香港教育大學

The Education University of Hong Kong

A Project entitled

Developing a web-based Information retrieval platform for course-specific learning materials

Submitted by

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Submitted to The Education University of Hong Kong for the degree of

Bachelor of Education (Honours) (Secondary) - Information and Communication Technology

In *April 2019*

Declaration

I, *Kwok Chak Kwan* , declare that this research report represents my own work under the supervision of *Assistant Professor / Department of Mathematics and Information Technology and Dr POON, Kin Man* and that it has not been submitted previously for examination to any tertiary institution.

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Kwok Chak Kwan

11 April, 2019

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Abstract:

This study had two aims. The first aim was to develop a web-based information retrieval platform for secondary school students to search for relevant slides. The second goal was to assess the student's learning experience and understand the student's attitude when using this information retrieval platform. A mixed research method was used in this research with a total of 19 secondary school student from F.5 were involved in this study.

The quantitative survey was carried out among students to explore the independent variables and dependent variables in the Technology Acceptance Model (TAM). Also, this study conducted two tests to understand student learning performance between using and not using the web-based information retrieval platform. Data collected through the questionnaire and the test result was analyzed using computerized social science statistical software package (SPSS) software. This study used frequency analysis, descriptive analysis, reliability testing, correlation testing, and multiple regression analysis.

Besides the study also adopted qualitative research to conduct a semi-structured interview to understand students' attitudes towards the web-based information retrieval platform better.

** Web-based information retrieval platform address: ltm.eduhk.hk/csearch

1. Introduction

Nowadays E-Learning is widely used in education due to rapid development in Information and Communication Technology (Arshad & Saeed, 2014), students can search for a variety of information online from using different web-based information retrieval platform such as Google Web Search (Jones, 2009).

Using a web search engine is convenient for students, and the web search engine can return many of the results specified by the keywords entered by the student. However, the web is a huge repository of information, but web search engines cannot identify which content results are appropriate or comprehensible for different students because web search engines do not consider the student's educational knowledge settings and return appropriate results that fit the student's needs (Kemman, Kleppe & Scagliola, 2014).

To accommodate the increasing number of contents, an effective information retrieval platform for searching contents is needed. It is important for students to retrieve the content and able to find a scene they should start to see effectively while using the E-Learning systems (Kobayashi, Nakano, Yokota, Shinoda & Furui, 2007).

The purpose of this research was to develop a web-based information retrieval platform for students to search for course materials so that students could enter keywords to search for lecture slides that fit their needs and have a revision.

2. Literature Review

2.1. Definition of information retrieval

Information Retrieval (IR) refers to searching for unstructured material, such as text in a large collection storing from large database sources (Singhal, 2001).

IR contains an indexing process, a filtering process, and a search process to achieve the goal. For the indexing process, it refers to the ability to convert a document into a keyword representation and build a search system that works efficiently on a large scale. For the filtering process, it refers to the stop words removal in the file, such as “is, am, are, etc...". For the search process, this means user can search for relevant information (Saini, Singh & Kumar, 2014).

2.2. Related Works

The text-based slide search engine is a traditional approach to find slides from user queries (Lee, Choi, Choi & Kim, 2011). There are some well-known slide search engines on the Internet, including SlideWord, SlideBoxx and Moodle advanced search course materials, but the slide search engine above have some drawbacks.

For example in SlideWord and SlideBoxx, both of them allows the user to upload and share their PowerPoint, they also allow users to search for a PowerPoint. However, SlideWord allows users to view PowerPoint online only. If the user wants to download PowerPoint to the local computer, the

user needs to pay before downloading. For SlideBoxx, users also need to subscribe to their products before downloading PowerPoint (Figure 1).

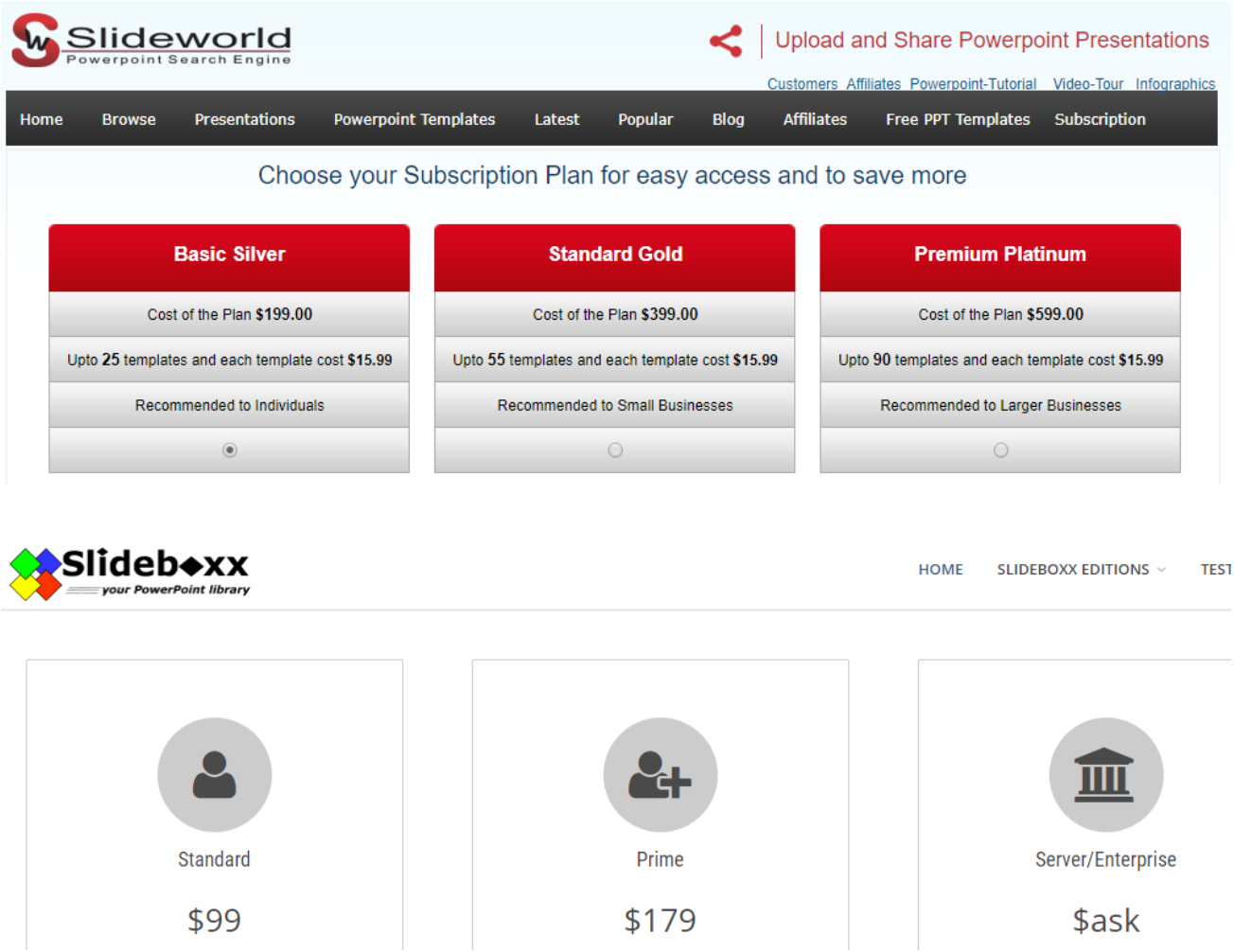


Figure 1 – Require user to pay before downloading PowerPoint

For Moodle Advanced Search, users can install the Advanced Search Plugin to search for course content. The plugin can search for course attachments, course overview files and summary files. It provides Latin languages support, sorting and fuzzy search in different ways (Moodle, 2017).

However, installing plugins is complicated for users. It is not just downloading a "*.exe*" files and compiling. It requires the user to download the administration management tool file and modify the "*renderer.php*" file, and then download another plugin called "*Solr*" and configures the "*Solr*" settings, and finally, the user can use the search function (Moodle, 2017). Therefore, users without relevant computing knowledge may have difficulties in setting up the Moodle Advanced search function.

Besides, another drawback of Moodle Advance Search is that the search result contains the file name and the course information for user reference only without letting the user know which slide number does the keyword come from and Moodle Advance Search does not allow the user to preview the search results. (Figure 2).

Figure 2 – Moodle Advanced Search result

Compared to the web-based information retrieval platform in this study, it is user-friendly, supports previewing search results function, stating keyword sources, and allowing users to download course slides.

Video search engine:

Yokota, Kobayashi, Okamoto & Nakano (2006) proposed a system called "Unified Presentation Slide Retrieval by Impression Search Engine (*UPRISE*)" for retrieving slides from a combination of lecture slides, video and slide title. The slides were rendered by synchronizing with the video, and the title of the slide developed using speech recognition technology.

Kobayashi, Nakano, Yokota, Shinoda & Furui (2007) also proposed a system for retrieving slides content using *UPRISE* and laser pointer information; they used the number of occurrences of laser spots as a weighting factor. If the laser pointer hits the target keyword in the slide and the keyword mentioned by the teacher, the search score weight will be higher.

The purpose of this research project is to retrieve and display the slides based on the user query, therefore this research is focusing on text search since the text is typically used in a secondary school teaching environment.

3. Web-Based Information Retrieval Platform

The following table (Figure 3) shows the components of the corresponding backend and frontend services in this web-Based Information Retrieval Platform.

Components of Web-Based Information Retrieval Platform	
Backend services	Frontend services
Elasticsearch	HTML
Fscrawler	
Python Flask	

Figure 3 – Components of Web-Based Information Retrieval Platform

3.1. Components of Web-Based Information Retrieval Platform

For the backend service, it consists of three main components, including Elasticsearch, Fscrawler, and Python Flask.

3.1.1. Elasticsearch:

Elasticsearch is the core component in this project; it is an open source RESTful search engine built on top of Apache Lucene. It is a real-time distributed search and analysis engine that allows developers to explore data at speed. It can be used for full-text search, structured search and index document files in diverse formats (Vidhya & Vadivu, 2016).

The reason for choosing Elasticsearch as a backend service was that it supported Chinese Word characters, and it allowed developers to modify different search query settings and take advantage of search concepts such as word proximity search (Gormley and Tong, 2015, P.241).

There are three main steps to perform when developing with Elasticsearch, including mapping, indexing, and Querying for data.

Mapping refers to how Elasticsearch should store and index specific documents and their fields. One of the features in Elasticsearch is that it can dynamically generate mappings for developers based on what it could guess about the field types (Gormley & Tong, 2015, p. 80).

Indexing is the process of inserting data into Elasticsearch and making it searchable when using the Indexing API. Elasticsearch can achieve a fast search response because it does not search for text directly but instead searches for an index (Gormley & Tong, 2015, p. 38).

Querying refers to user can input some criteria and get results, the query in Elasticsearch is in a JSON interface, It makes the queries more flexible, more precise, easier to read, and easier to debug, user also can input some filters to make the search result more accurate (Gormley & Tong, 2015, p. 98).

The following picture (Figure 4) is a summary of the Elasticsearch search mechanism.

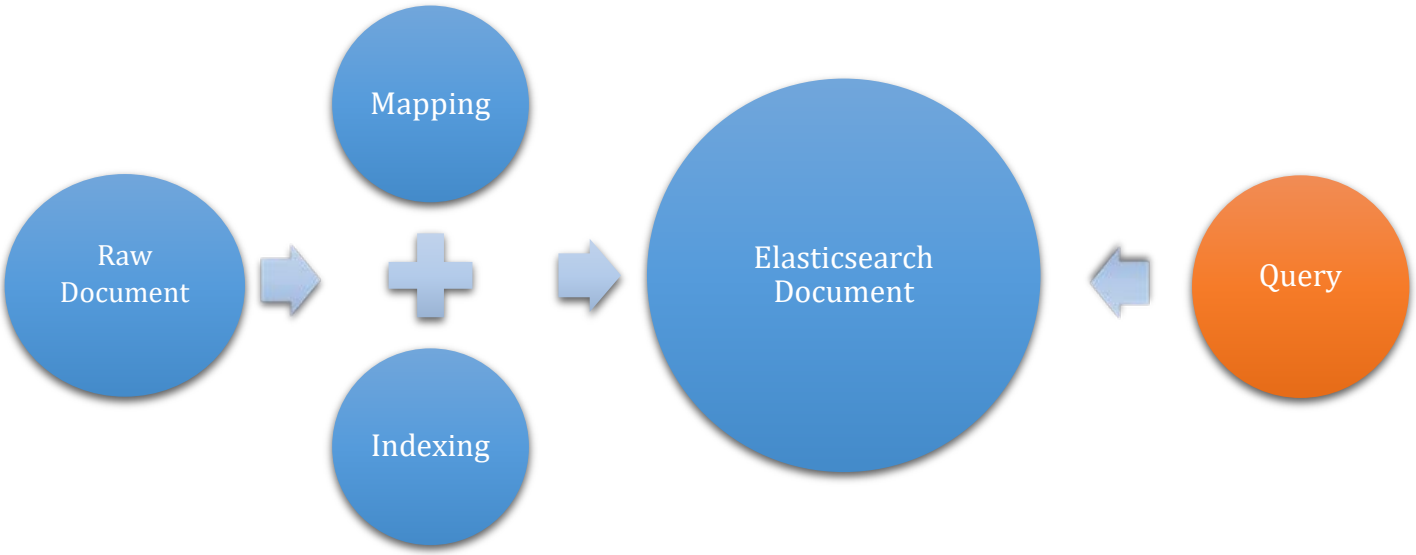


Figure 4 – Elasticsearch search mechanism

3.1.2. Fscrawler:

Since the web-based information retrieval platform consists of four chapters from the textbook and had approximately 200 PowerPoint slides, it was time-consuming for developers to index all documents one by one into Elasticsearch manually. Therefore, this web-based information retrieval platform used FSCrawler which is a third-party Elastic plugin to index binary documents.

FsCrawler is a quick open source solution for a developer to index documents from the local file system and over SSH. It crawls the file system and indexes new files, updates existing files, and deletes old ones. FsCrawler supports scheduled crawls, for example, every 15 minutes (Pilato, 2019).

3.1.3. Python Flask:

Flask is a Python-based micro framework for rapid prototyping and development of small and medium-sized web applications without the need for specific tools or libraries. This web-based information retrieval platform was built on top of the Flask Framework which connecting the database, core code, static files and templates (HTML file). Flask Models is the data access layer that contains all the information about the data being accessed and verified. It is the bridge between the Elasticsearch document and the front-end HTML interface (Greenberg, 2018, P.3).

3.1.4. HTML:

By default, this is a home page in the web-based information retrieval platform. The user can query the lecture slides based on the keywords since Elasticsearch allows the user to retrieves objects via a REST API like sending a POST or GET request (Divya & Goyal, 2013).

The following picture (Figure 5) is an overview diagram illustrating the mechanism for user queries in the web-based information retrieval platform.

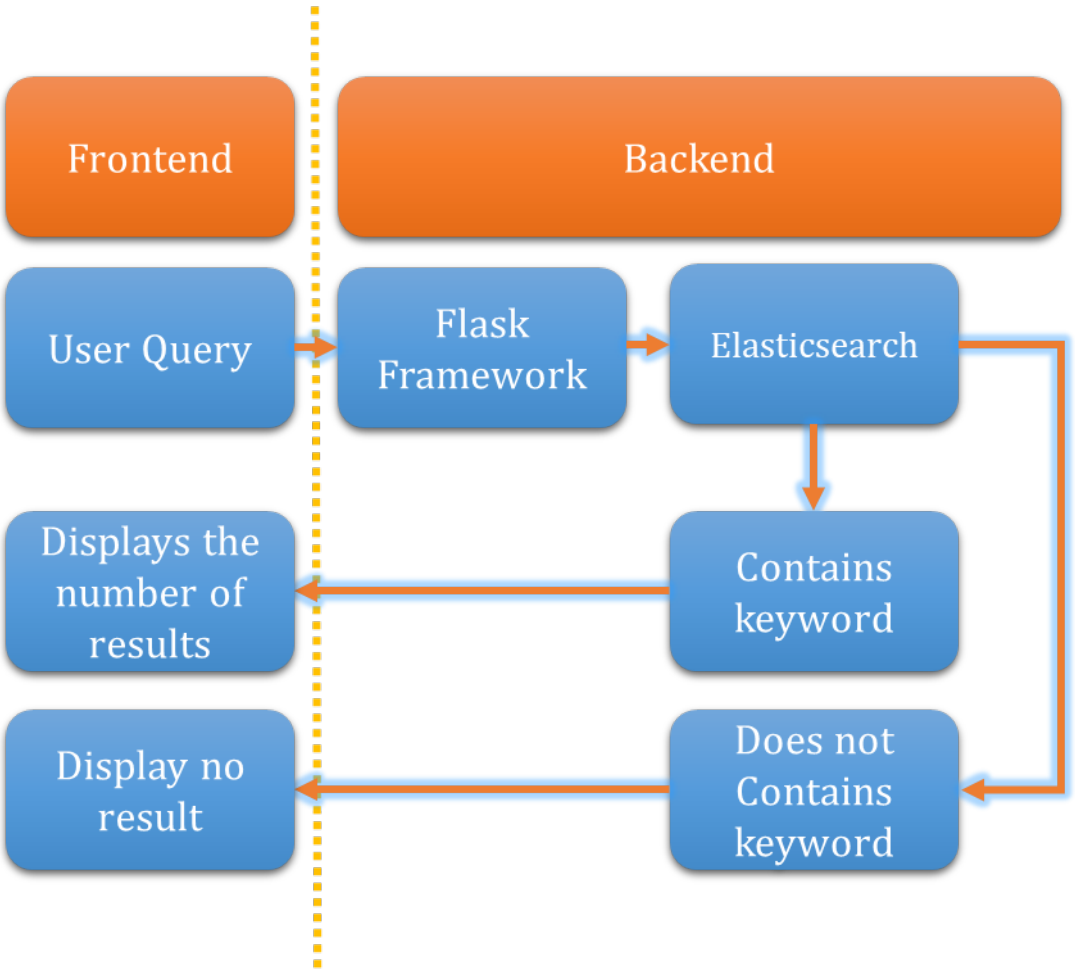


Figure 5 – Mechanism for user queries in the web-based information retrieval platform

3.2. Features of this Platform

The web-based information retrieval platform is designed to be user-friendly and uncomplicated. Once the user enters the home page (Figure 6), the user can enter any keyword to search for the presentation slide, and it will display the results to the user on the same page.

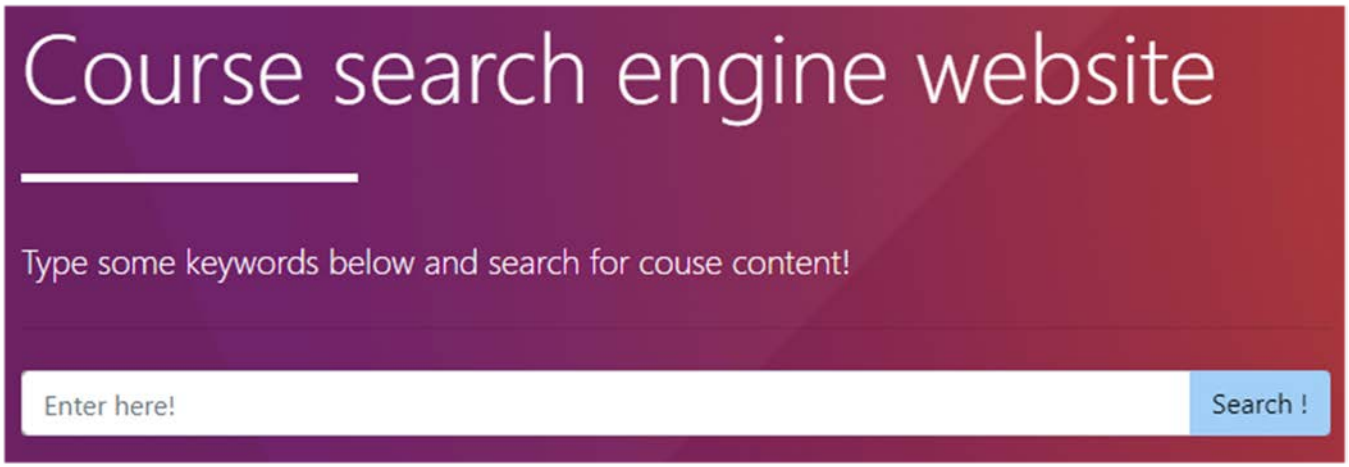


Figure 6 – Homepage in the web-based information retrieval platform

Once the query matches, the search page will navigate to the result page. It shows the number of relevant results from the user's keywords. For example, if user enters keywords "ICT," the platform will return "2 relevant results found" (Figure 7).

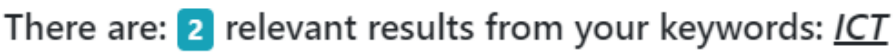


Figure 7 – Display the number of relevant results

Slides preview:

The slides preview function (Figure 8) is enabled for the user to preview the result before clicking it to view the full lecture slide. The preview slide contains a list of preview elements in a bullet point format which correspond to the lecture slides. Instead, the preview slide function can give user about the brief overview information of the slide (Farkas, 2005).

If student finds that the results are appropriate, they can click the “Open PDF” button to get a full view lecture slide to understand the front and back slide content.

Figure 8 – Slides preview function and the user can click “Open PDF” to have a full view

When the user clicks the “Open PDF button”, more details about the lecture slides are displayed, such as the topic number and slide number, and the user is allowed to scroll up and down (Figure 9) to view the entire lecture slide to see more content and look for the answer, users can also download lecture slides as needed.

Figure 9 – Full view about the lecture slide content

Fuzzy search:

Spelling mistakes often occur when entering keywords. Therefore, fuzzy search feature is included in this web-based information retrieval platform. Fuzzy keyword search can significantly enhance system usability since the search results not only show an exact match result to the query but also show the result which may match based on keyword similarity (Wang, Ma, Tang, Li, Zhu, Ma & Chen, 2013).

The fuzzy parameter in this web-based information retrieval platform depends on the number of characters in the word. The following is the maximum edit distance for the fuzziness parameters.

Number of characters in the word	Fuzziness parameter
0/1/2	0
3/4/5	1
>5	2

The web-based information retrieval platform contains three types of fuzzy features, including substitution, insertion, and deletion. The keyword "*GPRS*" will be used below to demonstrate three types of fuzzy elements.

- Substitution one character for another
  - The user wants to search for *GPRS*, but type *GP**E**S*.
- Insertion of a new character
  - The user wants to search for *GPRS*, but type *GPR**E**S*.
- Deletion of a character
  - The user wants to search for *GPRS*, but type *GPR* .

The following figures (10 - 13) are the search result of the above three fuzzy features; the search result is the same as the correct spelling keyword "*GPRS*".

There are: 7 relevant results from your keywords: *GPRS*

Figure 10 – Search result for keyword "*GPRS*"

There are: 7 relevant results from your keywords: *GPRES*

Figure 11 – Search result for keyword "*GPRES*"

Figure 12 – Search result for keyword "*GPES*"

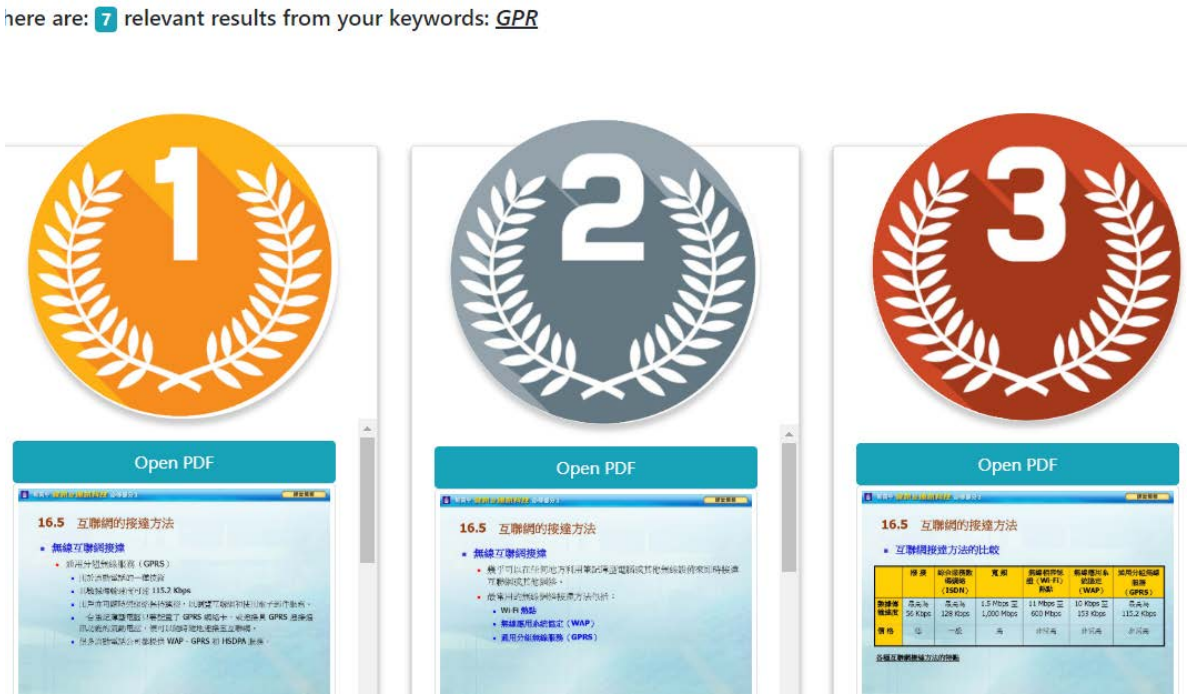


Figure 13 – Search result for keyword "*GPR*"

Term Frequency/Inverse Document Frequency (TF/IDF) Ranking:

Once Elasticsearch returns a list of matching documents, the web-based information retrieval platform will use the TF / IDF method to rank the search results. The reason why using TF / IDF as weighting method in this research is that TF / IDF is a simple and efficient algorithm for generating search results. The web-based information retrieval platform can become lighter, and results can be quickly returned to the user. There are two components in this method as weighting factors, including "term frequency" and "inverse document frequency" (Aizawa, 2003).

Term frequency refers to the frequency of the term appears in the field. The more frequent means it is more relevant. A field containing three mentions of the same term is more likely to be relevant than a field containing just one mention (Xia & Chai, 2011).

Inverse document frequency refers to the frequency of the term appears in the index. The more frequent means it is less relevant. Terms appearing in many documents will have a lower weight than less common terms (Xia & Chai, 2011).

For example, using "GPRS" as a search key, there are seven related results returned from the web-based information retrieval platform. The first result shows the keyword "GPRS" four times (Figure 14), while other results such as second and third place contain the keyword "GPRS" once only (Figure 15). Therefore, the first result from topic 16 (slide number 63) will score a higher mark under the TF / IDF method.

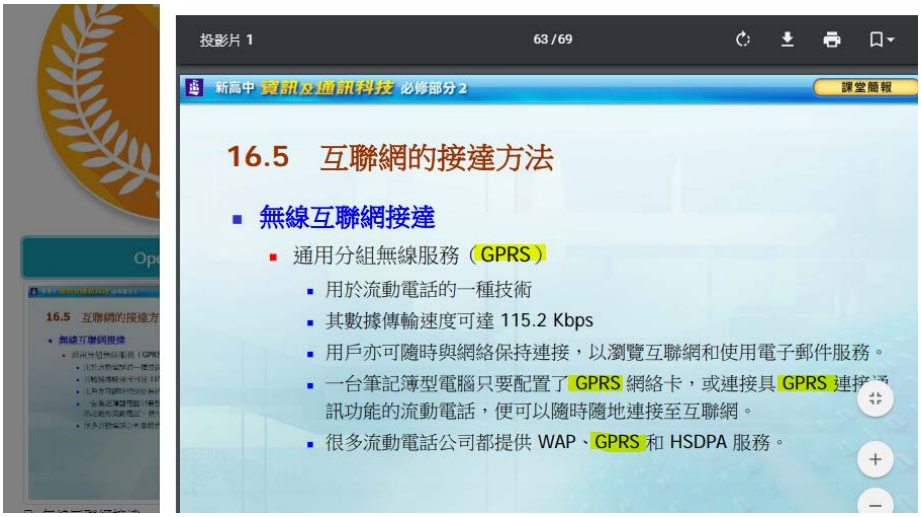


Figure 14 – Rank number one for keyword “GPRS.”

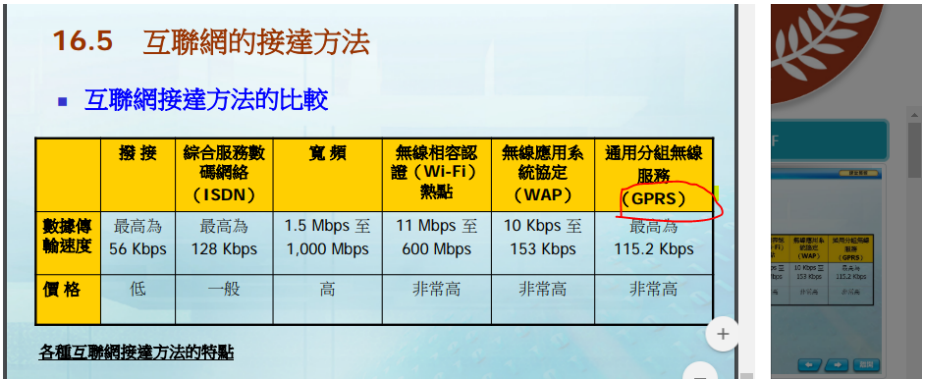


Figure 15 – Second and Third place for keyword “GPRS.”

4. Research objectives

This study has two purposes. The first purpose is to develop a web-based information retrieval platform. Students can search for relevant slides from a teacher's lecture based on the similarity of keywords or text. The system will display the appropriate results for the student according to their educational background.

The second goal is to use this information retrieval platform to assess the student's learning experience comparing with others who use Google search, and to understand student learning motivation when using this information retrieval platform.

5. The significance of this research

For students, using this information retrieval platform can reduce the time it takes to search for keywords. Traditionally, if students want to do revision and search for keywords in a presentation slide, they need to open each lecture slide file and search using "Ctrl + F," however it is time-consuming to open different lecture slides and look for the keywords since keywords may exist in different presentation slide files.

The advantages of using this information retrieval platform are that it enables students to find which lecture slides contain keywords entered by students. For example, if students enter keywords "互聯網上的流式傳輸技術," the information retrieval platform will automatically display relevant

slides even the keywords exist in different presentation slides, and it also allows students to preview slides (Figure 16).

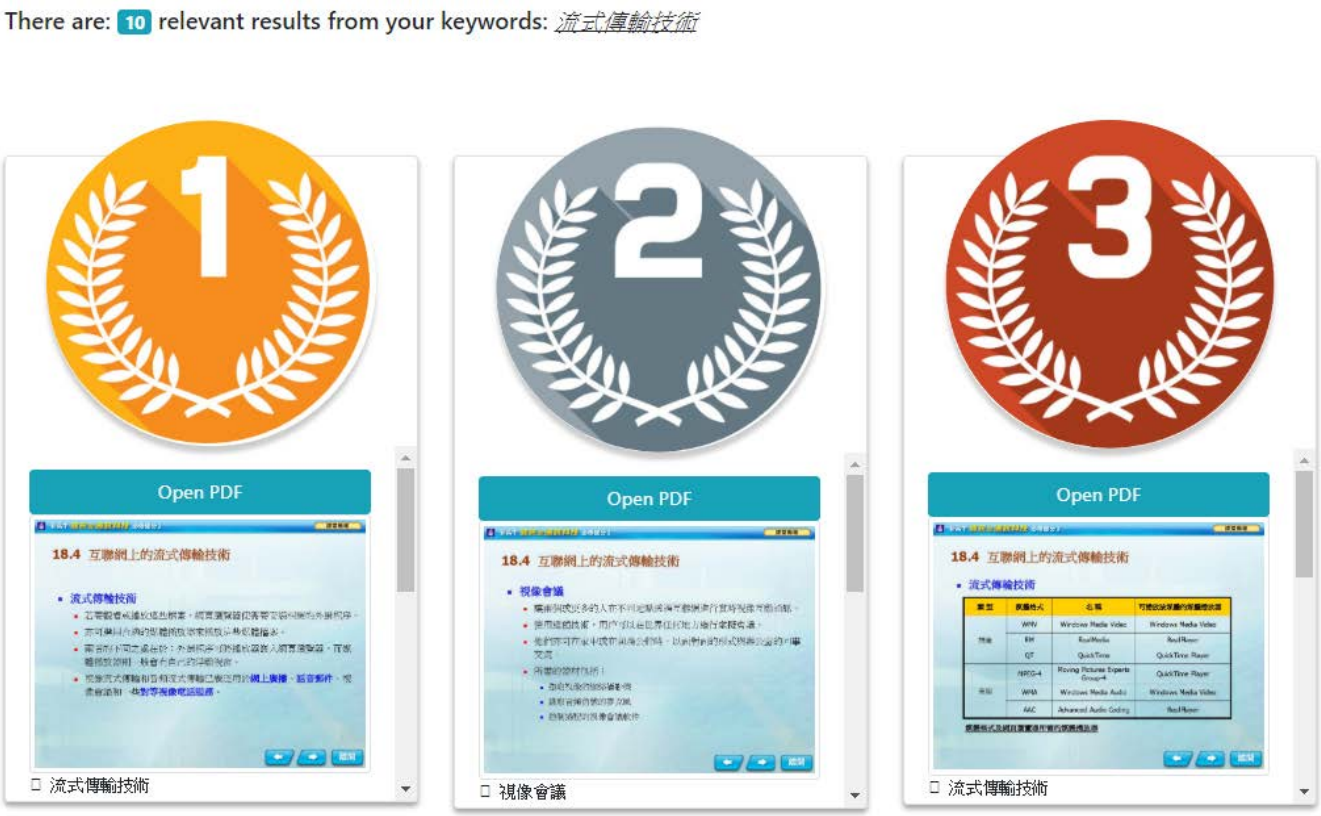


Figure 16 – Display the related lecture slide in one page

The second significant in this study is that students can find presentation slides that suit their needs and educational knowledge, as the teacher designs these presentation slides and the content is modified according to student needs. Comparing with using Google Web Search, the number of search results is very large, sometimes returning irrelevant search results and advertisements, and students may be confused when looking for the information they need (Brin & Page, 1998).

6. Research method

This research was conducted in my second teaching practice, which was from October 2018 to December 2018. The study was conducted at a CMI Secondary School in Hong Kong, all of the participants were for form 5, and the total number of participants was 19 students.

During my second teaching practice, an information retrieval platform was established for the student to have a revision and prepare for their exam. The information retrieval platform consists of four chapters from NSS ICT Compulsory Part textbook, including:

- Chapter 15 – Computer Systems Integrated Assessment
- Chapter 16 – The Networking and Internet Basics
- Chapter 17 – Communication Software and Protocols
- Chapter 18 – Internet Services and Applications

6.1. Research question

As can be seen from previous literature reviews, the use of information retrieval is suitable for the retrieval of text content materials. Since the purpose of this study is to help students search for slide content and help them to learn, followings three research questions will be investigated.

1.) ***How accurate are the search result from my Information Retrieval Platform?***

2.) ***Does student achieve better learning experience from using my Information Retrieval Platform?***

3.) ***What are the attitudes of students towards the information retrieval platform?***

6.2. Data collection

In this study, a mixed method with quantitative research method and qualitative research method was used to study the three research questions.

6.2.1. Quantitative Research Method

Web search engines are expected to provide accurate results from user queries (Büttcher, Clarke & Cormack, 2016, P. 2). The information retrieval platform in this study was manually configured in different settings and attempted to provide users with more accurate results. To solve the research question 1 and assess the accuracy of search results, user log activity feature was embedded. The log information included keywords which user has entered and which links they had clicked (Figure 17). This information was used to estimate the accuracy of the search results.

```
2018/10/09 17:55:23,3,kwokck,Click button number: 1
2018/10/09 17:55:27,3,kwokck,Click button number: 2
2018/10/09 17:55:30,3,kwokck,Click button number: 3
2018/10/09 17:55:35,3,kwokck,Click button number: 4
```

Figure 17 – User activities log function

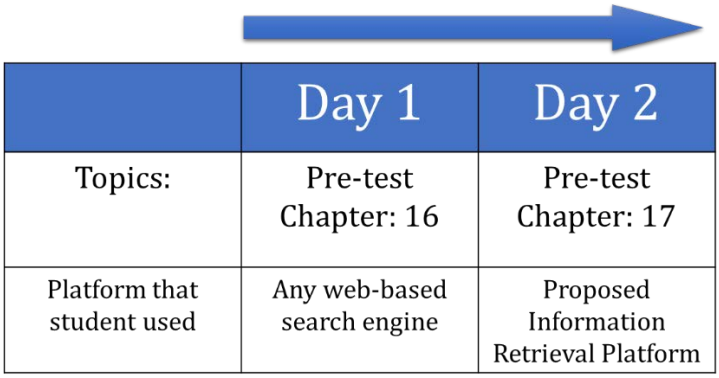
The next step was to convert the number of buttons to a value. For example, if the user clicks the "Open PDF button 1" (Figure 18), it will be recorded as a value of 1 in this search query.

Figure 18– Display the related lecture slide

Value	Button number
1	1
2	2
3	3
4	4
Etc…	Etc..

For addressing research question 2, this study adopted two tests to explore student's learning experience between using and without using the information retrieval platform. This study was conducted out in two revision lesson (Figure 19) since the question in two tests were not came from the same question bank, therefore the question from two tests was referenced in school textbooks when designing, there were ten multiple choices in both tests include ease, medium and difficult questions to made the questions remained the same difficulty level (Appendix 1 – 2).

The first-test was the control group on the first day, and the second-test was the experimental group on the second day. For the first-test control group, students could use any web-based search engine such as the Google search engine to complete the revision exercise. On the second-test, students were invited to use the information retrieval platform to search for answers.



	Day 1	Day 2
Topics:	Pre-test Chapter: 16	Pre-test Chapter: 17
Platform that student used	Any web-based search engine	Proposed Information Retrieval Platform

Figure 19– Process of the two tests

In addition, the study also adopted feature selection for logistic regression to understand which elements of the Technology Acceptance Model (TAM) will influence students to improve their learning between two groups of students including high-improvement group and low-improvement group. Feature selection is defined as the process of detecting related features and removing irrelevant, redundant or noisy data (Kumar & Minz, 2014). The feature selection script will be conducted using Python programming language with sklearn and Pandas library.

For addressing research question 3, it will conduct a quantitative questionnaire survey based on the Technology Acceptance Model (TAM) to address their attitudes and motivations when using the information retrieval platform. There are four aspects to the TAM questionnaire assessment including perceived of usefulness, perceived ease of use, behavioral intention and usage behavior (Venkatesh and Davis, 1996).

Appendix (3) is a questionnaire with five options for each statement, including

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

The final score is reported on a 5-point scale as follows:

Point	Option
5	Strongly agree
4	Agree
3	Neutral
2	Disagree
1	Strongly disagree

The higher the score, the more positive the student's attitude towards using the information retrieval platform.

6.2.2. Qualitative Research Method

A semi-structured interview was conducted to interview students for solving research questions 3. The purpose of using semi-structured interviews was that it was a more flexible version of the structured interview and semi-structured interview provided more opportunity for the student to share their ideas (Alshenqeeti, 2014).

Two students with one male and one female were invited, and the interview was audio-taped. Appendix (4) is a semi-structured interview question based on the theory of Technology Acceptance Model (TAM) theory.

6.3. Technology Acceptance Model

The Technology Acceptance Model (TAM) is one of the most widely used conceptual models for interpreting and predicting the behavior of information technology adoption (Hsu, Wang & Chiu, 2009). TAM was proposed by Davis in 1989 to explain and predict user behavior by using technological innovation, especially for user acceptance of information technology (Davis, 1989).

TAM contains two primary variables, including independent variables "perceived usefulness (PU)" and "perceived ease of use (PEOU)" and dependent variable "behavioral intent (BI)" (Davis, 1989).

In this study, students' acceptance of the web-based information retrieval platform was based on TAM with three core structures and one external structure, including perceived usefulness (PU), perceived ease of use (PEU), and behavioral intention (BI). Besides a new external structural anxiety (AN) had been added to assess students' perceptions of using the platform since anxiety is a determining factor in terms of PEOU and PU for certain systems (Compeau, Higgins, & Huff, 1999). The model presented in this study is shown in Figure 20, and it will be explained in detail in the next section.

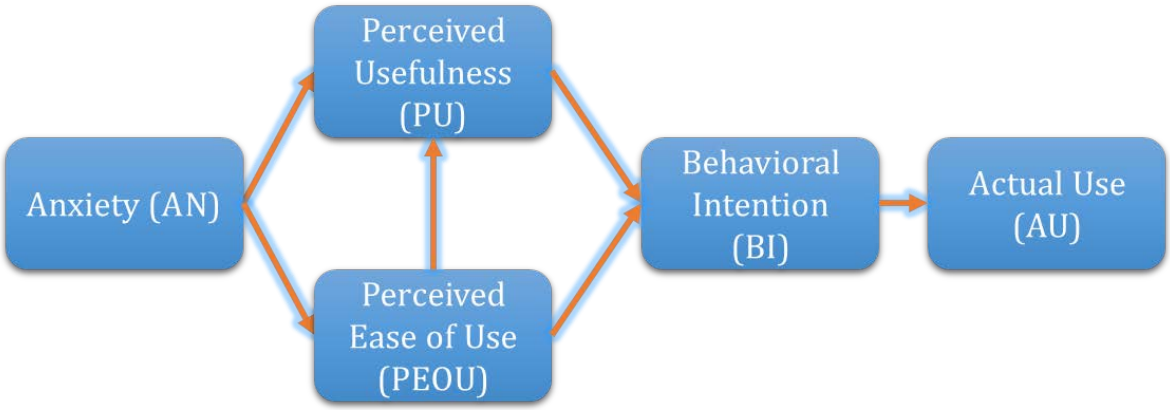


Figure 20 – TAM Model

PU, PEOU, BI and AU:

Davis (1989) defines PU as the degree to which people believes that the use of a particular information technology system can improve a user's job performance. PEOU is defined as the degree to which a person believes that using a particular system would be free of effort. In this study, PU is to investigate student's learning performance after using the web-based information retrieval platform, and PEOU is used to study the easiness of using the web-based information retrieval platform in the user learning process.

In addition, Davis (1993) pointed out that the actual use of the system (AU) is determined by behavioral intention (BI). Behavioral intent is jointly determined by PU and PEOU. BI refers to the positive or negative feelings when using the web-based information retrieval platform in this study. In addition, PEOU also affects the user's perception of the PU and affects the user's intention to use the system.

For anxiety, it refers to the apprehension or fear when an individual is faced with the possibility of using computers and some findings shows that anxiety was having a negative relationship on PEU and PU (Song & Kong, 2017).

From the above literature review of the technology acceptance model (TAM), the following are the hypothesis (Figure 21) included:

- H1: PEOU would positively affect PU
- H2: PU would positively affect BI
- H3: PEOU would positively affect BI
- H4: BI would positively affect AU
- H5: AN would negatively affect PU
- H6: AN would negatively affect PEOU

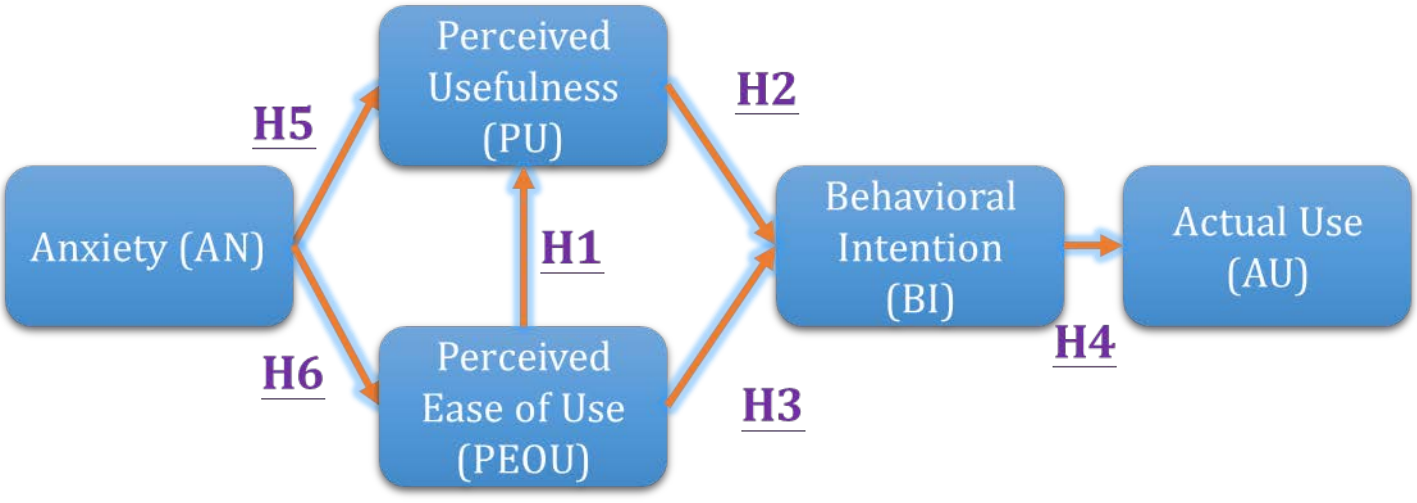


Figure 21 – Proposed hypothesis in this study

7. Finding and Analysis

7.1. Quantitative Research

First will discuss Research Question 1 - *How accurate are the search result from my Information Retrieval Platform.* Since the user log activity feature was embedded to track user activity, the following table (Figure 22-24) was a summary of user log information indicating which button they click to estimate the accuracy of the search results.

Number of "Click"	Number of "Query"
182	163

Figure 22 – Number of "Click" and "Query"

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
data	182	1.00	8.00	1.3736	.97650
Valid N (listwise)	182				

Figure 23 – Descriptive Statistics of user log activities

data

		Frequency	Percent	Valid Percent	Cumulative Percent
Button Value	***1.00***	***141***	***77.5***	***77.5***	***77.5***
	2.00	***30***	***16.5***	***16.5***	***94.0***
	3.00	***6***	***3.3***	***3.3***	***97.3***
	4.00	1	.5	.5	97.8
	6.00	2	1.1	1.1	98.9
	7.00	1	.5	.5	99.5
	8.00	1	.5	.5	100.0
	Total	182	100.0	100.0	

Figure 24 – Frequencies of the user log activity

From the above table (Figure 22), there were 163 query search records and 182 clicked record in the log activity. The minimum 1 and maximum 8 in the Descriptive Statistics table (Figure 23) represent the corresponding button values during the user search, the Mean value of the clicked button is 1.3736, which means that most users will choose to click the button between button 1 and button 2.

The table (Figure 24) shows the frequencies of each button clicked. It shows that the button values 1, 2 and 3 account for 95% of the search results. This means that when a user types a keyword into a web-based information retrieval platform, 95% of the search results were between buttons values 1, 2 and 3. Therefore users could quickly find the results they want.

In addition, since the Web information retrieval system had been configured and contains the fuzzy search function, this study also would like to compare the search results difference between fuzzy search and the non-fuzzy search from among the top ten keywords search queries extracted from user log activity.

The progress of this investigation was to first determine the top ten queries from user log activity, for example, one of the keyword searches is "GPRS", then the next step is to enter "GPRS" into two systems, one containing fuzzy search and the other containing non-fuzzy search. Finally, the researcher will check which slides were the most appropriate slides and then marked the corresponding button values.

The table below (Figure 25) was a summary of the ranking records for the top ten queries. The top ten queries had a total of 83 search records. The mean value of the fuzzy search was 1.4940, which means that once the user entered some keywords, it could get the result between the first or second search results. For non-fuzzy searches, the mean value was 2.59, which means the user could find the result between the second and third records.

Descriptive Statistics

	Number of search in top 10 queries	Minimum	Maximum	Mean	Std. Deviation
withFuzzy	83	1.00	8.00	***1.4940***	1.10843
withoutFuzzy	83	1.00	10.00	***2.5904***	2.00631
Valid N (listwise)	83				

Figure 25 – Frequencies of the top ten queries

Second, it will discuss research questions 2 - *Does student achieve better learning experience from using my Information Retrieval Platform.* Gerald (2018) suggested that sample t-test is suitable to the pre-tested post-test research design since the pre-test participants are the same participants at the post-test, and the scores before and after the test have a meaningful correlation.

The table below (Figure 26) was a summary of the student's two tests result. There were 19 students took the test. The mean value of test result using the web-based information retrieval platform was 8.63, the mean value was 5.95 without using the retrieval platform, and the mean difference was 2.68, the result shows that students often got a better learning experience from using

the web-based information retrieval platform.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	With_Csearch	8.6316	19	2.71233	.62225
	WithOut_Csearch	5.9474	19	2.75829	.63280

Figure 26 – Paired Samples Statistics

The table below (Figure 27) was the result of a paired sample test showing the t-value and p-value. Observing the t statistic for this row, t = 11.071, p = 0.000, indicating that the web-based information retrieval platform had strong evidence (t = 11.071, p = < 0.05) to improve student achievement. In this data set, it increased the test results by an average of 2.68 points in the 95% confidence interval.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair	With_Csearch - WithOut_Csearch	2.68421	1.05686	.24246	2.17482	3.19360	11.071	18	.000

Figure 27 – Paired Samples Test

To perform the feature selection process, logistic regression was used to compare the binary outcome variables between the two groups (Kirkwood & Sterne, 2005, p. 189). The study set the criteria for two groups of students, including the high-improvement group and the low-improvement group. The high-performance group students improved their test scores by more than

3 marks, and vice versa. In addition, the study also sets the maximum feature selected to be less than or equal to two suggested by Vergara & Estévez (2014) in the python script.

The following table (Figure 28) was a summary of the feature selection of the TAM model using logistic regression, which shows that among the four TAM variables, the selected features were PU and BI, and PEOU and AU were considered unimportant features.

TAM variables	Selected Features	Feature Ranking
PU	True	1
PEOU	False	2
BI	True	1
AU	False	3

Figure 28 – Feature selection for TAM model

To gain a deeper understanding of PU and BI features, logistic regression was performed again to understand which of the PU and BI questionnaires will have an impact on the student's learning outcomes.

The table below (Figure 29) shows that among the five questions in the PU questionnaire, the selected features were Question 2 and Question 3. It means that students thought that "可以讓自己學得更多" and "可以讓我的學習進步" were the important factors affecting their learning outcomes.

Questionnaire in PU	Selected Features	Feature Ranking
題目 **1:** 使用教材搜尋平台對學業是有好處的	False	4
題目 **2:** 使用教材搜尋平台可以讓自己學得更多	True	1
題目 **3:** 使用教材搜尋平台可以讓我的學習進步	True	1
題目 **4:** 我覺得教材搜尋平台的非常符合我的需求	False	3
題目 **5:** 教材搜尋平台的搜尋結果是我想要的	False	2

Figure 29 – Feature selection for PU questionnaire

For the feature selection of the BI questionnaire, the table below (Figure 30) shows that the selected features were Question 2 and Question 3. It means that students thought that “可以加強我的學習動機” and “擅長使用教材搜尋平台學習” are important factors influencing their learning outcomes.

Questionnaire in BI	Selected Features	Feature Ranking
題目 **1:** 當我使用教材搜尋平台，我會有信心找到答案	False	2
題目 **2:** 使用教材搜尋平台可以加強我的學習動機	True	1
題目 **3:** 我擅長使用教材搜尋平台進行學習	True	1
題目 **4:** 我相信我能用教材搜尋平台獲得好成績	False	4
題目 **5:** 當我使用教材搜尋平台時，我會想要一直使用	False	3

Figure 30 – Feature selection for BI questionnaire

Third, it will discuss research question 3 - *What are the attitudes of students towards Web-based information retrieval platform*. Since this research used the TAM questionnaire as a data collection method, data from different regression models will be used to analyze the hypothesis of testing the relationships between different variables of the Technology Acceptance Model (TAM).

A reliability analysis was conducted to check the reliability of the survey using Cronbach's alpha test. Cronbach's alpha test is commonly used in statistics to measure the reliability of tests, it provides a measure of the internal consistency of a test or scale and is expressed as the alpha value between 0 and 1 (Cortina, 1993).

Taber (2018) lists the following scales (Figure 31) and corresponding internal consistency implications for Cronbach's alpha. A higher alpha value means that the questionnaire design is more reliable.

Cronbach's alpha	Internal consistency
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

Figure 31 – Cronbach's alpha internal consistency

The results of the reliability analysis were shown in the following table (Figure 32). There were 20 questions in this study. Cronbach's alpha was 0.796, which was close to 0.8. According to Taber (2018), the questionnaire design in this study can be considered as a good design.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.800	.796	20

Figure 32 – Reliability of the questionnaire

The following table (Figure 33) was a result showing descriptive data. The mean value of PU, PEOU, BI, AU were all higher than 3.00. This result helps to understand students' attitudes toward the web-based information retrieval platform; the current results indicate that students generally had a positive attitude towards the Web Interval platform. In addition to the low value of AN, students did not feel fear or confusion when using the platform.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
PU	19	3.20	5.00	4.1895	.50099
PEOU	19	2.80	5.00	3.8632	.63614
BI	19	3.00	5.00	3.8421	.69787
AU	19	3.00	5.00	3.7711	.72050
Anxiety	19	1.00	3.00	1.7895	.60818
Valid N (listwise)	19				

Figure 33 – Descriptive data from TAM model

To gain a deeper understanding of the TAM model, the study also conducted a correlation analysis to understand the correlation coefficients between different factors in the TAM model and to analyze the research hypotheses. Recalling in the previous section, there will be six hypotheses to investigate.

Hypothesis:

- H1: PEOU would positively affect PU
- H2: PU would positively affect BI
- H3: PEOU would positively affect BI
- H4: BI would positively affect AU
- H5: AN would negatively affect PU
- H6: AN would negatively affect PEOU

From the correlation analysis, the summary results of the hypothesis test were shown in the below table (Figure 34), it showed that only H3 was supported, the PEOU had a strong and positive relationship ($r > 0.7$) on BI, and it was significant ($p < 0.01$).

Correlations

		PU	PEOU	BI	AU	Anxiety
PU	Pearson Correlation	1	.100	-.164	.424	-.081
	Sig. (2-tailed)		.684	.503	.071	.743
	N	19	19	19	19	19
PEOU	Pearson Correlation	.100	1	.714**	-.080	-.036
	Sig. (2-tailed)	.684		.001	.744	.885
	N	19	19	19	19	19
BI	Pearson Correlation	-.164	.714**	1	.204	-.187
	Sig. (2-tailed)	.503	.001		.402	.442
	N	19	19	19	19	19
AU	Pearson Correlation	.424	-.080	.204	1	-.052
	Sig. (2-tailed)	.071	.744	.402		.832
	N	19	19	19	19	19
AN	Pearson Correlation	-.081	-.036	-.187	-.052	1
	Sig. (2-tailed)	.743	.885	.442	.832	
	N	19	19	19	19	19

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 34 – Correlations data from TAM model

For H1, it shows that PEOU had a positive correlation ($r = 0.1$) to PU, but the no significant result was found in H1 ($p > .05$).

For H2, it shows that PU had a negative correlation ($r = -0.164$) to BI, and no significant result was found in H2 ($p > .05$).

For H4, it shows that BI had a positive correlation (r = 0.204) to AU, but the no significant result was found in H4 (p > .05).

For H5, it shows that AN had a negative correlation (r = -0.081) to PU, and no significant result was found in H5 (p > .05).

For H6, it shows that AN had a negative correlation (r = -0.036) to PEOU, and no significant result was found in H6 (p > .05).

The table below (Figure 35 - 36) was a summary of the correlation result. In summary, it showed that anxiety (AN) will have a negative impact on students using the web-based information retrieval platform. In addition, if the platform was easy for students to use (PEOU), it will also had a positive impact on the intent of used (BI).

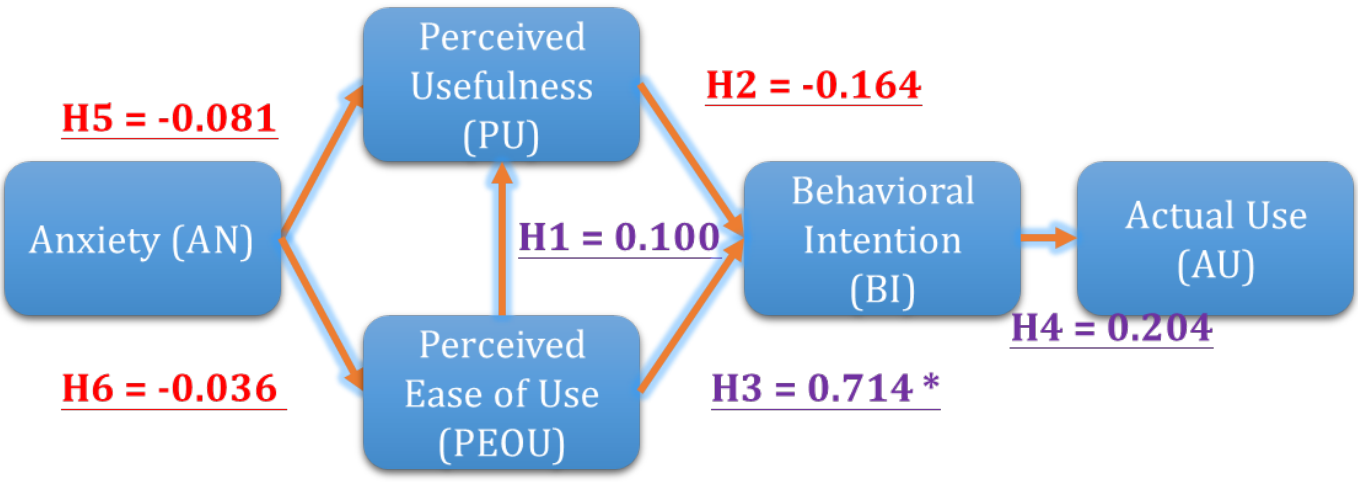


Figure 35 – Summary of correlation result (*P < 0.05)

Hypothesis	Specification	Results
H1	PEOU would positively affect PU	Not supported ($p > .05$)
H2	PU would positively affect BI	Not supported ($p > .05$)
H3	PEOU would positively affect BI	Support ($p < .01$)
H4	BI would positively affect AU	Not supported ($p > .05$)
H5	AN would negatively affect PU	Not supported ($p > .05$)
H6	AN would negatively affect PEOU	Not supported ($p > .05$)

Figure 36 – Summary of hypotheses

7.2. Qualitative Research

The study also conducted semi-structured interviews to address research questions 3 to understand students' attitudes toward the web-based information retrieval platform. The following will use the TAM model to analyze their attitudes.

For the Perceived of Usefulness, student responded that "*The search results are accurate and I can easily find the answer*," *"I can quickly find the answer without opening a textbook"* and "*When I enter a keyword or a misspelled keyword, the platform will display a similar answer*."

From the student's reaction, the web-based information retrieval platform was useful for students' learning, especially the fuzzy search features, because students could quickly find the results, and using e-learning is more interesting than finding answers from traditional textbooks (Knight, 2015).

Concerning the ease of use of the course content search engine platform, student all agreed that "*User interface is simple to design, platform is easy to use, no complicated operational skills required*", and *"The preview feature is easy to use, I just need to click on the "Open PDF button" and then I can take a full view of the presentation slides".*

The student's response indicated that they did not encounter any major problems when using the web-based information retrieval platform, and also appreciated the platform in terms of user friendliness and directness.

For the Behavioral intention and Actual Use, student stated that "*The web-based information retrieval platform has little impact on improving self-confidence, but it can enhance confidence in learning because it is easy to find answers and it can help prepare for the exam*", and "*This platform helps us to develop our Self-directed Learning skill, and the platform will provide the content that we needed*".

The student's response indicated that they were willing to continue using the platform and achieve their learning goals.

In summary, students had a positive attitude towards this information retrieval platform, which can improve their motivation and learning performance.

In addition, some students suggest that the platform can include filtering features since the search platform will return all chapter results, therefore students suggested to add filters and display only the results for a particular chapter.

8. Conclusion

In summary, this study had two purposes. The first was to develop a web-based information retrieval platform for students to search for relevant slides from inputting keywords or text similarities. The second goal was to use this information retrieval platform to assess the student's learning experience and to understand student attitudes while using this information retrieval platform.

Based on our findings, the first research question answered that when a user types a keyword into a web-based information retrieval platform, 95% of the search results are between buttons values 1, 2 and 3. Therefore users can quickly find the results they want.

For the second research question, the research found that the web-based information retrieval platform could improve the learning effect of students. Compared with the two tests, it shows that

the web-based information retrieval platform could increase the test results by an average of 2.68 points.

For the third research question, this study used the TAM model with three variables and an external variable to better understand the factors that influence students' acceptance of the web-based information retrieval platform. The results show that only "PEOU has a positive impact on BI" was significant and supported, which means that students think that ease of use was the main factor when using the platform. In addition, the study also conducted an interview; students replied that they enjoy using the information retrieval platform in learning, which can improve their learning motivation.

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10. Appendix (1) – Pre test

中五級 資訊及通訊科技科

CH16 建網及互聯網基本知識 溫習工作紙

姓名:_____ 班別:_____(___) 日期:

1. 以下哪個正確描述***對等網絡***...?
   (1) 不需要伺服器

   (2) 每台電腦都直接與其他的電腦連繫

   (3) 每台電腦都可以存取其他電腦的資源

   (4) 不少的小型機構和家居網絡都採用對等網絡

   a. 只有 (1)
   b. 只有 (1) 和 (2)
   c. 只有 (1) ， (2) 和 (3)
   d. (1)、(2) 、(3) 和 (4)

2. 以下哪個正確描述***客戶 / 伺服網絡***...?
   (1) 工作站會連接到伺服器

   (2) 工作站的用戶可存取伺服器中的資源

   (3) 提供較佳的保安控制

   (4) 不少的中型或大型的機構都會採用

   a. 只有 (1)
   b. 只有 (1) 和 (2)
   c. 只有 (1) ， (2) 和 (3)
   d. (1)、(2) 、(3) 和 (4)

3. ***硬件分享***的優點包括...?
   (1) 用戶可以傳輸實時資訊和傳送檔案等

   (2) 用戶可共享多種的電腦硬件資源

(3) 善用資源

(4) 需要增加購置硬件的開支

a. 只有 (1)
b. 只有 (1) 和 (2)
c. 只有 (2) 和 (3)
d. (1)、(2) 、(3) 和 (4)

4. ***數據集中管理***可以...?
(1) 讓多名用戶在同一時間為同一項目工作

(2) 不會導致數據更新的問題

(3) 已獲授權的用戶可隨時分享相同的最新資訊

(4) 增加管理成本

a. 只有 (1)
b. 只有 (1) 和 (2)
c. 只有 (1) ， (2) 和 (3)
d. (1)、(2) 、(3) 和 (4)

5. ***網絡許可證***是指...?
(1) 讓軟件可以合法地供不同的網上用戶同時使用

(2) 可以讓用戶重複安裝軟件

(3) 費用較每台電腦購買獨立的許可證為低

(4) 不會限制同一時間內可使用該軟件的人數

a. 只有 (1)
b. 只有 (1) 和 (2)
c. 只有 (1) ， (2) 和 (3)
d. (1)、(2) 、(3) 和 (4)

6. ***光纖電纜***的好處為...?
(1) 傳載信號容量大

(2) 抗干擾能力強

(3) 體積小、輕巧及較耐用

(4) 傳輸速較低

a. 只有 (1)
b. 只有 (1) 和 (2)
c. 只有 (1) ， (2) 和 (3)
d. (1)、(2) 、(3) 和 (4)

7. ***光纖電纜***的缺點為...?
(1) 價格高

(2) 安裝困難

(3) 靈活性較低

(4) 需要特別的設備才能將數碼信號和光學信號互相轉換

a. 只有 (1)
b. 只有 (1) 和 (2)
c. 只有 (1) ， (2) 和 (3)
d. (1)、(2) 、(3) 和 (4)

8. 哪一個***無線相容認證（Wi-Fi）連線***的數據傳輸速度最高...?
a. 802.11n
b. 802.11g
c. 802.11b
d. 802.11a

9. 以下哪個不是（Wi-Fi）連線的好處...?
a. 建立網絡的成本較低
b. 更改網絡結構更具彈性
c. 網絡能伸延至戶外區域
d. 最高數據傳輸速度高於有線網絡

10. 以下哪個不是常用的無線網絡接達方法...?
a. Wi-Fi
b. WAP
c. WAV
d. GPRS

11. Appendix (2) – Post test

中五級 資訊及通訊科技科

CH17 通訊軟件及協定 溫習工作紙

姓名:_____ 班別:_____(___) 日期:

資料搜尋網站: ltm.eduhk.hk/csearch

1. 透過***電腦網絡來進行溝通***的優點包括...?
   (1) 即時通訊或有更高的傳輸速度

   (2) 更低的傳輸成本

   (3) 支援多媒體信息

   (4) 所傳輸的資訊能在大部分的情況下再使用

   a. 只有 (1)
   b. 只有 (1) 和 (2)
   c. 只有 (2) 和 (3)
   d. (1)、(2) 、(3) 和 (4)

2. 身處香港的陳小明想與身處美國的陳大明傳輸音頻信息，以下哪一個通訊軟件較為合適...?
   a. 互聯網電話
   b. 視像會議
   c. 電子郵件
   d. 網上聊天室

3. 為應用軟件而設的界面，以設定與另一應用軟件之間的通訊是開放系統互連（OSI）模型的哪一層...?
   a. 話路層
   b. 表示層
   c. 應用層
   d. 傳輸層

4. 開放系統互連（OSI）模型當中的實體層是負責...?
    a. 決定數據的路徑選擇和轉寄
    b. 管理電腦通訊設備和網絡媒體之間的互通
    c. 把傳輸表頭（TH）加至數據以形成數據報
    d. 把數據轉換為能與接收者的系統格式兼容並適合傳輸的格式

5. 以下一哪一項正確描述當數據檔使用 TCP 經網絡被傳送的結果...?
    a. 該檔案被分拆為一個或多個數據包
    b. 數據包被編上號碼，並合併傳送至 IP 層
    c. 當數據包到達接收者的電腦時，TCP 層會把所接收的數據包重新集合為多個數據檔
    d. 為每個數據包加上 IP 目的地位址

6. 以下哪個正確描述 互聯網協定位址 (IP 位址)...?
    (1) 獨一無二的

    (2) 識別在網絡中的每台電腦

    (3) 8 位元的數字組成

    (4) 可以利用全域名稱代替 IP 位址以瀏覽網頁

    a. 只有 (1)
    b. 只有 (1) ， (2) 和 (4)
    c. 只有 (1)、(2) 和 (3)
    d. (1)、(2) 、(3) 和 (4)

7. 以下哪個正確描述劃一資源定位（URL）...?
    (1) 指出網站中某個網頁或檔案所在的位置

    (2) 不需要包含所使用的協定和網域名稱

    (3) 相應網伺服器的根目錄的資料夾名稱和檔案名稱亦能附於 URL 的尾端

    (4) 可以在 URL 的尾端加入埠號碼來接達指定的伺服器

    a. 只有 (1)
    b. 只有 (1) 和 (2)
    c. 只有 (1) ， (3) 和 (4)
    d. (1)、(2) 、(3) 和 (4)

8. 網域名稱系統（DNS）的用途是...?
   (1) 把網域名稱翻譯成 IP 位址

   (2) 可讓網頁瀏覽器（HTTP 客戶）解譯和顯示

   (3) 把網域名稱的資訊進行解譯和在數據庫裏搜尋對應的 IP 位址

   (4) 讓使用者透過網域名稱存取互聯網上的資訊

   a. 只有 (1)
   b. 只有 (1) 和 (2)
   c. 只有 (1) ， (3) 和 (4)
   d. (1)、(2) 、(3) 和 (4)

9. 以下那個 ***不是*** 頂級域的例子...?
   a. com
   b. edu
   c. gov
   d. hk

10. 互聯網網域 (www.chc.edu.hk)當中，***第二層域*** 是...?
   a. www
   b. chc
   c. edu
   d. hk

12. Appendix (3) – Questionnaire

問卷調查

請填寫問卷調查，表達你的意見！ (用 1 至 5 來評分，5 表示非常同意，1 表示非常不同意)

感受有用性 (Perceived of Usefulness)					
	非常同意 (1)	同意 (2)	一般 (3)	不同意 (4)	非常不同意 (5)
題目 1: 使用教材搜尋平台對學業是有好處的					
題目 2: 使用教材搜尋平台可以讓自己學得更多					
題目 3: 使用教材搜尋平台可以讓我的學習進步					
題目 4: 我覺得教材搜尋平台的非常符合我的需求					
題目 5: 教材搜尋平台的搜尋結果是我想要的					

感受易用性 (Perceived Ease of Use)					
	非常同意 (1)	同意 (2)	一般 (3)	不同意 (4)	非常不同意 (5)
題目 1: 教材搜尋平台只需要花一點時間就懂得如何使用					
題目 2: 使用教材搜尋平台時，我可以很容易找到所需要的頁面和內容					
題目 3: 操作教材搜尋平台對我來說是簡單、容易的					
題目 4: 教材搜尋平台上所提供的操作功能，很容易點選使用					

題目 5: 與搜尋方式比較，「教材搜尋平台」的使用方法使我的學習變得比較困難					

行為意向 (Behavioral intention)					
	非常同意 (1)	同意 (2)	一般 (3)	不同意 (4)	非常不同意 (5)
題目 1: 當我使用教材搜尋平台，我會有信心找到答案					
題目 2: 使用教材搜尋平台可以加強我的學習動機					
題目 3: 我擅長使用教材搜尋平台進行學習					
題目 4: 我相信我能用教材搜尋平台獲得好成績					
題目 5: 當我使用教材搜尋平台時，我會想要一直使用					

使用行為 (Actual Use)					
	非常同意 (1)	同意 (2)	一般 (3)	不同意 (4)	非常不同意 (5)
題目 1: 我想上課時可以一直使用教材搜尋平台					
題目 2: 在課餘時，我也會使用教材搜尋平台增進我的學習能力					
題目 3: 我有疑問的時候，我就會想去教材搜尋平台中尋找答案					
題目 4: 對於「教材搜尋平台」的方式感到失望					

題目 5: 我對使用教材搜尋平台會感到害怕					

13. Appendix (4) – Semi-structured interview question

開放式提問問卷:

感受有用性 (Perceived of Usefulness)

1 你認為教材搜尋平台最有用 / 最吸引你的地方是甚麼？為甚麼？

1.1 提示例如: 圖片預覽功能？ / 打開該簡報頁面功能？

2 你認為這些功能能夠幫助你學習嗎？為什麼？

感受易用性 (Perceived Ease of Use)

1. 你認為教材搜尋平台容易使用嗎？

1.1 例如: 有什麼功能你喜歡使用？

1.2 例如: 你能夠容易找出所需要內容嗎？

2 你認為教材搜尋平台有什麼功能需要改善，幫助學生學習？

行為意向 (Behavioral intention)

1 你認為教材搜尋平台能夠提升了你的自主學習動機嗎？為甚麼？

1.1 例如: 你會否利用教材搜尋平台，主動探究不同知識內容？

2 你認為教材搜尋平台能夠提升了你的學習信心 / 學習興趣嗎？為甚麼？

使用行為 (Usage behavior)

1 日後你會繼續使用教材搜尋平台進行學習嗎？為甚麼？