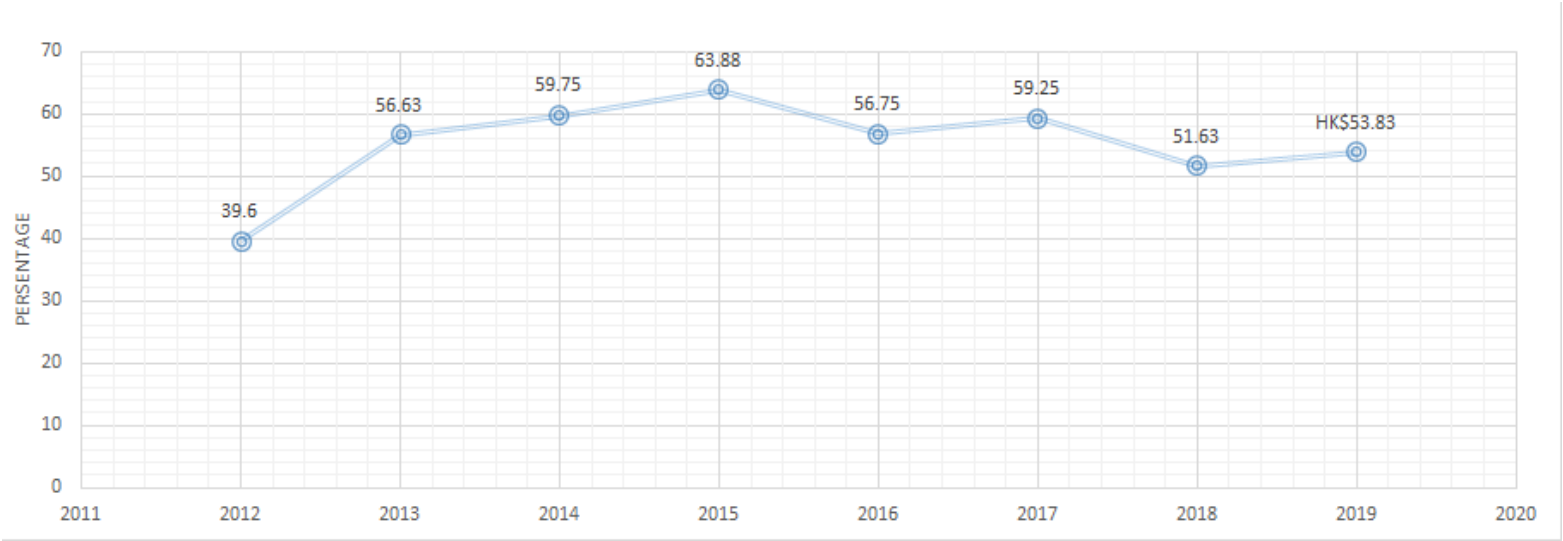

Figure 1. Candidates' correctness rate on map reading questions from 2012 to 2019

There are plenty of factors within the teaching and learning that could drive this poor performance. For example, students' abilities, teaching style, overloaded curriculum. The research took teaching material as the variable to examine students' learning effectiveness in different map tools.

Literature Review

Understanding Map Reading

A map is an informative tool for people to understand the location, direction and way in a unique place. Map skills had been categorized into three domains by Havelková and Hanus (2018) based on the literature review, which contains map reading, analysis as well as interpretation. Map reading is a skill of information extraction from the map features and symbols on the map. For example, detection of contour line, color, legend. Map analysis is a skill of describing spatial relationships and patterns that requires information processing. Map interpretation is a higher ability to provide an explanation or even a solution after acquiring information from the previous steps. (Beitlova, Popelka & Vozenilek, 2020). Geography Curriculum and Assessment Guide show that map reading covers plan view, arrangement, proportion, and map language. (Education Bureau, 2017) Thus, at a secondary level, teachers' and students' perception of map skills generally considers map reading, they pay less attention to map analysis and map interpretation.

National Research Council and Geographical Sciences Committee (2006) mentioned that spatial thinking is a "concept of space, tools of representation, and processes of reasoning. It is the concept of space that makes spatial thinking a distinctive form of thinking" (p.10). Map skills differ from spatial thinking, the former requires a map as a tool to extract information but the latter is an abstract concept that is embedded in school subjects(science, mathematics, geography), work and everyday life without using the map. Despite the two concepts being different, they are associated and interconnected. If students read the map frequently, they would perform better in map reading when they could imagine a mental map and think spatially. In Hong Kong Geography Curriculum, map reading is merely designed and taught for the examination but rather for thinking spatially.

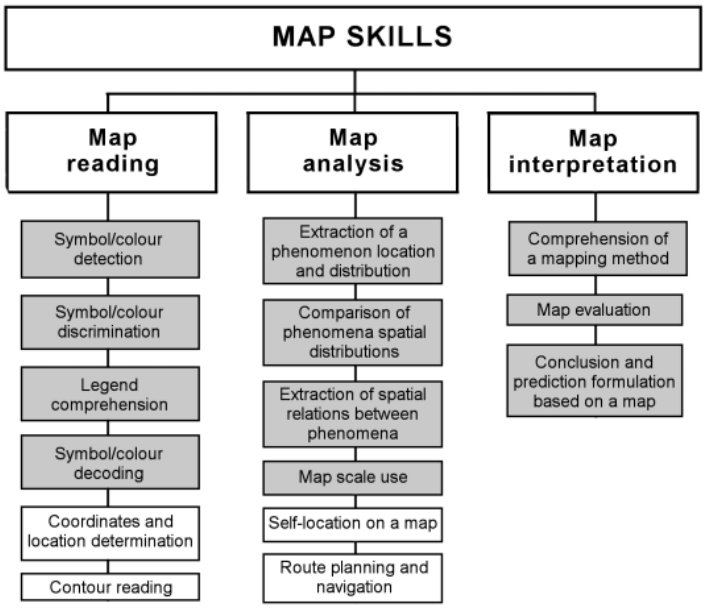

Figure 2. A model of a summary of map skill

Source: Havelková, L., & Hanus, M. (2018). The impact of map type on the level of student map skills. *Cartographica: The International Journal for Geographic Information and Geovisualization*, *53*(3), 149–170

Teaching Map reading

Muir (1985) pointed out most children lack the practice of scale exchange and detect a location from aerial view. The data from HKEAA also reveal a similar learning difficulty in learning map reading among Hong Kong secondary students. The correctness rate of those measuring the actual area and gradient were below 50 percent. To facilitate spatial thinking, and enactive experience is crucial for students to expose the real world so that students could compare the paper map to the familiar environment. (Bruner,1966; Muir, 1985) For example, compare the size, distance of an object between the map and the actual world to reduce students' confusion for the scale exchange. Students would be earlier to imagine a 3D mental map when we look at a 2D map with many symbols. Still,

limited opportunities to expose is one of the reasons leading to the lack of spatial thinking among students.

In terms of the assessment tool for map skills, there are countless indicators for spatial thinking. For instance, the speed, wayfinding accuracy, and independence during wayfinding(Hergan & Umek, 2017), the accuracy and feature extraction of drawing sketch maps (Shin, 2006; Field et al., 2011), journey planning and creating (Hurst & Clough, 2013). Standardized tests are also commonly used for map reading skills assessment. Collins(2018) used Spatial Thinking Ability Tests to assess map skills of eighth-grade students in South Carolina. HKDSE is a public examination for Hong Kong secondary six students. Despite the map skills being assessed in the Multiple-Choice section, Data-based question and Fieldwork question section, the examination mainly focuses on students' geography content knowledge rather than map reading skills.

Geospatial technologies and Geography Education

Geospatial technology represents the Geographical Information System, Global Visualisation Tools and Global Positioning System. (Bodzin, Anastasio & Kulo, 2014). The advantage of Geospatial technology on Geography Education has been proved by many scholars, despite people's concern about whether these technologies are selected and implemented correctly. The function of GIS such as the overlying layer, abundant data insert, flexible zooming greatly enhances students' reap reading skills and geography content knowledge. (Taylor & Plewe, 2006; Wiegand, 2003) For instance, Students could identify geography phenomena and proposed solutions as GIS provides visual patterns with temporal and spatial data. (Taylor & Plewe, 2006; Baker & White, 2003; Shin, 2006). As Keiper (1999) claimed GIS is a pedagogy material to " shift from learning about geography to learning to do geography"(p. 57). Shin (2006) found students managed to draw better sketch maps by using aerial view, different colors, lines and symbols after teaching with GIS. Although this research uses Google Maps as

instructional media, both geospatial technologies are interactive map tools with some similar functions.

Students Achievement with Paper map and digital map

Despite there being a consensus of geospatial technology and learning effectiveness, it is debatable whether the digital map can replace paper maps because different instructional tools are selected for different learning objectives and activities. (Verdi et al., 2003; Cunningham 2005; Pedersen et al., 2005; Collins, 2018). Due to the 3D-visualization of Google Maps, some high-school students showed better geomorphology knowledge and topographic map reading skills than paper maps. (Hsu, Tsai & Chen, 2017) Hergan and Umek, (2017) found a primary school student performed better in wayfinding with mobile navigators than with paper maps. Students in the experimental group were faster, more independent, and accurate to find their route. However, mobile navigators failed to encourage students to practice map reading skills, such as self-location, object recognition when they kept looking at the screen. A similar result also found students who used digital maps performed poorer in map construction because they had fewer opportunities to think spatially by using a mouse. (Collins, 2018; Cunningham 2005) Since Google Earth limited students' active thinking and recalling prior knowledge, students relied on the automatic function of calculating distance. Collins (2018) found that students who used paper maps performed better in the Spatial Thinking Ability Test. There was no significant difference in the result between paper map and digital map in Pedersen, Farrell & McPhee (2005). In short, the effectiveness of two instructional tools depends on the teaching objective, subjects as well as the assessment tools.

Figure 3. The Summary of the literature review

Digital Map > Paper Map	Digital Map < Paper Map	Digital Map ~ Paper Map
Hsu, Tsai & Chen (2017) Hergan & Umek (2017) Thomas & Steven (2007)	Carbonell-Carrera et al. (2018) Hegarty et al. (2009) Collins (2018) Cunningham (2005) Niedomysl et al. (2013)	Pedersen , Farrell & McPhee (2005) Verdi, Crooks & White (2003)

Students Attitude with Paper map and digital map

Learning motivation is related to students' academic achievement, therefore many scholars investigate their perception and attitude of electronic maps and paper maps. Students' opinion was quite diverse in different research. First, Clough (2013) found more than half of people favored electronic maps because the digital map allowed students to see the map and additional information simultaneously which was helpful and easier for them to learn and use (Clough, 2013). Several researchers found that students favored paper maps over digital maps (Keiper 1999; West 2003; Pedersen et al., 2005; Hurst & Clough, 2013; Collins, 2018) The reasons for choosing printed maps were that it allowed students to see a whole map without consuming time on zooming and scrolling (Pedersen et al., 2005), its information reliability, presentation, and appearance seemed to be clearer than computer maps. Interestingly, Hurst and Clough (2013) indicated that education level influenced the map choice, geographic specialists and those had higher geographic knowledge preferred paper map

The paper has differentiated map reading skills and spatial skills, the latter is a way of thinking without using the map. It is found the digital map is more likely to improve map reading skills by the interactive and automatic functions. Meanwhile, those functions also inhibit people to train their spatial skills. It is important to understand digital material is not always more favorable than the traditional map. It encourages me to survey the

opinion of Hong Kong secondary students regarding the map tool. Importantly, the students' perception and impact of digital maps require more research, the outcome is various with the different participant and assessment tools.

Research Questions

Despite many scholars studying the impact of geospatial technology on geography lessons, fewer studies have compared printed maps and Google Map. Thus, the question arose to what extent Google Map teaching has a greater impact than printed maps on students' map reading skills. To measure the effectiveness, this study analyzed the correctness rate and the improvement between two maps via multiple-choice questions. Although some similar research has been done by Collins (2018), Hergan, and Umek (2017), the results were different by the research objective and methodology. Therefore, this study was significant to fill the research gap, compared the correctness rate on HKDSE typed questions between two teaching materials. Second, this research focused on contour line reading, including gradient calculation which is the biggest difficulty for secondary students. It is hoped to improve teaching pedagogy and students' performance in HKDSE in the future.

The research objectives :

1. To compare students' correctness rate and improvement on HKDSE typed multiple-choice questions between Google Map instruction and printed map instruction
2. To explore students' perception with Google Map instruction and paper map instruction in a geography lesson

Methodology

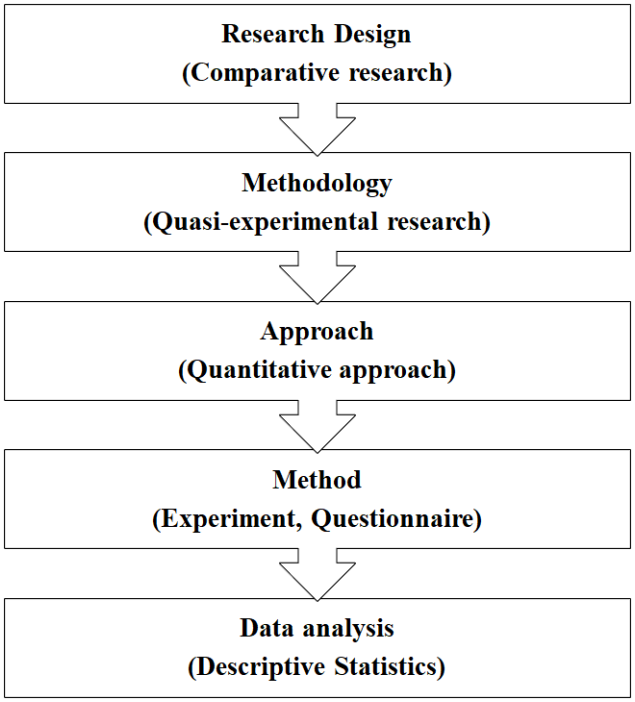

Figure 4: The summary of the Methodology

Research design

It was a comparative research to investigate the impact on the correctness rate of HKDSE Typed-questions between Google Map instruction and the paper map instruction. To understand the effectiveness of map tools, a before-and-after design was adopted. Students were undergoing a pre-test without lecturing and pro-test after the intervention. Despite this research design regarded as time-consuming (Guthrie, 2010), the experience could be completed in two lessons. Therefore, the study mainly focused on contour line reading rather than all map skills. The regression effect might be a challenge for this research, it showed a natural result between two maps. Therefore, a student's attitude became valuable information to enlarge the result and make it more convincing. Some extraneous variables can affect the fairness of this research. For example, the different

interactions or instructions in the lesson. To minimize this bias, students who participated in this research watched a video to learn map reading skills but rather face-to-face teaching, to ensure similar teaching instruction and procedure.

In terms of the methodology, this study will adopt quasi-experimental research and collect data by pretest and protest from both the control group and the experimental group. Since the control group is the paper map group, there is no treatment for that group. There are 48 participants invited from 2A and 4A, to avoid bias from students' ability, the allocation of the two groups was even. Both the control group and the experimental group would contain students from 2A and 4A.

Approach

The study adopted quantitative approaches that mainly focus on numerical information. Numbers and statistics are important information for analyzing data. It differs from the qualitative approach, which pays more attention to the description of participants' feelings and perceptions. (Walliman, 2017). In short, the result of students' correctness rate and their attitude would be presented by measurable data.

Method

Procedure

The research was conducted during my block practice period (17 Oct to 28 Nov) at AD & FD POHL Leung Sing Tak College. Generally, students both in the control group(paper map) and digital group(Google map) were asked to complete 8 HKDSE typed questions before and after the intervention (video-teaching with Ipad). The procedure of the research would be pre-test, intervention, and teaching, pro-test. The process lasted for 45 minutes and took two lessons. (Figure 4.)

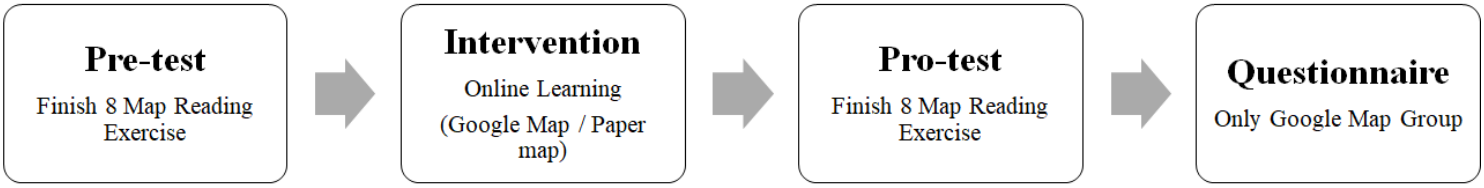

Figure 5. The procedure of the quasi-experimental research

Design of the pre and pro test (Appendix 2)

The assessment was designed in a multiple-choice format because the DBQ and FBQ in HKDSE are likely to test students' Geography content knowledge rather than map reading. The questions mainly tested the skills of contour line reading and analysis. It covered the measurement of the gradient, relief identification, and direction recognition from photography. In this paper, HKDSE typed questions refer to the exact DSE questions and modified questions that provided more hits. For example, some of the questions provided a horizontal line for students to calculate the gradients and highlight the spot height. Those adjustments only assist students to identify the location quickly, details given to the participants do not affect students' contour line reading and the

findings. The questions design of both pre-test and pro-test would be the same but students did not get the answer after the pre-test, therefore the change of their performance majorly dependent on the video-teaching.

Participants

School level	Number of participants in Google map's group	Number of participants in paper map's group
4A	10	9
2A	14	15
Total	24	24

Figure 6. The number and distribution of participants

After the pre-test, students picked one video link from two for the experiment allocation. However, they would not know which is which. The participants were selected on the basis of non-random sampling as the classes were assigned by the school. The research invited a total of 48 students: 24 from the two classes that formed Paper map's group and Google map's group respectively. (Figure 6) Paper map group was designed as a control group, while the Google Map group was the experimental group. The samples were collected on the basis of convenience sampling that allowed students to choose one set of exercise from two but they were not told which was which.

Design of the teaching (Appendix 4)

For the intervention, all participants would learn in a video-teaching by using an Ipad. The reason for video-teaching but rather face-to-face teaching is to control both 2A and 4A students could get a similar teaching instruction without over-explain. The research controlled the time of two videos, neither more nor less than 3 minutes. Further, the mode of teaching was also affected due to the infection of COVID-19, which ensured the

experiment could be continued during the class suspension. Students in the control group would learn the contour line reading skills with a 1:20000 paper map that is the typical teaching material in Geography lessons. Students in the experiment group would learn with the Google Map, that provides various map scales.

Questionnaire design(Appendix 3)

Given that the control group did learn with the Google Map, only the experimental group finished the follow-up survey. The questionnaire was distributed by the teacher after the pre-test in the class. The key questions are 1) How do you feel about the paper map and Google Map in learning map reading. 2) How Google Map and printed map affect you to learn map reading and answer HKDSE typed questions. Since it was a self-completion survey, close-ended questions with a 5-point Likert scale would be adopted to keep the survey simple. For example, to what extent do you agree it is more enjoyable to use the Google Map in the lesson? Finally, students would choose their favorite map tool and there is an open-ended question for them to explain their decision.

Data analysis

Measurement variables

The study adopted discrete categories to analyze the data. The independent variables were the map type and the attitude. The dependent variable was students' test score change or correctness rate. Furthermore, according to the HKDSE past paper, there are several types of questions requiring the skills of reading contour lines. For example, calculating the gradient, recognizing the topology, and identifying the direction. It was hoped to investigate which kind of questions would be affected most by digital map instruction.

Statistical analysis

This paper demonstrated students' correctness rate of pre-test and pro-test by descriptive statistics. The analysis compared students' mean scores of pre-test and pro-test between 2A and 4A. It was not only observing the impact of digital maps but also the effect between two different grades.

The data of students' perception with two map tools were presented by descriptive statistics, showing the responses in percentage and standard deviation. Also, this research used the Kendall rank correlation coefficient to investigate the correlation between students' score change and their attitude towards the maps.

Result and Discussion

In this section, the paper will illustrate the teaching effectiveness of Paper map and Google map instruction. The mean test score compared by two experience groups, the context of students' learning interest will be reported. Overall, the result shows students in Google Map instruction perform marginally poorer performance but higher score change than Paper Map. Regarding students' attitude towards two maps, students had more positive feelings when they were learning with Google Map so that most of them favored and preferred Google Map teaching. The research concluded that Google Map and Paper Map could complement each other but 3D map teaching may not replace the traditional teaching, at least for the HKDSE Geography map reading.

Effectiveness of Google Map and Paper Map instruction : Comparison of students test score

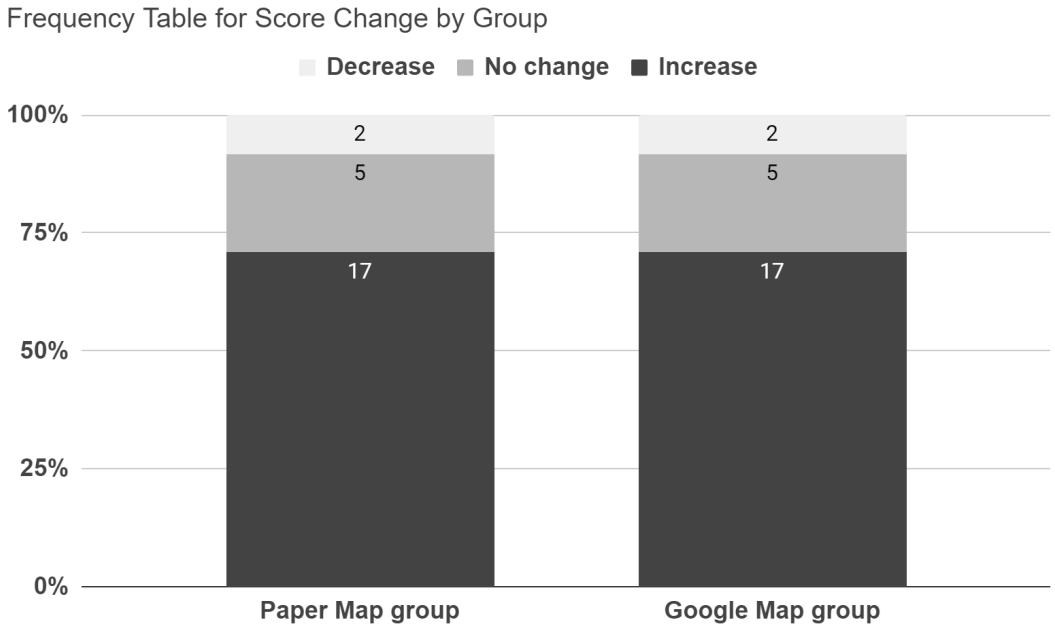

Figure 7. The stacked bar chart of students' score change

Comparing the test scores in the pre-test and pro-test, students in the Google Map group performed similarly to the Paper map group. First of all, the stacked bar chart displays an overview of the result. Surprisingly, there was no difference between the two teaching approaches, as the same result observed from Figure 1. 71 percent of the students had score improvement after the intervention, 21% of them had no change and 8% of them had a mark decreased after the intervention.

Figure 8. Mean score from Pre-test and Pro-test by group (Score 1-8)

	Google map's group (experiment group)			Paper map's group (control group)		
	Pre-test	Pro-test	Change	Pre-test	Pro-test	Change
4A Class	3.20 (40%)	5.10 (63%)	+1.90 (23%)	4.00 (50%)	5.56 (69%)	+1.50 (19%)
2A Class	1.71 (21%)	3.64 (45%)	+1.93 (24%)	2.07 (25%)	3.87 (48%)	+1.70 (23%)
Total	2.33 (29%)	4.25 (53%)	+1.92 (24%)	2.79 (34%)	4.50 (56%)	+1.71 (22%)
SD	1.8	1.8		1.9	1.6	

The table displays students' performance and improvement in the experiment by groups. The means score and correctness rate (percentage of students answer correctly) present students' achievement and the mean score change presents the improvement and the effectiveness of two different maps. The total test was 8, students in the Paper map group (4.25) got higher mean scores than the Google Map group(4.5) in the pro-test. Both 4A and 2A class students performed better after learning with the traditional map. To compare the effectiveness between the two maps, the degree of the score change is more critical than the actual mean score because students' ability and their prior knowledge are influential to the test score. In the pre-test, the Paper Map group also performed better

than the experimental group, with 0.6 and 0.9 score differences in 2A and 4A respectively. The reason for getting a higher achievement in the pre-test and pro-test might be the students' ability rather than the impact of two maps.

Regarding the score change, despite the value of the score change showing a minimal difference, students who underwent the Google Map teaching increased more than the Paper map. 4A students obtained a gain of 1.9 score increase with Google Map instruction, 1.5 score increase with Paper Map instruction. The score gain of senior students was higher than the junior. 2A students had a 1.9 score change with Google Map instruction, 1.7 score change with Paper Map instruction. Combined with 2A and 4A, the gain of students in the Google map group was 1.92 in the pro-test, while 1.71 in the control group.

This research indicates that Google Maps were not more effective than the paper map as the data were insufficient to compare two teaching methods with slight differences. This result coincides with previous research (Pedersen, Farrell & McPhee, 2005; Verdi, Crooks & White, 2003). They found no significant difference in learning outcomes among students using traditional 2D or digital maps. It is undoubtedly the virtual and tangible 3D map that displays the precise image of the relief and provides a great visual effect(Hegarty et al. 2009), the realism could assist some students to imagine a mental map as well as to think spatially. However, the HKDSE Geography, pretest, and protest are paper-based exercises so some students were familiar with the paper format rather than the digital. Carbonell-Carrera and other scholars (2018) studied the performance between Augmented Reality and paper maps. They also found that one of the obstacles for 3D map teaching was it's dissimilar to the traditional exam.

The result could be interpreted by Bloom's Taxonomy(1956) that describes the level of cognition. HKDSE Geography is a public examination for secondary graduates, the level

of the assessment involved high-order thinking skills. The map reading section mainly tests application and analysis which is hard to be trained by Google Map because its format would discourage students from applying the skills when they take the conventional exam. In contrast, Google Map seems a better instruction tool than paper maps in terms of knowledge recall and understanding, the beginning level of cognition. Verdi, Crooks & White (2002) asserted the students taught with the computer map were able to recall more text information and map features. However, map reading exercises tend to be skills-oriented that require a considerable amount of time to study.

Effectiveness of Google Map and Paper Map instruction : Comparison of map skills area

Despite there being no contradiction between Google Map and paper map in terms of the student's overall achievement, the research found that students taught with Google Map performed stronger improvement than the paper map in the exact HKDSE past paper questions(Question1, Question5). Q1 and Q5 were obtained from HKDSE 2018 and 2016. The growth of the correctness rate of Q1 in the experimental group is 54%, which is double of the paper map group.

Figure 9 shows the number of students who answered correctly and its percentage (correctness rate) in map reading skill categories by test among 24 students in each group. With reference to the Geography Curriculum and Assessment Guide (Education Bureau, 2017), the categories followed with “Plan View”, “Arrangement” and “Proportion”. Collins (2018) stated that “different media might be better equipped for teaching students different spatial thinking skills”.(p.147). In this paper, 3D maps were useful to teach “Proportion” which includes gradient calculation and scale conversion. Besides, 2D maps were probably appropriate to teach “Plan View” such as perspective and relief identification.

Figure 9. The correctness rate in map reading skill categories by group and test (N = 24)						
	Google map's group (Experiment group)			Paper map's group (Control group)		
Catorgories	Pre-test	Pro-test	Change	Pre-test	Pro-test	Change
Plan View (perspective and relief)						
Q2	7 (29%)	6 (25%)	-1 (4%)	11 (45%)	17 (70%)	+6 (25%)
Q3	13 (54%)	17 (70%)	+4 (16%)	6 (25%)	12 (50%)	+6 (25%)
Q6	13 (54%)	17 (70%)	+4 (16%)	5 (21%)	13 (54%)	+8 (33%)
Q8	7 (29%)	18 (75%)	+11 (45%)	14 (59%)	18 (75%)	+4 (16%)
Proportion (scale, distance and selection)						
Q4	2 (8%)	12 (50%)	+10 (42%)	8 (33%)	12 (50%)	+4 (16%)
Q5	5 (21%)	6 (25%)	+1 (4%)	7 (29%)	7 (29%)	0
Arrangement (location, direction and orientation)						
Q1	1 (5%)	14 (59%)	+13 (54%)	11 (45%)	17 (70%)	+6 (25%)
Q7	8 (33%)	12 (50%)	+4 (15%)	5 (21%)	12 (50%)	+7 (29%)

The result illustrated that “Proportion” suited teaching with the digital map, students in that group improved more than the paper map group. Question 4 and 5 examined the skills of gradient calculation. In Q4, 42% more students in the Google Map group were able to choose a correct answer, while only 16% more students improved in the paper map group. No students improved in Question 5 after learning with the paper map. This result coincides with Collins (2018), students taught with Google Earth increased more than the SC Maps(paper map) in the skill area IV which is imagining a slope profile.

In contrast, “Plan View” suited teaching with the paper map, students in that group had better improvement than the paper map group in Question 2,3,6. Q6 tested the cross-section, the correctness rate grew 33% in the paper map group but only 16% in the Google Map group. To master the cross-section, students are capable of mentally visualizing 3D relief based on the 2D map. A similar finding reported students taught with Google Earth faced more difficulty and performed worse in the same map skills category (Collins, 2018). Besides, the 2D map was also more practical to teach “intervisibility”(Q3) because better changes could be observed among students with the paper map instruction (25%) than Google Map (16%).

The reason for different maps doing a better performance in a particular map area is limited. Despite Collins (2018) conducted a similar study, it lacks a further explanation of the result. In short, both maps are influential in teaching different categories of map skills. 3D maps tended to teach students better in “Proportion”, yet the 2D map was appropriate to teach “Plan view”. This result can also explain the previous finding, why it was complicated to differentiate two maps. It is because they were good at teaching different categories of map skills. Therefore, Google Map and Paper Map could complement each other, teachers should focus specifically on the learning objective and how to teach rather than paying too much attention to the map type.

Effectiveness of Google Map and Paper Map instruction : Comparison of students' attitude.

The experiment reveals there was a marginal difference between Google map and Paper map instruction in terms of the test score change and map skills area. Apart from the effectiveness of the maps, the schoolteacher may consider the student's preference and attitude in teaching planning. The research found that students favored teaching with Google Map, most of them had positive feelings when they were learning with the 3D map. They believed Google Map helped them to learn map reading. However, there was no correlation between students' attitude and their test performance.

Regarding the feelings of teaching with the paper map, the majority of students chose "Neutral" to all the 10 emotion words. Despite this unbiased view, very few people enjoyed using a paper map, with only 8% of students agreed paper maps were "Excited", "Motivated" and "Feeling of success". However, they did not have a negative feeling when they were using paper maps as more than 30 percent of them disagreed with the description of "Distracted", "Frustrated" and "Confused". As the paper map is the most common and traditional map tool, students do not have any extreme feelings or disfavor.

There were less unbiased results to the feeling of using Google Map. It also reflects students favored the Google map because 62 percent of the students agreed it was "Motivated", "Concentrated" and "Relaxed". About half of them disagreed with "Bored" and "Frustrated" respectively. Interestingly, over 30 percent of students agreed to feel "Difficult" when they were learning with either the Paper map or Google map. The number of students sensed more "Confused" in the Google Map group (29.1%) than the paper map group(16.7%). It reveals meaningful information that the influence of map type is less critical than what we expect. It reveals meaningful information that the influence of map type is less important than what we expect. Georgiou et al. (2007) suggested another key for effective teaching is appropriate teaching material, teaching approach, and passionate teachers.

Students' Feelings of using Google Map (Total 24 students)								Students' Feelings of using Paper Map (Total 24 students)						
Survey Item	Responses in %													
	SDis	D	N	A	SA	Mean Score	SD	SDis	D	N	A	SA	Mean Scroe	SD
Excited	4.2	0.0	45.8	25.0	25.0	3.7	1.0	12.5	25.0	54.2	0.0	8.3	2.7	1.0
Feeling of success	4.2	0.0	50.0	29.2	16.7	3.5	0.9	12.5	20.8	58.3	0.0	8.3	2.7	1.0
Relaxed	4.2	8.3	25.0	37.5	25.0	3.5	1.2	12.5	33.3	45.8	0.0	8.3	2.6	1.1
Motivated	4.2	0.0	33.3	29.2	33.3	3.9	1.0	12.5	25.0	54.2	0.0	8.3	2.7	1.0
Concentrated	4.2	0.0	33.3	41.7	20.8	3.8	0.9	2.0	16.7	54.2	12.5	8.3	3.0	1.0
Bored	25.0	29.2	25.0	12.5	8.3	2.8	1.3	4.0	12.5	45.8	20.8	4.2	2.9	1.1
Difficult	20.8	20.8	25.0	25.0	8.3	2.9	1.3	12.5	12.5	37.5	25.0	12.5	3.1	1.2
Distracted	16.7	20.8	37.5	16.7	8.3	2.8	1.2	3.0	29.2	41.7	8.3	8.3	2.9	1.1
Frustrated	20.8	29.2	29.2	12.5	8.3	2.6	1.2	12.5	16.7	50.0	12.5	8.3	2.9	1.1
Confused	16.7	25.0	29.2	20.8	8.3	2.8	1.2	12.5	20.8	50.0	12.5	4.2	2.8	1.0

SDis - Strongly Disagree; D - Disagree; N - Neutral; A - Agree; SA - Strongly Agree

Figure 9. The feelings of students learned with two maps

Figure 10 illustrates additional reasons for students more favoring the Google Map. For example, the digital function was more “clear and easy to read" (83% agreed), “informative”(79%), and “helped them to imagine the real world” (75%). Those positive effects of geospatial technologies on students’ interest have been noted in previous papers as well. (Keiper 1999; West 2003; Pedersen et al., 2005; Hurst & Clough, 2013; Collins, 2018). Students displayed both knowledge enhancement and interest in Earth Science with Google Map instruction in Landicho (2020). However, The research discovers the phenomenon of overestimation of the impact of Google Map. First of all, the majority of students thought Google Maps was more effective to improve map skills but the previous findings have indicated two kinds of instruction merely had marginal differences to students' learning outcome. Secondly, 79 percent of them thought Google Map was a better instructional tool for them to learn and recognize relief, while the research experiment showed students’ relief identification skill had greater improvement in the paper map group rather than Google map group. There are some loopholes in learning with Google map. About one-third of the students were confused with Google Map instruction (Figure 9) and believed learning with Google map would take more time than the paper map(Figure 10), which was mentioned in the Hegarty et al. (2009), stating that the 3B map might bring detrimental effects to learning. In their research, adding realism function increased participant's response times and lowered the accuracy of their test performance.

Figure 10. Students' Perceived Effectiveness between Google map and Paper map instruction (N=24)

Survey Item	Responses in %						
	SDis	D	N	A	SA	Mean Score	SD
Google Map is more helpful in real world imagination	4.2	0.0	20.8	45.8	29.2	4.0	1.0
Google Map is clearer and easier to read	4.2	0.0	12.5	50.0	33.3	4.1	0.9
Google Map is more informative	4.2	0.0	16.7	37.5	41.7	4.1	1.0
The function in Google Map can better meet my needs	4.2	0.0	29.2	33.3	33.3	3.9	1.0
I am more likely to be motivate to learn map reading by Google Map	4.2	4.2	41.7	25.0	25.0	3.6	1.1
Google Map instruction is more effective to improve map skills	4.2	0.0	29.2	37.5	29.2	3.9	1.0
Google Map instruction is more helpful to learn direction	4.2	0.0	25.0	33.3	37.5	4.9	1.0
Google Map instruction is more helpful to learn gradient	4.2	0.0	29.2	33.3	33.3	3.9	1.2
Google Map instruction is more helpful to learn relief	4.2	0.0	16.7	41.7	37.5	4.1	1.0
I think Learning with Google Map takes more time	12.5	20.8	29.2	29.2	8.3	3.0	1.2
I prefer Google Map than Paper Map despite the exam adopts paper-format	4.2	0.0	37.5	33.3	25.0	3.8	1.0

SA - Strongly Disagree; D - Disagree; N - Neutral; A - Agree; SA - Strongly Agree

In terms of the mismatch between students' attitude and their score improvement, the paper adopted the Kendall rank correlation coefficient to investigate the correlation between them. (Figure 12) It is found that there is an insignificant correlation between students' preference and their score change. ($p = 0.37$, $p<0.05$) These results are in contrast to some research findings. Bakaret et al. (2010), Papanastasiou (2000) proved students' achievement in General Education and Mathematics could be raised by attitude. Bakaret et al. (1997) stated that "motivation and attitude were the best predictors of student academic performance"(p.1).However, there is sufficient evidence demonstrating that two variables could appear discrepancy. For instance, Collins (2018) suggested no correlation between the gain of STAT scores and the perception of students to Geography. Langat (2015) suggested students who liked Mathematics still perform worse than those who disliked it. She explained that the possible reason could be time-consuming, getting a high score required an extra and a considerable amount of time to study. The way students perceived their assignments was also critical as the result reflects whether the students were lazy or were not serious. As pointed out by Georgiou et al. (2007), "High achievement could serve to predict a positive attitude towards math, but such an attitude could not predict stronger achievement" (p.18). Student's attitude is merely one of the factors to their academic achievement, it could be affected by teaching methods, style and learning material.

The objective of this research was not simply to display students' attitudes and encourage teachers to meet their desire. Instead, teachers are expected to be professional. They should select the best learning material for their students but not allow students to take control of the lesson. Above 50 percent of students preferred learning with Google Map even though they understood its constraint, exam adopts paper format. (Figure 10) Likewise, Hegarty et al. (2009) revealed that undergraduate and post-graduate meteorology students' performance was impaired by the realistic map but they consistently selected this display. Students are more likely to consider the attractive visual

learning experiences rather than the effectiveness of the map tools on their study. Therefore, teachers should maintain a balance between students' attitudes and actual learning effectiveness when they plan the lesson.

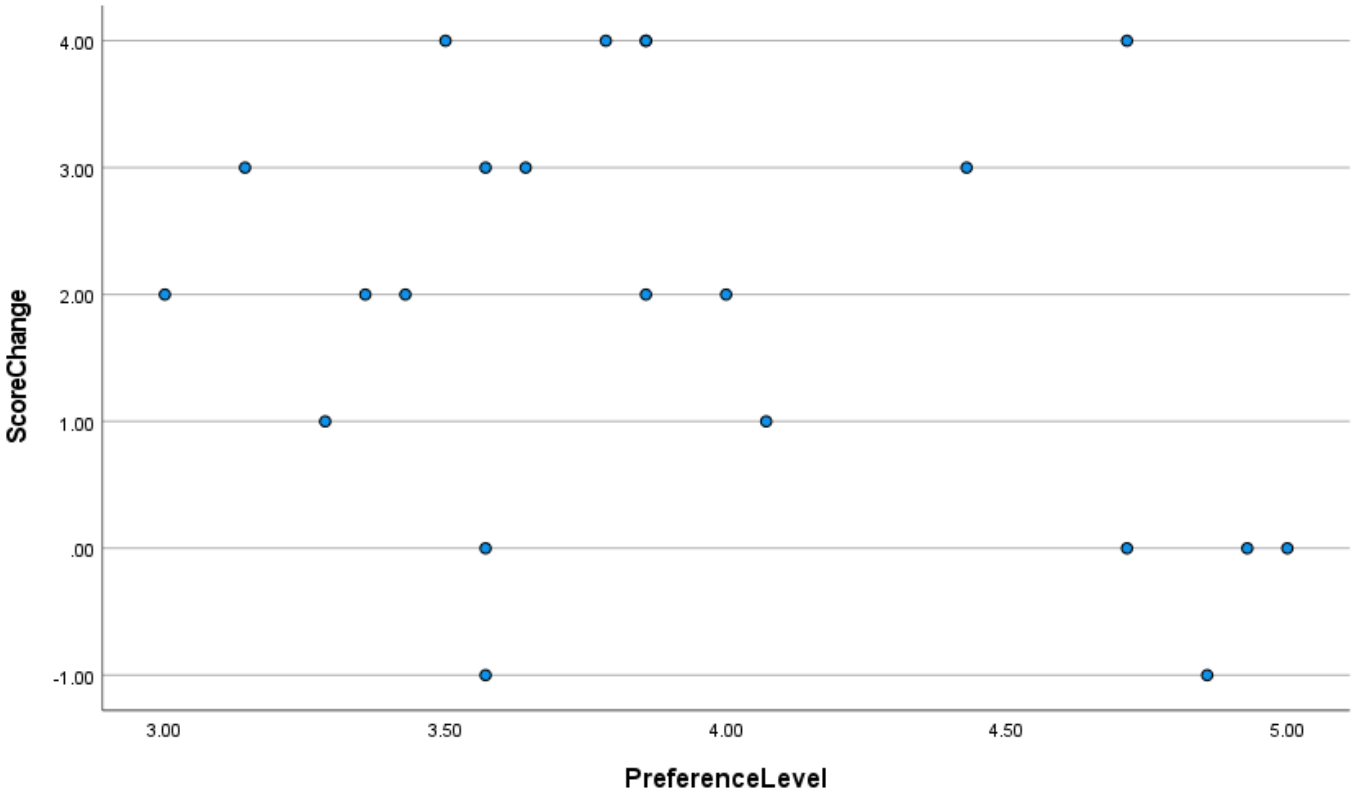

Figure 11. The Scatter plot of Attitude Level and Test Score change

Correlations

			Score Change	Preference Level
Kendall's tau_b	Score Change	Correlation Coefficient	1.000	-.148
		Sig. (2-tailed)	.	.370
		N	22	22
	Preference Level	Correlation Coefficient	-.148	1.000
		Sig. (2-tailed)	.370	.
		N	22	22

Figure 12. The Correlations between Students' score difference and their attitude in the Google Map group

Limitation

The research has filled the gap that compared the effectiveness between Google Map and Paper map instruction in the Hong Kong context. The focus of the research is HKDSE Geography and secondary school students. Due to the different educational systems and cultural differences, the application of the research might not be covered in other countries. Also, the participants came from different grades, despite the research minimized the impact of student's learning capacity by dividing them evenly into four groups, It might also be desirable in future research to invite the senior students in the same grade, at least they will regard the research more serious. The final constraint of this work is the mode of the teacher. The 3D map is perceived to be more effective because of its interactiveness. As the COVID 19, the experiment shifted the face-to-face teaching to the teaching video learning, which might fail to utilise the benefit of the Google Map and cater for learning diversity.

Conclusion

The research has made a comparison between the Google Map instruction and paper map instruction on the students' map reading achievement as well as the attitude. For the learning outcome of students, although students taught by Google Maps performed slightly higher than the paper map in all grade levels, it argued that there was a marginal difference between the two instruction tools. The main reason is the format of the exam adopted in the paper-based, students unfamiliar with the digital map would affect their performance. To compare the impact among the three map-reading areas, it was found that Google Map was more appropriate to teach "Proportion" that includes gradient calculation and scale conversion. While the Paper map was more beneficial on the "Plan View" which means perspective and relief.

In terms of students' attitudes, the characteristics of convenient, interesting, and informative were attractive for students so that they had more positive feelings towards Google Map and agreed Google Map can help them to learn. Importantly, in this research, the high preference could not predict a high test score improvement because there was no correlation between them. The implication is that teachers could motivate students by using the digital map but could not overestimate its impact and rely on it.

In conclusion, the Google Map is a good complement but not a replacement to the paper maps. It is suggested to combine two instruction tools by considering the learning objectives and purpose because both maps have advantages and disadvantages. In HKDSE Geography, the Google Map is more likely to be used in the introduction that allows students to understand the precise map image immediately. After, students should be taught and practiced with the paper map.

(Word count: 6725)

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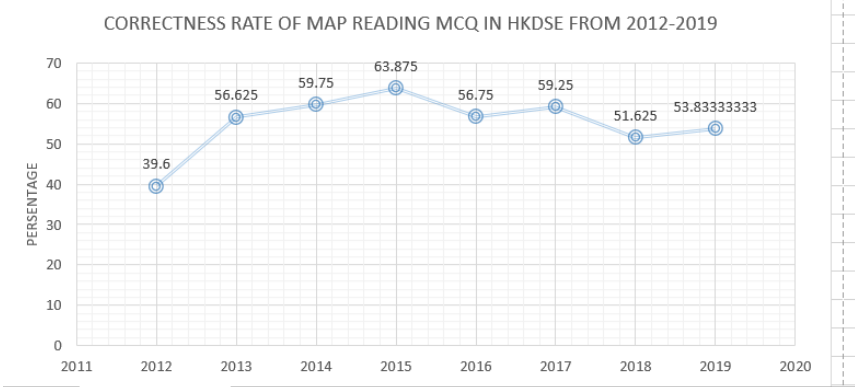
Appendices

Appendix 1: HKDSE Candidates' correctness rate in map reading

Questions	%	Catagary: Plan view, Arrangement, Proportion, Map language	
2012Q1	38	Map language	
2012Q2	32	Proportion	Area
2012Q3	43	Proportion	
2012Q4	54	Arrangement	
2012Q5	31	Mixed	Plan view + Map language
2013Q1	77	Plan view	
2013Q2	48	Arrangement	
2013Q3	27	Proportion	Gradient
2013Q4	50	Proportion	
2013Q5	67	Arrangement	
2013Q6	73	Map language	
2013Q7	42	Mixed	Plan view + Map language
2013Q8	69	Mixed	Plan view + Map language + Arrangement
2014Q1	64	Plan view	
2014Q2	82	Map language	
2014Q3	39	Proportion	Area
2014Q4	35	Proportion	
2014Q5	61	Arrangement	
2014Q6	54	Arrangement	
2014Q7	71	Mixed	Plan view + Map language
2014Q8	72	Mixed	Plan view + Map language
2015Q1	91	Map language	
2015Q2	37	Arrangement	Direction
2015Q3	47	Proportion	
2015Q4	53	Proportion	
2015Q5	48	Arrangement	
2015Q6	87	Map language	
2015Q7	61	Mixed	Plan view + Map language
2015Q8	87	Mixed	Plan view + Map language
2016Q1	61	Map language	
2016Q2	67	Arrangement	
2016Q3	36	Proportion	
2016Q4	38	Proportion	
2016Q5	67	Arrangement	
2016Q6	33	Mixed	Plan view+Map language 橫切面
2016Q7	71	Mixed	Plan view+Map language
2016Q8	81	Mixed	Plan view+Map language
2017Q1	68	Map language	
2017Q2	72	Arrangement	
2017Q3	33	Proportion	
2017Q4	32	Proportion	Area
2017Q5	63	Mixed	Plan view+Map language
2017Q6	81	Mixed	Plan view+Map language
2017Q7	61	Arrangement	
2017Q8	64	Map language	
2018Q1	43	Map language	
2018Q2	56	Arrangement	
2018Q3	30	Proportion	Gradient
2018Q4	36	Arrangement	
2018Q5	61	Plan view	
2018Q6	54	Mixed	Plan view+Map language
2018Q7	53	Mixed	Plan view+Map language
2018Q8	80	Map language	
2019Q1	62	Proportion	
2019Q2	68	Map language	
2019Q3	50	Map language	
2019Q4	62	Mixed	
2019Q5	41	Mixed	
2019Q6	40	Mixed	Arrangement+Map language

Avarage % from 2012-2016	56
Avarage % by year	
2012	39.6
2013	56.625
2014	59.75
2015	63.875
2016	56.75
2017	59.25
2018	51.625
2019	53.8333



以下照片是從大頭洲上的高程點 56 拍攝的，此相片是朝哪一個方向拍照的?

A. 東南
B. 西北
C. 西南偏南
D. 西北偏北

圖中 代表不同斜坡，哪一個斜坡最陡峭 ?

A. a
B. b
C. c
D. d

下列哪些可與三角網測站 217 互見?

1. 高程點 205
2. 高程點 210
3. 高程點 119

A. 只有 (1)及 (2)
B. 只有 (1)及 (3)
C. 只有 (2)及 (3)
D. (1)、(2)及 (3)

下列哪一項是三角網測站 217 至 紅點 的平均坡度?(水平距離 = 420 米)

A. 1: 4.2
B. 1: 5.9
C. 1: 3.6
D. 1: 5.1

下列哪一項是高程點 178 至 紅點 的平均坡度?(水平距離 = 460 米)

A. 1: 1.7
B. 1: 2.6
C. 1: 3.9
D. 1: 5.9

下列哪一項正確顯示由三角網測站 314 至 黃點 的橫切面 (山勢)

A. B.

C.

D.

照片是從馬頭角 拍攝的，此相片是朝哪一個方向拍照的?

北
南
東北
東南

那一條小徑最陡峭 ?

a
b
c
d

Appendix3 : Questionnaire

學生對紙本地圖及電子地圖(Google Map)學習的態度

隨機代號_____

請根據你的經驗**圈出**你認為最適合的答案。
1= 非常不同意　2= 不同意　3= 中立　4= 同意　5= 非常同意

學生使用紙本地圖及電子地圖學習的心情

當老師使用**紙本地圖**教授地圖閱讀時，我感到……

	非常不同意	不同意	中立	同意	非常同意
1. 興奮	1	2	3	4	5
2. 成功感	1	2	3	4	5
3. 沉悶	1	2	3	4	5
4. 輕鬆	1	2	3	4	5
5. 困難	1	2	3	4	5
6. 分心	1	2	3	4	5
7. 有學習動力	1	2	3	4	5
8. 挫敗	1	2	3	4	5
9. 專注	1	2	3	4	5
10. 迷惘	1	2	3	4	5

當老師使用**電子地圖(Google map)**教授地圖閱讀時，我感到……

	非常不同意	不同意	中立	同意	非常同意
1. 興奮	1	2	3	4	5
2. 成功感	1	2	3	4	5
3. 沉悶	1	2	3	4	5
4. 輕鬆	1	2	3	4	5
5. 困難	1	2	3	4	5
6. 分心	1	2	3	4	5
7. 有學習動力	1	2	3	4	5
8. 挫敗	1	2	3	4	5
9. 專注	1	2	3	4	5
10. 迷惘	1	2	3	4	5

紙本地圖及電子地圖教學對學生地圖閱讀技巧的影響

	非常不同意	不同意	中立	同意	非常同意
1. 電子地圖比紙本地圖更有助我想像真實世界	1	2	3	4	5
2. 電子地圖的資訊比紙本地圖清晰，讓我更容易閱讀及分析地圖	1	2	3	4	5
3. 電子地圖的資訊比紙本地圖豐富，讓我更全面了解真實世界	1	2	3	4	5
4. 電子地圖的功能比紙本地圖多，更能滿足我學習需要	1	2	3	4	5
5. 電子地圖教學比紙本地圖教學更鼓勵我學習地圖閱讀	1	2	3	4	5
6. 電子地圖教學比紙本地圖教學更有效改善我地圖閱讀技巧	1	2	3	4	5
7. 電子地圖教學比紙本地圖教學更有助我熟習地圖閱讀試題題目	1	2	3	4	5
8. 電子地圖教學比紙本地圖教學更有助我辨認方向	1	2	3	4	5
9. 電子地圖教學比紙本地圖教學更有助我計算坡度	1	2	3	4	5
10. 電子地圖教學比紙本地圖教學更有助我辨認地勢	1	2	3	4	5
11. 電子地圖教學比紙本地圖教學更有助我計算地形高度	1	2	3	4	5
12. 學習閱讀電子地圖比紙本地圖花更多時間	1	2	3	4	5
13. 在課堂上使用電子地圖比紙本地圖方便	1	2	3	4	5
14. 儘管公開考試使用紙本地圖，我認為以電子地圖教授比紙本地圖實際	1	2	3	4	5

在地圖閱讀課中，我較期望使用
☐ 電子地圖
☐ 紙本地圖

因為_____

Appendix4 : Link of teaching video

Control group (paper map instruction)
Google drive link:
https://drive.google.com/file/d/1-Ef4jnA_0BERewOHKUZw9G1uDQnhzDhw/view?usp=sharing
Youtube link
https://youtu.be/PCYVA90FX1E

Experiment group (Google map instruction)
Google drive link:
https://drive.google.com/file/d/1ylyFIuCNmZPYuM842WIAH1HAXxxTQ-LF/view?usp=sharing

Youtube link
https://youtu.be/aZoYgvYg84w

Appendix5 : Information Sheet

有關資料
<比較紙本地圖與電子地圖教學：
看學生對不同教材的態度以及在學生在香港中學文憑試練習試題中的正確率>

誠邀閣下及 貴子女參加王韵琳博士負責監督，鄧麗盈負責執行的研究計劃。她們是香港教育大學社會科學系的學生/教員。

研究計劃簡介
研究目的比較傳統的紙張地圖以及電子地圖(Google Map)，在改善學生地圖閱讀技巧的有效性。是次計劃邀請了中二甲班以及中四甲班地理學生，目的是比較不同年級對於不同的教學工具的學習成效會否不一。此外，研究會利用問卷調查，收集學生對電子地圖教學的態度。班別的安排是跟據本人實習被分派的班級，故此研究對象是隨機分配。

研究方法
是次研究大約邀請五十位學生，整個研究約需時1小時，首先每位學生會在15分鐘內完成一份地圖閱讀試卷，然後每一班學生會被平分為兩組，一半學生會透過傳統的紙張地圖學習地圖閱讀技巧，另一半會以電子地圖(Google Map)。最後，學生需要完成與早前一樣的地圖閱讀試卷。是次研究並不為閣下提供個人利益，但所搜集數據將對研究學習動機的問題提供寶貴的資料。研究會以代號取代學生姓名作研究分析，故無須收集任何學生資料。

說明風險
是次研究風險低，此研究已經過學院的研究操守審查，因學生年齡低於十八，研究亦會於收集中學校長、家長及學生同意後才開始進行。

閣下及 貴子女的參與純屬自願性質。閣下及 貴子女享有充分的權利在任何時候決定退出這項研究，更不會因此引致任何不良後果。本人不會記錄能識別 貴子女身份的個人資料(包括姓名及聯絡資料)。

如閣下想獲得更多有關這項研究的資料，請與研究者鄧麗盈聯絡　　或聯絡她的導師王韵琳博士

如閣下或 貴子女對這項研究的操守有任何意見，可隨時與香港教育大學人類實驗對象操守委員會聯絡(電郵: hrec@eduhk.hk ; 地址:香港教育大學研究與發展事務處)。

謝謝閣下有興趣參與這項研究。

鄧麗盈
首席研究員

Appendix 6: Consent Form

香港教育大學
<社會科學系>

參與研究同意書

<比較紙本地圖與電子地圖教學：
看學生對不同教材的態度以及在學生在香港中學文憑試練習試題中的正確率>

茲同意敝子弟_____參加由王韵琳博士負責監督，鄧麗盈執行的研究項目，她們是香港教育大學社會科學系的學生/教員。

本人得知是次研究不會記錄能識別敝子弟身份的個人資料(包括姓名及聯絡資料)。

研究者已將所附資料的有關步驟向本人作了充分的解釋。本人理解可能會出現的風險。本人是自願讓敝子弟參與這項研究。

本人理解本人及敝子弟皆有權在研究過程中提出問題，並在任何時候決定退出研究，更不會因此而對研究工作產生的影響負有任何責任。

參加者姓名: _____

參加者簽名: _____

父母姓名或監護人姓名: _____

父母或監護人簽名: _____

日期: _____