

**NANYANG
TECHNOLOGICAL
UNIVERSITY**

**DESIGN AND EVALUATION OF A VIDEO RETRIEVAL ENVIRONMENT FOR
EXPLORATORY SEARCHES IN A LEARNING CONTEXT**

CLIFF LOKE CHOON MUN

**Supervisor: Professor Schubert Foo Shou Boon
Wee Kim Wee School of Communication & Information**

A thesis submitted to Nanyang Technological University
in partial fulfilment of the requirement for the degree of
Doctor of Philosophy

2020

STATEMENT OF ORIGINALITY

I hereby certify that the work embodied in this thesis is the result of original research, is free of plagiarised materials, and has not been submitted for a higher degree to any other University or Institution.

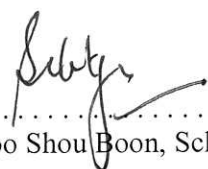
6 | 1 | 2020
.....
Date


.....
Cliff Loke Choon Mun

SUPERVISOR DECLARATION STATEMENT

I have reviewed the content and presentation style of this thesis and declare it is free of plagiarism and of sufficient grammatical clarity to be examined. To the best of my knowledge, the research and writing are those of the candidate except as acknowledged in the Author Attribution Statement. I confirm that the investigations were conducted in accord with the ethics policies and integrity standards of Nanyang Technological University and that the research data are presented honestly and without prejudice.

6/1/2020
.....
Date


.....
Prof Foo Shou Boon, Schubert

AUTHORSHIP ATTRIBUTION STATEMENT

This thesis contains material from 1 paper from papers accepted at conferences in which I am listed as an author:

Loke, C., Foo, S., & Majid, S. (2017) Video seeking behavior of young adults for self-directed learning. In S. Choemprayong, F. Crestani, & S. Cunningham (Eds.), *Digital Libraries: Data, Information and Knowledge for Digital Lives*. ICADL 2017. Lecture Notes in Computer Science, vol. 10647. Springer, Cham.

6 / 1 / 2020

.....
Date



.....
Cliff Loke Choon Mun

ACKNOWLEDGEMENTS

This research could not be completed without the support and guidance of some very special people. I would like to express my sincere gratitude to my supervisor Professor Schubert Foo for his supervision, support, guidance and for providing timely and constructive feedback that led me to the completion of this thesis. Prof Schubert's comments have always been insightful and it triggered me to develop deeper and reflective thinking on the problems encountered. It is my privilege and honour to be supervised by him.

Next, I would like to express my utmost appreciation to Prof Shaheen Majid and my thesis advisory committee members. Prof Shaheen has been patient and his opinions often offer me to think in a wider perspective.

I extend my appreciation to all staffs in the school for being helpful and have provided the support throughout my candidature. I extend my gratitude to a few individuals - Chea Wan, Kit Hong, Ren Kang, Chuan Ping, Eileen, Khairina and Gemma - whom had helped and supported me at various stages of my research.

In the past four years, I am thankful to have met many wonderful friends at WKWSCI who walked with me through my PhD journey.

Most of all, I thank my wife, Carol, for her constant encouragement, continuing support and believing in me that I will complete what I have set out for. Without her by my side through the journey would be unimaginable.

TABLE OF CONTENTS

STATEMENT OF ORIGINALITY	II
SUPERVISOR DECLARATION STATEMENT	III
AUTHORSHIP ATTRIBUTION STATEMENT	IV
ACKNOWLEDGEMENTS.....	V
TABLE OF CONTENTS.....	VI
LIST OF FIGURES	XI
LIST OF TABLES	XII
ABSTRACT.....	XIII
CHAPTER ONE - INTRODUCTION	1
1.1 BACKGROUND.....	1
1.2 MOTIVATION OF RESEARCH.....	5
1.3 RESEARCH OBJECTIVES AND QUESTIONS	6
1.4 OVERALL RESEARCH DESIGN.....	8
1.5 SIGNIFICANCE OF RESEARCH	10
1.6 THESIS CONTENT AND ORGANISATION	10
CHAPTER TWO – LITERATURE REVIEW	12
2.1 INTRODUCTION	12
2.2 INFORMATION SEEKING BEHAVIOR RESEARCH	12
2.2.1 Information Seeking Process and Information Seeking Model.....	13
2.2.1.1 Information seeking behavior model for Exploratory Search	13
2.2.2 Exploratory search, exploratory search tasks and process	21
2.2.3 Seeking resources in self-directed learning	25
2.2.4 Use of videos in learning	27
2.2.5 Retrieval of educational and learning videos	29
2.3 VIDEO INFORMATION RETRIEVAL APPROACHES AND INTERFACES	31
2.3.1 Developments in interface and features	33
2.3.1.1 Expressing information needs and navigation of search domain.....	34
2.3.1.2 Resource management and selection.....	38
2.3.1.3 Resource consumption	41
2.3.2 Summary of key gaps	43
2.4 SUMMARY	44
CHAPTER THREE – STUDY 1: INVESTIGATING THE VIDEO SEEKING BEHAVIOR OF ADOLESCENT LEARNERS	46
3.1 INTRODUCTION	46
3.2 AIMS OF THE STUDY	46

3.3	METHOD	48
3.3.1	Research approach and design	48
3.3.1.1	Pilot Study	49
3.3.1.2	Search tasks design.....	49
3.3.1.3	Participants	51
3.3.1.4	Data collection.....	53
3.3.1.5	Study procedure.....	55
3.3.1.6	Data analysis procedure	56
3.3.1.7	Data transcription	57
3.3.1.8	Codebook development.....	59
3.3.1.9	Coding method	60
3.4	RESULTS	63
3.4.1	Video seeking behavior of young adolescents	63
3.4.1.1	Theme 1 – Selection of resources	63
3.4.1.2	Theme 2 – Query formulation and reformulation	66
3.4.1.3	Theme 3 – Selecting videos for preview	68
3.4.1.4	Theme 4 – Previewing the video.....	71
3.4.1.5	Theme 5 – Decision for search task	73
3.4.2	Interface features supporting exploratory video search	75
3.4.2.1	Theme 6 – Supporting query formulation	75
3.4.2.2	Theme 7 – Interaction with video metadata	77
3.4.3	Features suggested by participants	80
3.5	DISCUSSIONS.....	81
3.6	SUMMARY OF CHAPTER.....	85

CHAPTER FOUR – STUDY 2: EXPERTS INTERVIEWS TO ELICIT DESIGN CONCEPTS FOR A VIDEO RETRIEVAL PLATFORM.....87

4.1	INTRODUCTION	87
4.2	PURPOSE OF STUDY	87
4.3	METHOD	88
4.3.1	Adapting from Expert interviews and research approach	88
4.3.1.1	Identifying and recruiting interviewees.....	89
4.3.1.2	Role of the interviewer.....	92
4.3.1.3	Interview guide.....	93
4.3.1.4	Interview procedure and interaction strategies.....	94
4.3.2	Data analysis procedure.....	95
4.3.2.1	Data transcription	96
4.3.2.2	Coding process	96
4.4	DESIGN CONCEPTS FOR VIDEO RETRIEVAL ENVIRONMENT	97
4.4.1	Augment knowledge boundaries visually	98
4.4.2	Keywords management	100
4.4.3	Integrate multi-modal input.....	103
4.4.4	Advanced input options.....	106
4.4.5	Exploration of relationship between concepts and results	108

4.4.6	Multi-sources recommendations	110
4.4.7	Granular interaction.....	112
4.4.8	Enriched interaction with video content.....	114
4.4.9	Affiliation of seeker profile	116
4.5	DESIGN CONCEPTS AND FEATURES	118
4.6	SUMMARY	120
CHAPTER FIVE – PROTOTYPE DERIVATION, DEVELOPMENT AND EVALUATION.....		122
5.1	INTRODUCTION	122
5.2	FEATURES TO SUPPORT EXPLORATORY VIDEO SEARCH.....	122
5.2.1	Discussions with Information Retrieval experts	123
5.3	THE FEATURES TO SUPPORT EXPLORATORY VIDEO SEARCH ENVIRONMENT.....	126
5.3.1	Concept Map group	126
5.3.2	Granular interaction group	128
5.3.3	Metadata group.....	133
5.3.4	Value-adding group.....	135
5.4	GENERAL DESIGN OF CONCEPTUAL PROTOTYPE EVALUATION.....	139
5.4.1	Prototype evaluation methodology.....	139
5.4.2	Participants	140
5.4.3	Instrumentation and Material	140
5.4.4	Data collection.....	144
5.4.5	Data analysis procedure.....	145
5.5	SUMMARY	146
CHAPTER SIX – STUDY 3: USER PROTOTYPE EVALUATION FINDINGS		147
6.1	INTRODUCTION	147
6.2	EVALUATION RESULTS AND FINDINGS	147
6.2.1	Participants’ profile	148
6.2.2	Concept Map group	150
6.2.3	Granular interaction group	155
6.2.4	Metadata Group.....	160
6.2.5	Value-adding group.....	163
6.3	FINDINGS SUMMARY	174
CHAPTER SEVEN – DISCUSSION AND CONCLUSION		176
7.1	DISCUSSION OF EVALUATION FINDINGS.....	176
7.1.1	Concept Map Group	176
7.1.2	Granular Interaction Group	179
7.1.3	Metadata Group.....	182
7.1.4	Value-Adding Group.....	184
7.1.5	Summary of the recommended features	188
7.2	SUMMARY OF RESEARCH	188
7.3	CONTRIBUTIONS TO KNOWLEDGE AND PRACTICE	194

7.4	LIMITATIONS.....	196
7.5	DIRECTIONS FOR FUTURE WORK.....	198
7.6	CONCLUDING REMARKS	200
REFERENCES.....		201
APPENDICES		218
APPENDIX 3-1: IRB APPROVAL FOR STUDY 1.....		218
APPENDIX 3-2: EXPLORATORY SEARCH TASKS FOR PARTICIPANTS (STUDY 1)		220
APPENDIX 3-3: ADVERTISEMENT FOR RECRUITMENT OF PARTICIPANTS (STUDY 1).....		221
APPENDIX 3-4: INTERVIEW QUESTIONS (STUDY 1).....		222
APPENDIX 3-5: PART OF THE INTERCODER-RELIABILITY COMPUTATION		223
APPENDIX 4-1: IRB APPROVAL FOR STUDY 2.....		224
APPENDIX 4-2: EMAIL TEMPLATE TO ENGAGE THE EXPERTS		226
APPENDIX 4-3: INTERVIEW GUIDE		227
APPENDIX 5-1: IRB APPROVAL FOR STUDY 3		229
APPENDIX 5-2: RECRUITMENT ADVERTISEMENT FOR STUDY 3.....		231
APPENDIX 5-3: TASK DESCRIPTION AND TASK STEPS		232
APPENDIX 5-4: PARTICIPANT QUESTIONNAIRE		234
APPENDIX 5-5: STUDY INFORMATION SHEET AND CONSENT FORM		251
APPENDIX 6-1: PARTICIPANTS' PROFILE SUMMARY		254
APPENDIX 6-2: SUMMARY OF THEMES AND COMMENTS FOR CONCEPT MAP.....		257
APPENDIX 6-3: SUMMARY OF THEMES AND COMMENTS FOR GRANULAR INTERACTION.....		263
APPENDIX 6-4: SUMMARY OF THEMES AND COMMENTS FOR METADATA.....		269
APPENDIX 6-5: SUMMARY OF THEMES AND COMMENTS FOR VALUE-ADDING		274

LIST OF FIGURES

Figure 1.1. The three main research stages	8
Figure 2.1. Information-Seeking Strategies	15
Figure 2.2. Marchionini's sub-processes of Information Seeking	16
Figure 2.3. Berry picking model	18
Figure 2.4. Activities of different searches	22
Figure 2.5. Anchor points within an instructional video in ViZig	30
Figure 2.6. Combining content-based and semantic approach in bridging semantic gap	32
Figure 2.7. Similarity calculation based in ontology structure	33
Figure 5.1. Concept map from the query	127
Figure 5.2. The same video resource with different search concepts highlighted	129
Figure 5.3. The mapping of segments of high interactivity between practice and prototype	130
Figure 5.4. Navigating the video to the point of the selected segment	131
Figure 5.5. Populating the video segment container from two videos.....	132
Figure 5.6. Video segment container page and the sequencing of video segments.....	133
Figure 5.7. Additional metadata included in the results list and video play view	135
Figure 5.8. Session history and session history numbers for video resources	136
Figure 5.9. A view on the types of comments visualization for a video resource	137
Figure 5.10. The display of the concept map	142
Figure 5.11. The concept and View Count video segments	143
Figure 5.12. Video segment container that has video segments from two videos	143

LIST OF TABLES

Table 1.1. Thesis organization	11
Table 2.1. Characteristics of Exploratory Search	24
Table 3.1. Participants profile and their post-secondary courses enrolled.....	522
Table 3.2. Extract from codebook for first cycle coding	60
Table 3.3. List of features and examples cited by the participants	81
Table 4.1. Basic profile of interviewees	911
Table 4.2. Core interview questions.....	944
Table 4.3. Design concepts, features and intended effects	119
Table 5.1. List of features and utilities for conceptual prototype development	125
Table 6.1. Logical grouping of features for results reporting	1488
Table 6.2. Breakdown on the number of participants by course.....	1499
Table 6.3. Descriptive statistics and agreement percentage for the Concept map group ..	15050
Table 6.4. Descriptive statistics and agreement percentage for the Video segment group..	1566
Table 6.5. Descriptive statistics and agreement percentage for the Metadata group.....	1600
Table 6.6. Descriptive statistics and agreement percentage for the Value adding group	1655
Table 6.7. Agreement percentage of the participants for the comments visualization	1699
Table 6.8. Counts for comments visualizations	1711
Table 6.9. Agreement percentage of the participants for recommendations	17373
Table 6.10. Counts for recommendations	1744
Table 7.1. Summary of the recommended features	19090

ABSTRACT

The proliferation of Internet has made information more accessible to many people, including self-directed learners to support their learning needs. With technology and the Internet omnipresent, students today have grown up and immersed themselves in technologies for leisure and learning. These younger information seekers appear to be comfortable with finding information on the Internet. However, studies (Foo et al., 2014; Chang et al., 2012) have shown that they have limited higher order information literacy skills such as evaluation of information. This makes the search for useful and relevant information on the Internet challenging.

Videos have been used in numerous environment to support learning. Public video repositories on the Internet, such as YouTube, Vimeo, and others serve as good resources for self-directed learning (SDL). Videos, being a richer form of medium and can engage the students better as compared to textual resources. Video is complex, where text, images, and audio can all be automatically extracted and indexed. The multi-dimensional makeup of a video has highlighted the need for better ways to interact with a video retrieval system so that retrieval can be more effective, more so for younger video seekers for SDL.

The aim of this research is to study the interfaces of video retrieval systems that are deemed desirable and support the video seeking behavior of post-secondary students for SDL. The berrypicking model is used to guide this research. To address the research aim, the research will comprise of three interrelated studies.

Study 1 explored the video seeking behavior of these adolescents and identify the video seeking process. 14 post-secondary students were recruited to perform two exploratory video search tasks while applying the think-aloud technique. The analysis of the results collected identified themes that are related to the video seeking behavior of the post-secondary students and the challenges encountered when performing exploratory video search tasks for learning.

The themes are *Selection of resources*, *Query formulation and reformulation*, *Selecting videos for preview*, *Previewing the video*, *decision for search task*, *Supporting query formulation* and *Interaction with video metadata*.

These findings serve as inputs to Study 2, where ideas and opinions were elicited from 20 experts with experience and skills from various fields to derive design concepts for a video retrieval environment. The thematic analysis resulted in nine design concepts for video retrieval environment in an exploratory search context. Discussions with two additional information retrieval experts were conducted to cogitate the design concepts and potential features that were derived and further elicit features for the development of the video retrieval prototype. Consequently, a set of video retrieval platform features were derived and a conceptual prototype was developed to demonstrate how these features support an exploratory video search.

Study 3, an empirical evaluation on the conceptual prototype through a task walkthrough and a questionnaire that collected both quantitative and qualitative data. A total of 85 post-secondary students from the polytechnics and Institute of Technical Education (ITE) were recruited. The participants performed a task walkthrough that allowed the examination of the features using the conceptual prototype. The questionnaire was designed to capture the participants' opinions on the utility of the features and what the participants liked and dislike about the features. The evaluation findings established the features that were deemed desirable and useful by post-secondary students for an exploratory search for learning videos. While the results cannot be generalised, they nonetheless provide an important insight to participants' perception on the features.

The research contributed to the stream of studies dedicated to video retrieval and seeking behavior, interactive design and studies as well as the design of video retrieval system to support the search for learning videos. A set of key features grouped into Concept Map,

Granular interaction, Metadata and Value-adding was developed to be included in the design and delivery of video retrieval to support self-directed learning. These features have updated and support the strategies put forth by the berrypicking model. A number of limitations were noted where the research was conducted on the search using laptop and video seeking behavior is likely to differ on mobile devices. The research was limited to post-secondary students who are enrolled in vocational courses. Other post-secondary students with less vocational needs may result in different search behavior and challenges.

CHAPTER ONE - INTRODUCTION

1.1 Background

The proliferation of the Internet has changed the way the world functions. The Internet affords businesses through e-commerce, entertainment through videos and online games, and information sharing through repositories and social media. The expansion of information resources and electronic resources, coupled with the advancement in information and communication technologies have catered to the diverse learning needs. The Internet has become a public space for information seeking and learning. This has brought on changes in the learning process as the Internet becomes a part of learning medium (Lee, Cheung, & Chen, 2005). More e-learning platforms are developed as people get comfortable with online learning.

The accessibility of the Internet to many people had them turning to the Internet in seeking information for learning and to fill knowledge gaps. Researches were conducted for various domain to investigate how information seeking has affected the growth of information on the Internet (Cline & Haynes, 2001; Khoo, Bolt, Babl, Jury, & Goldman, 2008; Lee & Tsai, 2011). Such growth in the use of the Internet suggested that people are comfortable in self-directed learning (SDL) in public spaces. While the information-rich Internet has a vast amount of information resources to support SDL, the lack of information literacy impedes the learning process. The heterogeneity of information found on the Internet (Kaldoudi, Dovrolis, & Dietze, 2011) and the increase of self-authored content from Web 2.0 and social media (Luo, 2010) are some reasons that lead to challenges in finding relevant and useful resources for their learning without adequate information literacy.

Search engines such as Google have simplified the search for information with the use of text input interface. This easy to use input interface allows natural language inputs and will

present list of results without any indication of error. The query-response paradigm adopted by search engines has become the *de facto* standard. While this retrieval paradigm made searches with search engines seemingly simple, inadequate query can lead to an overload of irrelevant search results that convolutes the search process (White & Roth, 2009). Such a situation becomes more pronounced in an exploratory search (ES). Marchionini (2006) suggested a broad classification of searches into lookup and exploratory. A lookup search is basic and returns specific and precise information resources. This form of searches is well supported by the query-response paradigm used in search engines.

ES are complex as it can often begin with imprecise or open information needs, resulting in intertwining with other search activities and having open-ended search goals (Kim, 2009; White & Roth, 2009). The query-response paradigm does not support ES well (Singh, Hsu, & Moon, 2013; Teevan, Alvarado, Ackerman, & Karger, 2004) as the information needs and other contextual factors changes through the search process. In an ES process, a tentative query is often submitted to explore and navigate the resources in the domain of interest to better understand the area before finding more cues to continue. ES can be triggered by various factors such as information need, ill-defined problem situations and uncertainty (White & Roth, 2009). Such triggers point toward situations in SDL.

Information retrieval (IR) systems act as intermediaries between information resources and information seekers by providing interfaces for interaction. In the process of IR, the interface of the IR system allows the information seeker to input the request and present the information resources after matching the request to its collection (Belkin, Oddy, & Brooks, 1982). The diverse needs and experience of people have influenced the information seeking process. Information seeking behavior (ISB) models are often used to study and understand the dynamics of interaction between people and IR systems. Through the analysis of ISB

models, the identification of various stages of information seeking process allows clear reflections of the types of interactions and actions that take place.

There are many ISB models developed over the years. The berrypicking model is one of the ISB models that can be regarded as a prototypical model for ES. The berrypicking model was developed before the Web came into existence and it describes information seeking as an adapting activity with which information resources are identified and selected, akin to picking berries in a bush (Bates, 1989). Put into the context of SDL, the berrypicking model characterises the information seeking process and supports the understanding of the ES tactics.

In many learning settings, the learner explores the domain of interest independently. They begin the exploration of the domain or topic with vague and basic understanding. Often, ES are conducted via the Internet as a convenient way to acquaint themselves to the domain. The vast amount of information resources found online and the lack of gatekeepers on the quality of information can be perplexing for the learners to find relevant and useful resources. This challenge may be more pronounced for adolescent learners. Adolescence marks the critical developmental period between the start of physical puberty and the establishment of social independence (Steinberg, 2014). The age for adolescences has been defined by various organizations and theorists to have different ranges and can fall between 10 to 25 years of age (Curtis, 2015).

The adolescent learners grow up in the digital age and appear comfortable with information technology and digital resources for their learning. However, they lack information literacy skills to discriminate the quality of the resources they encounter (Foo et al., 2014). In the search for resources in the Internet, they have used more trial and error strategies to acquire their resources (Kolikant, 2010). The normative development change in

adolescents makes them more vulnerable to risky behavior and has a higher propensity in risk taking (Steinberg, 2010). This suggests that these young learners may use the less-than-optimal resources found on the Internet for their learning.

As the query-response paradigm takes prominence in the Internet search engines, the lack of information literacy and high level of satisficing in adolescent learners can result in poor selection of resources for learning. Post-secondary students in Singapore are represented by adolescents between ages of 16 to 22 and are continuing education beyond secondary schools. In secondary schools, the students tend to be spoon-fed where the teachers can guide them on the subject and direct them to suitable resources for their learning. After completing their secondary school education, students in Singapore typically choose to continue their post-secondary education through three pathways – (i) pre-university education, (ii) polytechnic course, or (iii) Institute of Technical Education (HNITEC/NITEC) certification. The latter two pathways focus on vocational hands-on training for students to acquire relevant and specific skills for the workplace (Ministry of Education Singapore, 2019). These pathways involves more vocational and practical skills training. The use of videos are often utilised in their vocational-based learning. Moving to post-secondary education, learning becomes more autonomous where the student takes more responsibility and accountability in learning.

These challenges are compounded in ES for SDL. Researchers operationalized ES tasks according to complexity and search goal (Athukorala, Głowacka, Jacucci, Oulasvirta, & Vreeken, 2016). ES tasks have vague and open-ended search goals. As the students turn to the Internet to start their SDL on a new topic, their vague knowledge of the topic or domain can lead to the lack of contextual awareness to formulate adequate queries. This in turn can result in the acquisition of an overwhelming amount of poor quality and irrelevant resources that impedes self-learning.

Videos are an important learning resource for post-secondary students enrolled in vocation-based education. Public video repositories, such as YouTube, serves as good resources for learning. However, the wide selection of videos in these repositories and the quality of metadata add to the challenge of finding effective videos for learning. This is more so when the video search is exploratory where the students have poorly defined goals. Videos retrieval can be more complex as compared to textual resources as they are comprised of frames of images and sound.

As more people become assimilated in using the Internet to inform themselves, there is a need to address the concern of finding relevant and effective videos for learning. The use of simple and popular free-text search facility found in most search platform cannot adequately support ES activities (Wilson & White, 2009). This suggests that the retrieval interfaces and features can be developed to better support interaction in ES for learning.

1.2 Motivation of research

Earlier work done on information retrieval included development of retrieval algorithms to improve precision and recall. Marchionini (2006) distinguished ES and lookup searches. Some previous work dealt with modelling ES behavior to improve search strategies (Aula, Khan, & Guan, 2010; Yue, Han, & He, 2014), while others were concerned with the outcome for ES (Halvey, Vallet, Hannah, & Jose, 2014; Kules, Capra, Banta, & Sierra, 2009; Marie, Gandon, Giboin, & Palagi, 2014). Other researchers explored various metrics for the evaluation of ES systems (Qu & Furnas, 2008; Shah, Hendaheewa, & González-Ibáñez, 2015).

The Strategic Workshop on Information Retrieval in Lorne (SWIRL) discussed about long-range challenges and opportunities in the field of information retrieval. ES system has been a recurring theme in the past two SWIRL workshop (Allan, Croft, Moffat, & Sanderson, 2012; Culpepper, Diaz, & Smucker, 2018). In particular, the research to improve support of

information retrieval systems for broadening knowledge and learning remains as a research challenge.

Retrieval platforms meant for different usage will have varying emphasis on the interface and features than others. For instance, a platform with a huge repository of archival reports will have a more elaborate querying interface, while a platform containing entertainment videos will have stronger emphasis on interface feature in terms of browsing and playback. Many new interactive techniques, visualisation technologies and interfaces have materialized as a result of the need to support ES. In the ES for learning resources, there is a need to move beyond simple query interfaces to support richer interactions and expressions, and to represent the search context.

Video is an important resource for learning, especially in vocational post-secondary education settings. The complex makeup of videos offers richer information attributes such as visual, audio, and other metadata. This presents a richer form of medium that offer students better engagement and interactivity as compared to textual resources (Guo, Kim, & Rubin, 2014; Zhang, Zhou, Briggs, & Nunamaker Jr, 2006). Much of the work on ES were done on textual resources. While video retrieval has undoubtedly benefited from these work, the distinctive characteristics of video demand for work to adapt the findings and ensure applicability in the learning context. The richness of the video retrieval interface features influences the amount of interaction and decision making (Burgoon et al., 2000; Flanagin & Metzger, 2007), and hence have implications for interface designers. This makes it reasonable to investigate video retrieval features independently for a specific context.

1.3 Research Objectives and Questions

An information retrieval system is crucial in information seeking as it is a gateway for information seekers to express their information needs and presents resources that match the

needs. The overarching goal of this research is to develop a set of video retrieval interface design features that will support learners in their ES for learning videos. For achieving this goal, three interrelated research objectives are postulated.

The first objective (RO1) is to understand the video seeking behavior of adolescent learners during ES for learning videos. Adolescent learners in this research are defined as students between ages of 16 to 22 and are continuing education beyond secondary schools. They are enrolled or will be enrolled in post-secondary institution such as Polytechnics and the ITE. University students are excluded from this study as SDL is more prevalent to polytechnics and ITE students due to the focus on skill-based study with which videos are used extensively. Hearst (2009) asserted that it is pertinent to understand the information seeking process in order to design effective user interfaces for searches. This objective is meant for uncovering challenges faced by adolescent learners during ES. Through the deeper understanding of the challenges involved and searching behavior, user-centric features pertinent to better support exploratory video search can be explored. The following research question aimed to address RO1:

RQ1: What is the video seeking behavior of adolescent learners during an ES for learning videos?

The second research objective (RO2) is to derive conceptual design features in a video retrieval environment that supports the way adolescent learners perform exploratory video searches, as well as their interactions, needs and addressing their challenges. This research objective related to the exploration of design considerations for a video retrieval environment. In addressing RO2, the following research questions were proposed:

RQ2: What video retrieval interfaces or features can mitigate challenges faced by learners in an ES for learning videos?

RQ3: What important video retrieval interfaces or features can better support learners in an ES for learning videos?

The deliverable for the two research objectives is a video retrieval prototype. The last research objective (RO3) is to derive a list of design features to be included in a video retrieval environment based on the evaluation findings. The final research question is guided by RO3 and is as follows:

RQ4: Which are the proposed video retrieval features that meet the expectations and needs in the user-based evaluation?

1.4 Overall research design

To achieve the research objectives, this research was carried out in three sequential stages.

Figure 1.1 depicts the stages and related work involved in each stage.

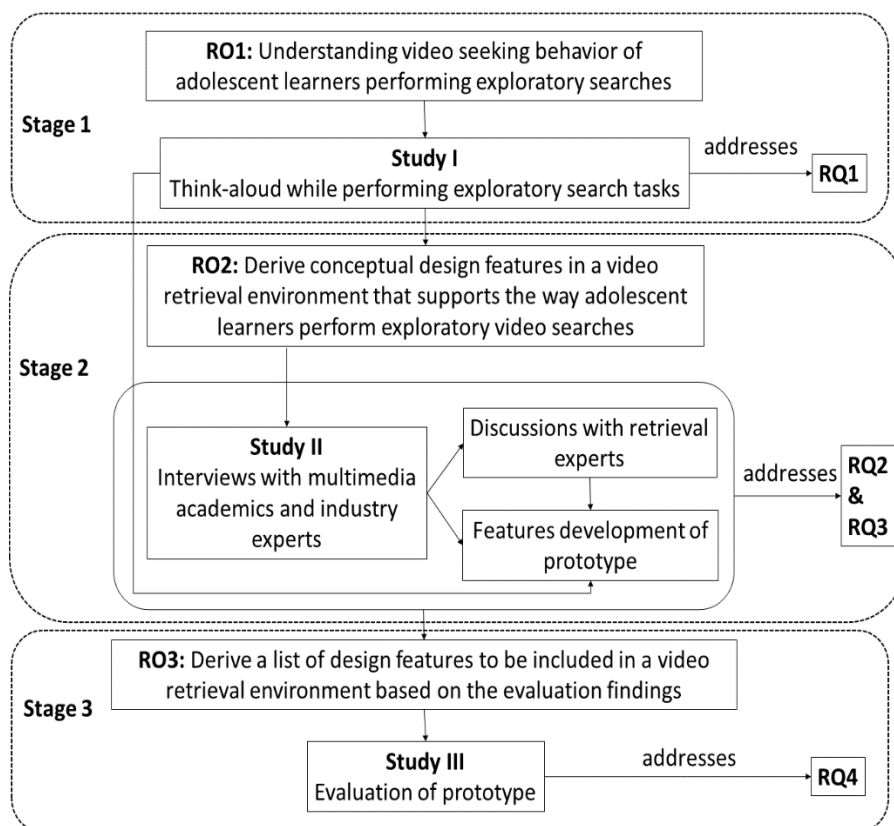


Figure 1.1. The three main research stages

Stage 1 of the research began with a review of information seeking behavior literature. In addressing RO1 and RQ1, Study I investigated adolescent learner's exploratory searching behavior on existing public video repositories. The study was conducted using a concurrent verbal protocol, the think-aloud technique, when customised ES tasks were performed. 14 post-secondary students were involved, completing a total of 28 exploratory video search tasks that were customised within their learning domain. This study helped in understanding the challenges encountered by adolescent learners when embarking in an exploratory video search. The findings from this study forms the basis for the next stage of the research.

Stage 2 of the research starts with Study II. In addressing RO2, 20 academic and industry experts in the domain of multimedia, retrieval and learning technology were interviewed for their opinions and ideas in addressing the challenges faced adolescent learners during exploratory video searches. Following Study II, further discussions with information retrieval experts lead to the formalisation of the video retrieval system features, addressing RQ2 and RQ3. The list of features was used to guide the development of a conceptual prototype.

The prototype developed was subsequently evaluated in Stage 3. To achieve RO3, an empirical evaluation of the conceptual prototype was conducted through Study III. 85 post-secondary school students participated in the user-based evaluation of the conceptual prototype. This study helped in understanding the perceptions and preferences of adolescent learners on the video retrieval environment in an exploratory video search setting. Through the evaluation, a list of features to be included in a video retrieval platform to support ES was derived, addressing RQ4.

1.5 Significance of research

This research contributes to the body of information seeking behavior and human computer interaction knowledge. The research expands the knowledge base regarding video seeking behavior of adolescents in an exploratory context through the use qualitative data that supports known quantitative data. It further examines how interface design can support a range of interaction tasks through the use of features and functionalities that can align to exploratory video seeking behavior. More specifically, the contributions of the research are:

- Understanding of exploratory video seeking challenges of young learners within a learning context.
- A set of video retrieval features derived to support interaction in an ES environment within a learning context.
- A conceptually designed prototype to illustrate how various video retrieval features could support exploratory video searches in the learning context.
- Empirical data from the prototype evaluations with representative users in a simulated exploratory video search task. These findings will have implications to the design of features for video retrieval systems to better support ES in the learning context. Some generalisation may be extended to other video or multimedia retrieval systems.
- The findings will have implications for other research domains such as education, platform development and multimedia processing.
- The findings will suggest aspects of video retrieval features that require further investigations.

1.6 Thesis content and organisation

The remaining chapters for this thesis are depicted in Table 1.1.

Table 1.1. Thesis organization

CHAPTER	
2	Review of related literature
3	An investigation of the video seeking behavior of adolescent learners
4	Derivation of design concepts for a video platform and the development of a conceptual prototype
5	Conceptual prototype development
6	User evaluation of conceptual prototype
7	Discussion and Conclusions

CHAPTER TWO – LITERATURE REVIEW

2.1 Introduction

The chapter presents the relevant literature to provide a context for the current research. This chapter is divided into two sections. The first section begins with a review of information seeking behavior followed by an examination of literature concerning exploratory search in the context of the research. The next section surveys the literature in the field of information and video retrieval and interfaces developments.

2.2 Information Seeking Behavior research

Early library and information science user studies involved scientists in the physical science discipline, examining their information needs and information use (Siatiri, 1999). Library and information science concepts such as information use or needs, information communications channel and information seeking behavior are interdependent. This lead to information science researchers to develop information seeking models to illustrate the co-existence of these concepts. Information seeking models were developed to describe the various stages that occur during information seeking under different contexts (e.g. Ellis, 1989; Kuhlthau, 1991).

Ingwersen (2003) suggested three periods of information seeking behavior development: 1960-85, 1986-1996, and beyond 1996. The first period focused on information service provision and quality where users were scientist seeking scholarly information. The second period had empirical studies conducted and saw the development of activity-based information seeking models. The last period was represented by work to design more comprehensive models and framework that integrates information seeking and information retrieval research as well as the emergence of longitudinal studies of information seeking. Following this, more information behavior studies looked at different user groups and in

various information seeking contexts (e.g. George et al., 2006; Sapa, Krakowska, & Janiak, 2014).

2.2.1 Information Seeking Process

Information seeking is an essential human behavior with which a person purposefully seek out information resources to satisfy an information need (Wilson, 2000). Belkin et al. (1982) defined a state with which information seeking is triggered by a void in the users' current knowledge as an *anomalous state of knowledge*. Hence the information seeking process begins when users are motivated to address their uncertainties or a gap in their existing knowledge (Marchionini, 2006). During the process of information seeking, the individual may interact with manual resources manually (such as books or a library) or electronic resources (such as webpages or a digital library). The varied resources and diverse means in seeking information highlighted the importance of research in information seeking.

The need to understand how people seek information resources to plug information gaps and how the information resource is consumed can be important for effective design of systems and services (Wilson, 2000). Willson and Given (2010) found that users tend to use similar search strategy, even on different retrieval platforms. This suggested the use of information seeking models to explain the processes behind the behavior. Information seeking models provide insights to understand the users' needs and responses in information seeking decisions through inferences from information seeking behavior (Case & Given, 2012). This is because information needs and decision are psychological perceptions and reactions that resides in the mind of the user.

2.2.1.1 Information seeking behavior models for ES

There were many information seeking models developed to explain and understand human information behavior over the years. Marchionini (2006) broadly classified searches into

lookup searches and ES. He highlighted the types of search activities between the searches and noting the high levels of engagement and participation in an ES. An ES is seen as multifaceted, intertwining with different search activities simultaneously to meet an evolving search goal (White & Roth, 2009). The exponential growth of information resources played a part in influencing the information seeking behavior. The traditional models for IR that predominantly draw upon the lookup search paradigm do not realistically represent the user-centric complexity of an ES behavior. This gave rise to the development of models such as Bate's berrypicking model (Bates, 1989) and Pirolli and Card's information foraging theory (Pirolli & Card, 1995), which are often used for studying ES. Other user-centric models like Belkin's Information-Seeking Strategies (1993) and Marchionini's sub-process of information seeking (1995) focused on the interaction between user and the IR system.

Belkin's Information Seeking Strategies

Belkin et. Al. (1995) conceptualized information seeking behavior as the movement from one searching strategy to another during a search. They claimed that people would use a variety of information seeking strategies within a single search episode and the interactions between the information seeker and other aspects of the IR system are construed as strategies adopted to perform the search task. A matrix (see Figure 2.1) containing 16 information seeking strategies was developed from the factors of information seeking that were characterised by actions or values.

Using cognitive task analysis for IR system interface specification, problems that prevent the fulfilment of a search task and potential support mechanisms for overcoming these obstacles are identified. With the information-seeking strategies and search tasks defined, the researchers looked into the aspects of interaction required by an IR system, the kind of support required for the interaction and strategy, and the provision of a smooth transition

between the strategies to complete a search episode. Through this conceptual model, a model of IR design that supports effective interaction was proposed.

ISS	Method		Goal		Mode		Resource	
	Scan	Search	Learn	Select	Recognize	Specify	Information	Meta-Information
1	X		X		X		X	
2	X		X		X			X
3	X		X			X	X	
4	X		X			X		X
5	X			X	X		X	
6	X			X	X			X
7	X			X		X	X	
8	X			X		X		X
9		X	X		X		X	
10		X	X		X			X
11		X	X			X	X	
12		X	X			X		X
13		X		X	X		X	
14		X		X	X			X
15		X		X		X	X	
16		X		X		X		X

Figure 2.1. Information-Seeking Strategies (Belkin, Cool, Stein, & Thiel, 1995)

Marchionini's sub-processes of Information Seeking

Focusing on the design interfaces of electronic retrieval systems, Marchionini's information-seeking model draws its roots from various disciplines including information science, psychology, education, communications and computer science (Marchionini, 1995). This model depicts information as an problem-solving activity that depends on communication and interaction with the source of information. Marchionini stressed that electronic IR systems need interfaces that support such problem-oriented information seeking activities. He asserted that the mental model of the IR system formed by the information seeker would influence the performance of the search.

Although linear by default, Marchionini's model allows recursive transitions and iterations through paths of varying probability. Hence, these sequences of transitions might be opportunistic in the ES. In this model, information seeking begins when the information seeker becomes aware of a problem, and ends when the problem is resolved or abandon. Marchionini established the dependencies, effects and influences among the sub-processes and described them (see Figure 2.2).

Figure 2.2. Marchionini's sub-processes of Information Seeking (Marchionini, 1995)

Pirolli & Card's Information Foraging Theory

The concept of information scent in the model aids the information seeker to determine how promising a potential source of information before deciding to forage other sources of information. This model allows the understanding of how information seeking strategies and technologies are adapted to the information resources in the environment.

The success of the complex ES is dependent on adaptive nature of humans on the information gathering, sense-making, decision making and problem solving. Information foraging theory refers activities dealing with assessing, seeking and handling information sources. The assessment of cost-benefit supports the extent to which the information seeker move from one information patch to another.

Bate's Berrypicking model

Bates (1989) introduced the metaphorical berrypicking model to address the inadequacies in traditional search models. She had argued for the need for an information search model that depicts realistically of how people search for information before human-centric search interfaces that people use naturally can be developed. Although developed before the popularity of the web came into existence, the berrypicking model was often seen as a prototypical model for its closeness in encompassing the characteristics of an ES. The berrypicking model differs from the traditional IR models through four aspects: nature of query, nature of overall search process, range of search techniques and information domain of search being conducted.

Bates depicted searching as having evolving queries and the conception of each query leads to a different bit of knowledge or idea gained. This improves problem comprehension and can change the search direction. In an exploratory search, the information seeker adopts a continuous search effort, with which the seeker's information needs, search strategies, and information sources change. This is similar to that of picking berries from a bush (see Figure 2.3). Started with an initial query (Q0), the user studies the documents and information

presented to have a modification of the initial query. Through the thoughts (T) for identifying new or additional documents and information, the user's query evolves (Qs 2-5) with ideas and knowledge gained from preceding sessions. The course of the search can change throughout the search process until the information need is met as depicted by the search exit point, E. This depicts the numerous search iterations to sample and select bits and pieces of information that play a role in influencing the focus of the search. The model, however, did not explicitly describe the termination of the search process when the information need is not met.

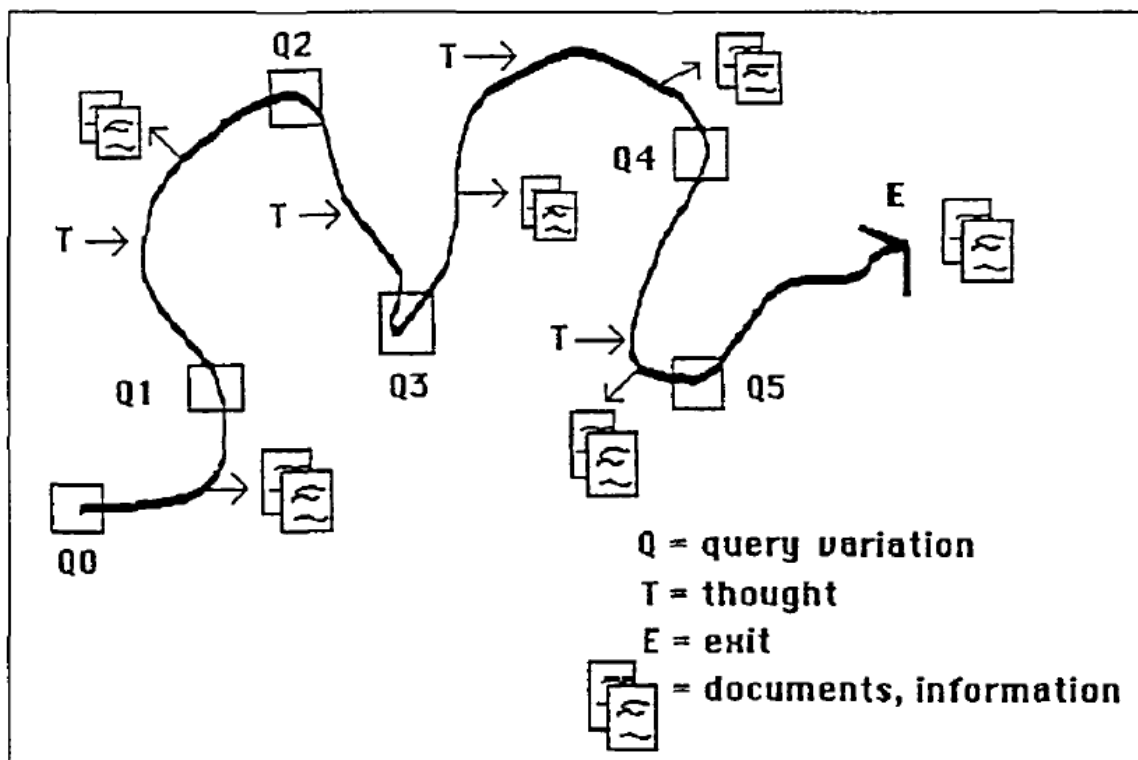


Figure 2.3. Berry picking model (Bates, 1989)

The evolving search called for the use of several strategies that lead to various information sources in the domain of interest. The six strategies that were proposed based on the browsing concept included *footnote chasing* ('backward chaining'), *citation searching* ('forward chaining'), *journal run*, *area scanning*, *subject searches in bibliographies and abstracting and indexing service*, and *author searching*. This model depicts the need for

interfaces to support the interactions for such strategies and illustrated design features to support the various strategies that can be adopted by users for searching for information to meet their information needs.

The model was revisited by Bates (2002) to integrate information searching and seeking in the form of sampling and selecting behavior. With the integration, she posited that browsing is an undirected form of sampling and selecting while berrypicking is more direct and retains the same nature of evolving queries and reconceptualises the search. This suggests that through browsing, the user can encounter information that is not directly related to the problem area.

The berrypicking model has established itself as one of the key frameworks of human information behavior research where many researchers used the model in addressing information seeking and information systems design issues as well as work on browsing and search tactics (Bates, 2005). Savolainen (2018) examined theoretical frameworks for ES, the berry picking model and the information foraging theory, based on two critical aspects of an ES: focused searching and exploratory browsing. He concluded that the berrypicking model had a more nuanced portrayal of focused searching while having a less concrete focus on exploratory browsing.

The use of various searching strategies depicted by the berrypicking model was referenced in the development of a lightweight interactive visualization for exploring faceted information resources (Dörk, Riche, Ramos, & Dumais, 2012). They found success in the visualization in supporting different exploration styles and that improved the engagement of users. To make suggestions for the design of the ebooks-based digital library, a study investigated book selection behavior in academic libraries and found that users performed quick scans and identify interesting resources (Hinze, McKay, Vanderschantz, Timpany, &

Cunningham, 2012). This confirmed the exploratory browsing behavior depicted in the berrypicking model.

More recently, a study examined the exploration strategies people used in discovering the functionalities of interactive visualizations (Blascheck et al., 2018). Among the exploration strategies identified, the researchers concurred that the use of personal entry point for search corresponded strongly to that described in the berrypicking model where exploratory browsing is performed through the bits of information collected through sampling in the evolving search. In the investigation of causal factors for workplace ES task performance, Cleverley, Burnett, and Muir (2017) found that a results handling strategy adopted by the users, akin to the berrypicking behavior, led to more successful searches. With the growth of information resources, searches become more complex and ES behavior models can help in the understanding investigation of more complex search tasks and context.

A carefully selected behavior model for exploratory search provides a basic foundation of understanding upon which the user interfaces and features with the system can be build. The behavior model can guide the understanding of exploratory search process of users, informing us of the strategies adopted and inform what search activities were employed by users. While there is a number of existing ISB models, the study adopted the Bates berrypicking model in the current research to inform the exploratory study of video seeking behavior and the strategies adopted. The model is more holistic and comprehensive among the existing ISB models, and it has also been widely and successfully used in similar studies. This high-level model better encapsulates and allow the video seeking activities used in the SDL to better capture the intrinsic information seeking process to aid the identification of the points of interaction.

The reference model depicts information seeking as an evolving activity with which the information seeker identifies and consume resources in the domain of interest. The model captured the continuous search effort where the user's needs and search strategy changes. This aided the identification of the points of interaction for the information seeking activities through the exploratory search. This model can help inform when and how the retrieval system's interface and features are being used to support the changes of query, strategies, as well as how it supports the synthesis of the bits of information retrieved. Using a model-driven approach to understand the search behavior, it can guide the design of a retrieval environment by detecting the important activities and supporting the strategies taken. Hence, the work done from this research will further inform the model of new and evolved strategies adopted by the adolescent learners when performing ES for learning.

2.2.2 Exploratory search, exploratory search tasks and process

People conduct various searches to narrow and plug information needs or gaps. One form of search, the lookup search, occurs when the information seeker has a well-defined information need. The information seeker then issues an effective search query and can identify the precise search resource to plug the information gap, adopting the query-response paradigm (White & Roth, 2009). Despite many of the search engines and IR system catering well to the lookup search, real-world scenarios are often more complex and the information needs cannot be directly translated into appropriate queries. This could be due to the unfamiliarity with the domain of interest or even an unclear search goal (Jiang, 2014).

An ES is often defined as a multi-faceted and ill-structured information problem that can take on multiple paths to the open-ended solution, calling for learning and investigative activities (Marchionini, 2006; White & Roth, 2009). Unfortunately, even with the growing interest in exploratory information behavior work, the definition of ES continues to be evolving and vague as many work used the dichotomy between the lookup search and ES

characteristics and activities to facilitate the understanding of ES (Palagi, Gandon, Giboin, & Troncy, 2017). According to Marchionini (2006) who categorized search tasks in terms of complexity, an exploratory search encompasses learning and investigative activities with which lookup activities are also embedded in to acquire knowledge. He proceeded to list the learning activities based on Bloom's taxonomy of educational objectives where he argued for the involvement of human in learning and investigative searching. The list of activities of different searches defined by Marchionini are shown in Figure 2.4.

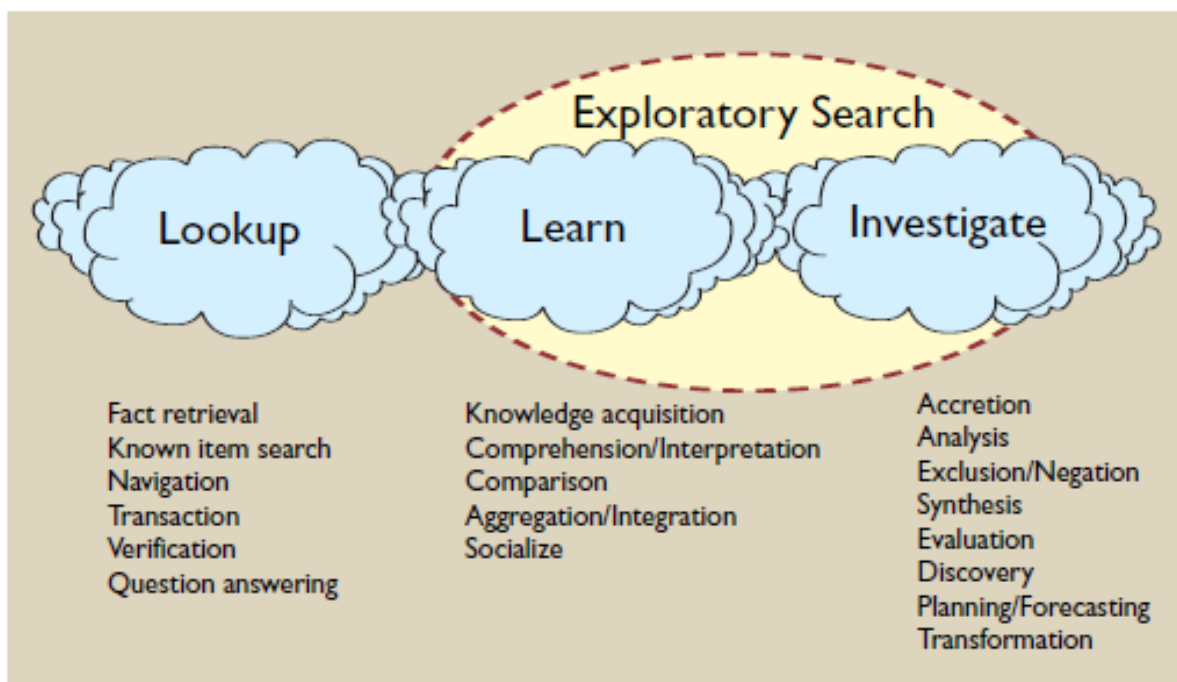


Figure 2.4. Activities of different searches (Marchionini, 2006)

Serendipitous information encountering was contended to play an important role in an ES strategy through connection building, discovery and creativity. In a study with 45 researchers from a range of academic backgrounds working on interdisciplinary research topics, Foster (2003) found that serendipitous information encountering had reinforced problem conception and supported new direction in new problem conception. Serendipitous information encountering was found to make unexpected connections that can enlighten discoveries (Sun Xu, Sharples, & Makri, 2011).

Investigating search tasks is pertinent as understanding the search tasks allows the design of IR system features and interface that tailor support for the tasks. Athukorala, Medlar, Oulasvirta, Jacucci, and Glowacka (2016) developed a task type classifier for an IR system to adapt the balance of exploration and exploitation in ranking documents according to the task type. Studies have shown that search task complexity affects the search behavior (Capra, Arguello, & Zhang, 2017; Hassan, White, Dumais, & Wang, 2014; Rath, Ghosh, & Shah, 2018). Athukorala, Głowacka, Jacucci, Oulasvirta, and Vreeken (2016) conducted a study to distinguish between exploratory and lookup search tasks. They found that exploratory search tasks took longer time to complete, had shorter queries, and higher scroll depth. Understanding the effect of search task on the seeking behavior allows researcher to discern on the usage of interface and features used in the search process.

Task complexity is manipulated to study search behavior and interaction. Arguello, Wu, Kelly, and Edwards (2012) investigated the influence of task complexity and results display on user interactions. Searching behavior changes with task complexity (Aula et al., 2010). Operationalizing task complexity into *remember*, *understand*, and *analyse*, the researchers found higher level of search interaction in terms of number of queries, number of resources clicked on and amount of time spent when the users encountered more complex tasks. A study that used three levels of task complexity found that the participants used more query reformulations and new keywords for more complex tasks (Monchaux, Amadiou, Chevalier, & Mariné, 2015). Lookup search is triggered by basic search task as it requires less cognitive effort from the information seeker in examining the results as compared to exploratory searches (Kim & Allen, 2002). Wildemuth and Freund (2012) reviewed past studies to elicit a set of task attributes that characterises an exploratory search. They proposed that an exploratory search task would focus on learning and investigative search goals and that the search task is general as opposed to being specific, open-ended, and often leads to multiple

resources. The search task involves a high level of uncertainty, is motivated by ill-defined information needs that is dynamic and evolve through the search process.

More information seeking challenges come from exploratory search tasks. White and Roth (2009) posited that exploratory search is beyond the act of exploring, and includes cognitive activities that develop intellectual skills and increases knowledge. This is similar to the learning and investigative activities as suggested by Marchionini (2006). The fuzziness and uncertainty encountered at the start of an exploratory search is therefore reduced through these learning and investigative activities to learn about the domain of interest.

Exploratory search process, hence, typically involves the reduction of vagueness and unclear information needs through multiple iterations of learning and investigation (Jansen, Smith, & Booth, 2007; Rieh, Collins-Thompson, Hansen, & Lee, 2016). This suggests the level of complexity in an exploratory search that would incur substantial cognitive load through the search process. Table 2.1 summarises the characteristics of ES.

	Characteristics	Definition
1	Unfamiliar domain of interest	The user is unfamiliar with the search domain of interest, with little knowledge of the domain.
2	Evolving search process and information need	The user adopts an opportunistic search behavior, with changing strategies, objectives and/or search goals. There is no definitive plan to satisfy the search goal. Through the search session, information needs changes.
3	Ill-structured/defined search context	The user begins without a precise idea of what to look for (types of results, kind of information)
4	Multiple search iterations	Through the search session, the user can do several searches, closely related to sense-making of the topic of interest.
5	Undefined search goal	The user may have a vague objective and not one precise answer but an aggregate of information that can evolve.
6	Open-ended answers	
7	Serendipitous discovery	The user conducts the search with open-mindedness to allow serendipitous discovery. Such discovery may change the search strategy or search goal.
8	Fluctuating uncertainty	The level of uncertainty may be felt at the start of the search. The on-going search process leads to learning and a reduction of uncertainty. The level of uncertainty can increase when search goal changes.

2.2.3 Seeking resources in self-directed learning

The concept of self-directed learning has a rich history and took its roots from adult education and learning. Studies in the field of self-directed learning have been explored primarily from three perspectives: the self-directed learning process (e.g. van Wyk, 2017), personal attribute (e.g. Cazan & Schiopca, 2014; Song & Bonk, 2016), and context in which learning takes place (e.g. Dennis, 2003; Kim, Olfman, Ryan, & Eryilmaz, 2014). The idea of self-directed learning involves an individual in taking initiatives in their learning, whereby learning pace, learning strategies and resources are controlled by the individual (Zimmerman, 1990). The growth and openness of online resources have promoted self-directed and informal learning by encouraging people to have on-demand learning (Bonk, 2010). This proliferation of online resources convolutes searches in finding and selecting suitable resources for their learning.

A model of the autonomous and self-directed process was developed that integrated self-management, self-monitoring and motivation in self-directed learning to produce meaningful learning outcomes (Garrison, 1997). In this model, self-management is tightly coupled with self-directed learning tasks, including learning resources management. Critical thinking and reflexivity in the self-directed learning process, including the evaluation and selection of resources, is important (Garrison, 1992). The learner autonomy in self-directed learning has highlighted the importance of finding and evaluating the right resources for learning (Kop & Fournier, 2011). Self-directed learners need to discern the learning resources for appropriateness.

Song and Hill (2007) introduced a research-based framework for understanding self-directed learning in online context. The framework postulated the importance of gathering reliable and valid online information in effective self-directed learning. They argued that the online environment offers more autonomy for the learners and this affects the effective use of resources found online. The challenge to find the appropriate resources for learning is

compounded by topics or domains that are new to the learners as the search task becomes complex and exploratory. As a search task becomes more complex, finding appropriate resources places a premium on the cognitive load on the learners. Learners faced difficulties in finding appropriate resources when learning autonomously (Bouchard, 2009).

Self-directed learning often takes place beyond the online learning systems. The Internet offers a vast amount of resources for learning. Studies have shown that the increased time spent on appropriate and trustworthy resources and reflecting upon the integrity of the information sources have shown to positively influence learning (List, Grossnickle, & Alexander, 2016; Rodicio, 2015). Yu, Yang, Cheng, and Wang (2015) presented a resource construction and organization framework for ubiquitous learning. The framework calls for learning through a knowledge network where learners perform self-organization of resources. The immense amount of online resources creates a paradox for learning in the cyberspace where answers to questions can be found but the navigation and management of resources becomes convoluted (Borgman, 2011). Self-directed learning often takes the learner into a new and unfamiliar domain, hence, exploratory searches take place during self-directed learning. This compounds to the challenges faced during navigation and management of resources.

Agosto (2002) investigated the decision making of young people on the Internet and found that they exhibited two major satisficing behaviors – reduction and termination that arose from time, cognitive and physical constraints. The limited understanding of the search engine of the young information seekers contribute to the poor digital literacy skills in conducting effective searches and assessing the credibility of online information (Kodama, Jean, Subramaniam, & Taylor, 2017). Investigating the information seeking behavior of Chinese adolescents revealed that while the task complexity and grade had a significant impact on search performance, the adolescents generally had poor information search skills

and ability to process the search results (Wu & Cai, 2016). These studies revealed that young information seekers have poor literacy skills in discerning resources and satisfice when overloaded with information.

Internet search engines adopt the query-response paradigm where the search often respond with overwhelming amount of results. Caplin, Dean, and Martin (2011) found that most of their experimental subjects engaged in bounded rational models of search and satisfice upon meeting their requirements. The experiment concluded that the subjects were less reserved in their decision making when the complexity of choice increases and the reservation level increases with larger choice sets. This suggested that in an exploratory search during self-directed learning, the learners will satisfice in the search for resources while facing higher cognitive load in discerning the resources. Ngoon, Walker, and Klemmer (2019) proposed the use of problem-framing scaffolds to increase exploration before exploitation in order to have more creative outcomes.

2.2.4 Use of videos in learning

Videos have found its usage in many areas including entertainment, marketing and learning. In learning, videos were used within structured classroom settings (e.g. Demir & Uçar, 2016), to support learning of practical skills (e.g. Forbes et al., 2016), and as an integral component in e-learning platforms (e.g. Costley & Lange, 2017) to enhance the learning experience. Video lectures through webcasting were reviewed favourably by learners to improving their learning and were able to bring learning off classrooms (Traphagan, Kucsera, & Kishi, 2010). Hansch et al. (2015) found that video is the main form to deliver course content for Massive Open Online Courses platforms and compiled a series of video's affordances that centered on the use of visuals in supporting online learning. In a review of video podcast in learning, Kay

(2012) discussed how video podcast can benefit students in their learning and improve study habits. These studies suggest the benefits that video offer in students' learning.

Merkt, Weigand, Heier, and Schwan (2011) compared the effectiveness on learning between the use of video instructions and traditional prints and found that the instruction videos' interactive features fitted well with the micro-level learning strategies used by adolescent learners. Beyond classrooms, various forms of media, such as social media and videos, were used to supplement and support formal training programs (Kind & Evans, 2015). Research from the field of multimedia studies shown that video material complements static resources for learning for procedural tasks and skills acquisition (Arguel & Jamet, 2009; Van Genuchten, Scheiter, & Schüler, 2012). These studies supported video in playing a positive role in learning with better interactivity. Kammerer, Brand-Gruwel, and Jarodzka (2018) further argued for more research to investigate the search for online videos as an important source for declarative and procedural knowledge.

Students reacted positively towards videos as a pre-class learning material in a flipped classroom setting, indicating their preference for authentic environment provided by the instructor-developed videos (Long, Logan, & Waugh, 2016). Videos were found to be effective learning objects for both specialist and non-specialist when integrated in massive open online courses (Stöhr, Stathakarou, Mueller, Nifakos, & McGrath, 2019). Harnessing virtual technology to produce immersive videos in learning declarative knowledge, researchers found that immersive videos support better knowledge gains when simulation sickness is minimized (Rupp et al., 2019).

With the growing affordability to create suitable learning videos due to advances in technology, the trend in using videos for learning is set to grow. In self-directed learning, videos increase interactivity in the absence of teacher or instructor supervision to maintain engagement (Oomen-Early, Bold, Wiginton, Gallien, & Anderson, 2008). As the learner

exercises autonomy in self-directed learning, scaffolding the learner with video use is effective as it is self-regulated and supports interactivity (Delen, Liew, & Willson, 2014). The abundance of videos found on the Internet offers a wealth of video resources for learning. As technological advances afforded access to such resources readily, learners can use interactive features to assess these video resources for their learning.

2.2.5 Retrieval of educational and learning videos

Using a repository of fully transcribed Spanish learning videos from six topic models, Turcu, Mihaescu, Heras, Palanca, and Julián (2019) proposed the retrieval of videos through indexed transcriptions for the most representative videos. This technique provided a context for the learner to retrieve video containing transcriptions that match the user query rather than full-text search over typical metadata such as title and description. In the retrieval of educational resources, topical modelling appears to be salient in the creation of semantic space and context for the search. Learning video recommendations were made through the match between video content extracted from the transcriptions and topics extracted from e-learning blogs (Basu, Yu, Singh, & Zimmermann, 2016). This study attempted to correlate content in textual learning resources to automatically recommend lecture videos through topic modelling.

To support text-book styled navigation within instructional videos, Yadav et al. (2016) developed ViZig that automatically classify anchor points in instructional videos based on presentation aids such as figures, tables and flowcharts. The revealing anchor points in an instructional video in ViZig is illustrated in figure 2.5. The evaluation of this in-video navigation feature suggested significant time savings when compared to time-synched anchor points. Kleftodimos and Evangelidis (2016) developed a video-based learning environment using open source tools and open Internet resources that segment the educational videos into

topical sections and provided a table of content. These studies suggested that the appropriate segmentation of learning videos is significant in effective in-video navigation.

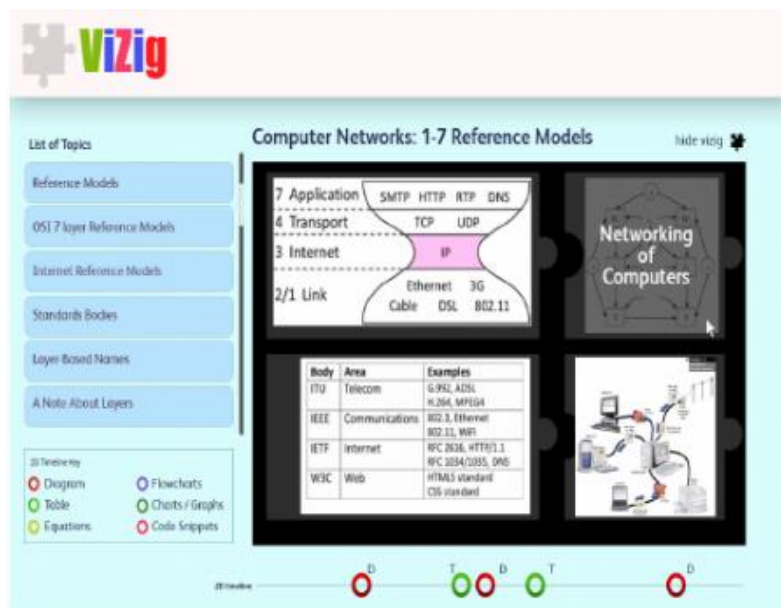


Figure 2.5. Anchor points within an instructional video in ViZig (Yadav et al., 2016)

There are numerous e-learning systems that integrated the retrieval of learning videos. Tsironis, Katsanos, and Xenos (2016) investigated the usability of three popular Massive Open Online Courses (MOOC) platforms, edX, Coursera and Udacity. Five user tasks, including a video search task, were used in the usability evaluation. Using repeated measure design, the researchers found that Coursera to have better usability as compared to edX and Udacity. Guided by the features of popular MOOC platforms, Elsaadany and Abbas (2016) developed an e-learning system that integrated a suite of learning features that included video and lecture slides hosting with an interface that supported rich user interaction. These developments suggested that video forms an integral part in e-learning platforms and the interfaces and features are salient in the effectiveness in the consumption of learning resources.

2.3 Video information retrieval approaches and interfaces

With the growing amount of video resources, the need for efficient searching for the desired media is growing. Much of the work on information retrieval was done on textual resources. Sivic and Zisserman (2003) attempted to mimic textual IR methods for video IR through the use of analogies. While video retrieval has undoubtedly benefited from these work, the distinctive characteristics of video demand for work to adapt the findings and ensure applicability (Ren & Bracewell, 2009). Video can be retrieved, in part as a segment or scene, or as a full video resource and is often done using the content-based and semantic approach.

In the content-based approach, videos or video segments are retrieved through the matching of sample video clips or images which is an extension of content-based information retrieval. The content refers to low-level features like colour, texture, intensity, the trajectory of objects or other statistical characteristics (Bhaumik, Bhattacharyya, Nath, & Chakraborty, 2016). There are many techniques on video content modelling and representation developed to improve the effectiveness of content-based retrieval. Deldjoo et al. (2016) proposed an automatic visual features extraction technique that exploits explicit content features of the video resources. However, the challenge of semantic gap exists between the low-level features and the high-level semantic content (Bhaumik et al., 2016).

The semantic approach attempts to bridge the semantic gap between the low-level video content features and the video semantics comprehended by humans. Amir, Srinivasan, and Efrat (2003) combined content-based (visual searching) and semantic (keyword searching) approach to present an interaction framework in guiding the development of video retrieval systems (see Figure 2.6.). The researchers posited that semantic approaches produced the best results for querying while the content-based information is best used for browsing and selection. This suggested a combination of both approaches are required for different stages in video search and retrieval.

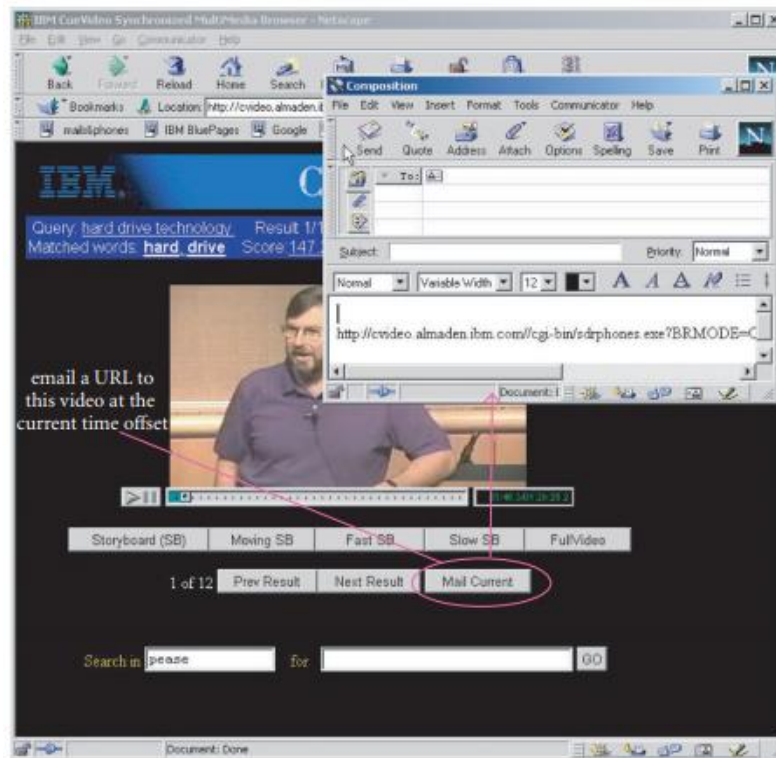


Figure 2.6. Combining content based and semantic approach in bridging semantic gap (Amir, Srinivasan, and Efrat, 2003)

Through a user-centric approach, Lee and Smeaton (2006) analysed several abstract information seeking models to establish an interface design framework for a digital video library that supported the salient interface features and functionalities for video retrieval systems. The framework considered user interactions and search strategies in defining interface frameworks and concluded with five video seeking stages with a corresponding set of supporting interface for each stage.

Considering both low-level and semantic features, Brindha and Visalakshi (2017) constructed a multimedia event detection system to bridge the semantic gap in video retrieval. In order to reduce the irrelevant resources retrieved, the subject ontology structure was used for semantic mapping and guided the ranking of resources (Krishnan, Krishnan, & Muthumari, 2017) (see Figure2.7.). Sikos (2018) proposed an ontology-based structure to

describe the depicted video concepts and their spatial relations so that machines can be used to interpret the structured descriptions. This enabled both the video semantics and low-level video features to be machine-readable. However, the challenges of ambiguous interpretations and the reliability of the automated video annotation structure remains.

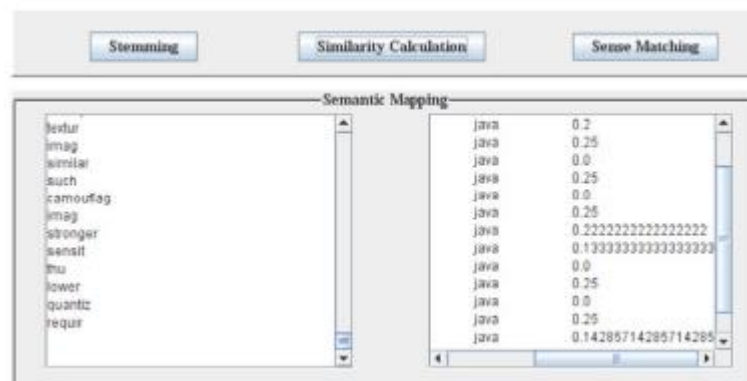


Figure 2.7. Similarity calculation based in ontology structure (Krishnan, Krishnan, & Muthumari, 2017)

The interface and features of an IR are important as they form the gateway between the information seeker and the video resources. The richness of the features influences the amount of interaction and the quality of decision making (Burgoon et al., 2000). The search interfaces are pertinent in a retrieval system as they aid the users in expressing their information needs in the form of queries, support them in the apprehension of the search results, and allow them to keep track of their information seeking progress (Hearst, 2009). The design of interactive features in a retrieval system would allow users to have more control over their search.

2.3.1 Developments in interface and features

It is pertinent to understand how the interfaces and features support information seeking tasks in their specific domain and intention. For instance, seeking behavior for finding a learning video and a video that is meant for entertainment is likely to be different. Hence, the design of

interfaces and features should fit with the users' seeking behavior and interaction as the cognitive and affective components influence the search process (Bilal, 2005).

In developing the potential video retrieval interface and features to support exploratory searches, it is important to review the developments related to the information retrieval domain. Due to the multiple modalities of videos, aural and visual cues were used for indexing and interface strategies for video retrieval (Xu et al., 2015). As a result, video retrieval interfaces may be more complex when compared to a retrieval interface for textual resources.

In the following sections, developments of interface and features for retrieval platforms were surveyed. The first group of interface and features were related to the presentation of information needs and exploration of the resources that are pertinent in an exploratory search. The next group comprised interfaces and features that provide resource management and selection. Finally, the features that support resource consumption were presented. The interfaces and features for public video repositories, YouTube and TedTalks were described at the end of each group.

2.3.1.1 Expressing information needs and navigation of search domain

In many information-seeking models, the information seeking process starts with the presentation of the information need to the retrieval system. This stage of the information seeking process is one of the most user-centric and offers the most potential for advancing interface and features. Three broad video query paradigms were identified: query by textual keywords, query by visual example and query by concept (Snoek, Worring, Koelma, & Smeulders, 2007). Among these query paradigms, query by textual keywords is the most well-established query paradigm and is used in both textual and video retrieval platforms.

The words used in the search query provided separation between relevant and non-relevant resources. Albertson and Meadows (2011) argued that keyword search would remain the most preferred input search feature, even for complex search tasks. The simplicity of the query by keywords afforded both trained and untrained users to handle searches. However, language ambiguity in the search query affects the performance of the separation between relevant and irrelevant resources (Krovetz & Croft, 1992). Several developments leveraged on visualizations to manage English language ambiguity in search.

Researchers developed DataTone that modelled natural language query into visualization and used interactive widgets to resolve ambiguity matters (Gao, Dontcheva, Adar, Liu, & Karahalios, 2015). Using a web-based interface, the query was mapped to a visual specification to identify meaningful concepts and relationships. The interactive widget resolved ambiguity by involving the users in making selections at decision points that were identified by DataTone. To mitigate the challenges in expressing search intent in an exploratory search, Klouche et al. (2015) developed a surface interaction interface, the Exploration Wall that allowed incremental exploration and made sense of large information spaces. In order to support query formulation in unknown information spaces and to learn and identify possible search directions in an exploratory search, the interactive interface supported search on simultaneous parallel streams. This allowed users to explore the domain without the fear of losing track current search as well as to support information comparison.

Information seekers are often faced with uncertainties and fuzziness in the domain of interest during ES. These challenges made query formulation a challenge. Bertini, Bimbo, Ferracani, Landucci, and Pezzatini (2013) proposed the use of ontology-based, multi-touch browsing interface that supported the users in the selection of search concepts in a visual structure. No significant differences were found between trained and untrained users when performing concept selection using the interface and the researchers concluded that ontology-

based structures of data supported query expansion. A framework that used the apriori algorithm and association rule mining to classify video shots to different concepts was proposed (Lin, Ravitz, Shyu, & Chen, 2007). The classification allowed video shots to be sorted into three major concepts found in news broadcast videos. Liu, Fan Chiang, Chou, and Chen (2010) suggested using concept association bank to recommend related concepts when exploring a domain. This supported the acquisition of new information and formed new perspectives by the cumulating new knowledge. Such a feature utilizes data- and goal-driven strategies to perform exploration in a new domain.

Knowledge structures support navigation and comprehension in the exploration of the domain. Chen, Chou, and Huang (2016) developed a learning platform that integrated augmented reality concept maps as learning structures to scaffold mobile learning. Cutrer, Castro, Roy, and Turner (2011) had similarly introduced knowledge structure, such as expert concept map to organize knowledge in a domain area and improve the understanding of a topic.

Concept maps were proposed as a form of semantic representation for navigation and comprehension in a highly connected environment (Amadiou & Salmerón, 2014). Peltonen, Belorustceva, and Ruotsalo (2017) introduced a topic-relevance map that allowed users to visualise the topical domain from the initial query. They found that the topic-relevance map improved the users' comprehension of the topic. These works highlighted the importance of knowledge structure in supporting the learning and navigation of the search domain in an exploratory search. One challenge to the use of a knowledge structure in the retrieval system would be the diversity of the search domain.

Chen and Teng (2009) used previous search history to support ES and to elucidate more search iterations. The researchers developed an interface that supported interactions with

browsing history to invoke thoughts and discover insights for the ES process. Personal history was visualized to provide insights to the users' navigation pattern in managing previously seen videos (Al-Hajri, Miller, Fong, & Fels, 2014). The researchers found that the visualizations helped the users to navigate the videos faster and more accurately. Further, a graphical representation of query history was used to support sense-making in ES and manage the search process (Zhang, Gao, Zhang, & Li, 2016).

Filter and facets were developed to complement the use of natural language input in textual search boxes. Huurdeman, Wilson, and Kamps (2016) integrated the keywords search textbox with input features. They found that features such as filter using categories, keywords suggestions through tag clouds, and query suggestions generated from Bing application plug-in complemented the simple keyword search and support the users in the pre-focus stage of information seeking. In handling different types of multimedia content, Weiland, Hanser, and Scherp (2014) developed a prototypical multimedia IR that supported the selection of media types using a filter in the form of checkboxes. They maintained the simple input interface and used a different interface for the advanced search.

In public video repositories, such as YouTube, the features that support users in reaching out and locating video resources include search query suggestions/completion, subscription channels, and trending videos. The YouTube query suggestion/completion is a prediction service by Google to help complete searches based on related searches, browsing history and popular searches. This feature is potentially useful for users conducting ES where help is required in query formulation. TedTalk, another popular learning video repository complemented the search bar with drop-down list to filter the videos based on topics, language and duration. More filter options including the event types and speaker can be used to further streamline the search.

2.3.1.2 Resource management and selection

Resource management and selection refer to interfaces and features that support users in managing their initial and subsequent search results as well as to aid them in their selection of resources that meet their information needs.

In the query-response paradigm, Web Search Engine Results Pages (SERPs) form the responses to the search query. Such display of results has been commonly used by web search engines as well as public video repositories. Information seekers typically examine the metadata and elements in SERPs to understand the content of the resource and select resources (Azzopardi, Thomas, & Craswell, 2018). As different search engines use different approaches to results pages' composition, users tend to retrieve diverse results sets (Höchstötter & Lewandowski, 2009). Researchers argued that the quality of the metadata affects the effectiveness of retrieval and end-users should be transparent to the creation of metadata (Stvilia & Gasser, 2008).

The metadata for a video resource is more complex due to the multi-modal nature of videos. Hürst, Snoek, Spoel, and Tomin (2011) examined the influence of several video metadata, such as thumbnail size, number and motion influence, on the recognition performance when retrieving video on mobile devices. They found that the richer form of dynamic thumbnails was more effective than static thumbnails as the use of dynamic thumbnails led to better verification results even with smaller thumbnail sizes. Descriptive metadata consisting of key-phrases and topic-based segments that summarized the content of lecture videos were extracted using audio transcripts and the content of the slides that was embedded in the video streams (Balasubramanian, Doraisamy, & Kanakarajan, 2016).

The temporal nature of videos had led to the development of video synopsis as a form of metadata. Using content-based information such as the background of a scene, motion trajectory of objects and colour, video synopsis was created and indexed to support effective

video retrieval from huge video databases (Thomas, Gupta, & Venkatesh, 2017). The utility of the multimodality of videos was further proposed to apply on video segments to create segment synopsis and keyframes (Salim, Haider, Conlan, & Luz, 2017). The study highlighted the challenge in producing balanced adequate video segments for this feature.

Users' bookmarks were used in social feedback systems as feedback to recommend search results (Chi, 2009). Fernquist and Chi (2013) found that users tend to consult social annotations in their decision making for more subjective searches. Studies have shown that social cues, such as user comments influenced the preconceptions of online resources (Viviani & Pasi, 2017; Winter, Brückner, & Krämer, 2015; Young & Gavade, 2018). These studies have shown that users inclined to use social cues as part of their information seeking process in exploratory searches. di Sciascio, Brusilovsky, and Veas (2018) introduced an exploratory search platform that was enhanced by a social search element to rank search results based on content information and social wisdom. Crowdsourced subjective scores were used to evaluate Internet videos quality (Figuerola Salas, Adzic, Shah, & Kalva, 2013). Incorporating social cues and social endorsement as metadata in the results list can support decision making by the information seekers in an exploratory environment. The calls for a need to understand the types of social cues and endorsements that can improve decision making for the information seekers.

Researches were done to examine the effects of results composition and layout on the search. Bernard, Ruppert, Scherer, Kohlhammer, and Schreck (2012) suggested a visual interface that grouped the resources by the similarity measure of the relationships to aid exploration of the data space. For an exploratory search, researchers found that the sorting of results in a SERP layout affected the retrieval performance and the grid interface mitigated this effect (Kammerer & Gerjets, 2014). Kelly and Azzopardi (2015) studied the effects of the number of resources within a page of the result list and found that 10 documents results list

had be most documents marked as relevant by the users. The study, however, did not determine the types of metadata and surrogates that were desired by users when making a selection from video results.

Clustering, filtering and visualization were developed to manage the large amount of videos or resources being retrieved. Various clustering techniques were developed and applied on video search results to provide contextual groupings and summarize video results (Nguyen et al., 2016; J. Wu, Zhong, Jiang, & Yang, 2017). Clustering of similar videos in the results list offers support in the exploration of large data sets and locate the video of interest. An information characteristics model comprising of seven user needs; Broad, Rich, Intriguing, Descriptive, General, Expert and Situational (BRIDGES) was proposed to complement facets and filtering mechanism (Cleverley & Burnett, 2015). The researchers argued that the comprehension of the BRIDGES model supported system design that encourage serendipity in exploratory searches.

The VisInfo digital library was developed to provide a visualised content-based overview for a large time-based corpus and supported the visual interaction of metadata filter to enhance the exploration of search results (Bernard et al., 2015). Bron et al. (2012) proposed an exploratory search interface to support media studies researches in adapting evolving information needs. The interface facilitated the comparison of results through a multi-view, side-by-side versions of independent search box interfaces. A time slider was incorporated to allow specifying the period, which is critical for media studies.

A typical YouTube results page contains 20 video resources, similar to other web search engines. YouTube provided filters for users to organize and refine search results. Several attributes, such as the recency of upload, the duration of the video, and resolution of the video, act as filters for the search. Users can manage a video collection in the form of a

playlist. The metadata presented in the YouTube results list allowed users to gauge the video content through the title of the video and the 2-line brief description of the video. Other metadata in the result list provide clues on the recency of video, the uploader identity and the number of views. The video management and selection features in YouTube appear to be simple and easy to use while not having many advanced features. TedTalk presents the results in a grid format. The results can be sorted by relevance, recency and number of views. The metadata displayed in the results grid includes the presenter name, title of the video and the date posted. Similar to YouTube, TedTalk did not place much emphasis on video management and selection features.

2.3.1.3 Resource consumption

The output or display feature is one of the most important components for video retrieval platforms as it allows users to view or consume the temporal content of the resource effectively. The literature on various techniques such as video summarization and skimming and in-video navigation were reviewed.

Video skimming is a form of dynamic summarization for a video resource that provides the benefit of conveying the content of the video in a shorter time. Semantic video skimming deals with high-level semantics that covers a wide range of constituents such as objects, environment and events (Sen & Raman, 2019), making this approach suitable for learning videos. A personalized video summarization framework used clustered users' reactions as training data to produce semantic preference in the creation of personalized summaries (Chung, Hsiung, Wei, & Lee, 2014). Darabi and Ghinea (2015) proposed video summaries to be personalized by adapting the summary to the viewer's profile that contained the concept preference. These work generated users-tailored video summaries based on the high-level human interpretable concepts.

Recently, Sharghi, Laurel, and Gong (2017) proposed using textual queries to create personalized video summaries to address user subjectivity in video summarization. Plummer, Brown, and Lazebnik (2017) enhanced video summarization by embedding image and text features in a common space to guide summarization. These work attempted to enhance video skimming through the egocentric approach by involving human feedback,

Entities were proposed to represent semantics to provide video skimming for videos that have limited metadata (Mitra, Biswas, & Bhattacharyya, 2016). Tracklets, a set of 10-15 frames containing the same entity were used to identify entities and the researchers found that the summary created using the entity discovery approach was concise and representative. In addressing the challenges in browsing and skimming informational talk videos, video digests were developed for video segments in the form of a chapter/section structure and textual summaries were created for each section (Pavel, Hartmann, & Agrawala, 2014).

The hierarchical visualization of keyframes in a video was used to represent the content of a video and to provide in-video navigation (Hudelist, Schoeffmann, & Xu, 2015). The researchers found that this navigation approach supported faster known-item search within the video as compared to a common video player and the users had lower mental load while doing so. The in-video navigation calls for work in concept discovery in video resources. To discover and identify concepts for a large number of unseen videos without labelled training data, researchers developed an optimization algorithm that required zero-shot learning (Chang, Yang, Hauptmann, Xing, & Yu, 2015).

A visual interface for searching and navigating within an online lecture video was introduced (Zhao, Xu, Lin, Wang, & Luo, 2019). The videos were segmented based on semantic cues derived from the video content to accord granular navigation for users to locate the content of interest effectively. Leveraging the multi-modal nature of videos, a multi-

faceted index comprising concepts covered in the video, a summary of key-phrases in the video and visual information in the video to serve as navigational cues (Kumar, Srivastava, Yadav, & Deshmukh, 2017). Focusing on YouTube based educational videos, the researchers found that this enhanced the navigation time when used in mobile devices.

YouTube automatically generates animated thumbnail in the results list for videos that are longer than 30 seconds and satisfy certain predefined criteria, such as video topic. This is a form of video digest to aid video selection. YouTube provides a simple video player interface for video consumption. The default viewer allows the user to pause the video, adjust the volume and to forward to the next video. Through the Internet browser, the user can skim the video by an increment of 5 seconds for each forward keystroke and in-video navigation is supported by the time bar slider. Customised playback speed from 0.25x to 2x can be set. Three other view modes, mini, full-screen and theatre, can be toggled. The full video description is available at the bottom of the video player. TedTalks results grid does not support dynamic or animated video thumbnails. The video player is similar to that of YouTube but does not support any form of video skimming. Beyond the default view, TedTalk supports only a full-screen viewing mode. The customised playback speed for TedTalk's video player is from 0.5x to 2x.

2.3.2 Summary of key gaps

In SDL, learning takes place in a new and unfamiliar domain that requires ES from the learner. The complexity of ES, coupled with the lack of domain knowledge, increased the cognitive load of the learner, affecting the searching behavior. The autonomy in SDL further drives the need for finding and selecting appropriate resources for learning in the online environment. Younger information seekers with poor literacy skills in discerning useful and quality information resources often have the tendency in satisficing. This is more prevalent

when they are cognitively loaded. Video retrieval features and interface offer potential in supporting the adolescent learners in their video search for learning. The design of retrieval interfaces and features need to fit with the users' seeking behavior and interaction as the cognitive and affective components that influence the seeking process.

There has been much work done on textual IR. However, work is needed to adapt the findings and to ensure applicability from textual IR to video IR. Semantic gap Further, video as a time-sequenced resource, presents challenges in representation and navigation of video content during searches. This calls for work to develop interface that supports richer user interaction in the consumption of the learning video resources. Literature suggested the combination of content-based and semantic approach in bridging the semantic gap.

In expressing information needs and navigation of the search domain, support for query formulation and addressing language ambiguity in an unknown information space is essential for an ES. Work is needed to understand and develop features and interface to better support the learning and identification of possible search directions for an ES. This calls for the establishment of a goal-driven strategy to perform exploration in a new domain.

For features involving resource management and selection, the development of metadata for multi-modal resources is largely dependent on work done for textual IR. The multi-modal nature of video resources offers richer forms of metadata that can be useful for retrieval. There is also potential in exploring the use of social cues to improve decision making in search.

2.4 Summary

This chapter first introduced information seeking behavior research. The literature related to information seeking process and information seeking models was put forth to give an understanding of the strategies, activities and challenges in information seeking. Bate's

berry-picking model was studied as the information seeking behavior model for ES. The characteristics of ES were examined concerning search tasks and search process. The review of the information seeking behavior model provided a basis for the formulation of questions in Study 1. The nature of seeking resources in self-directed learning calls for self-management and is autonomous. The decision-making in resource seeking for self-directed learning affects the quality of resources. Video is one of the common resources used for self-directed learning and is found in learning platforms and online courses.

The next section of the chapter examined the literature regarding video retrieval approaches and the interfaces developed. The multi-modal nature of video had led the development of interface and features that were unique for video retrieval domain. The chapter ended with a review of literature related to three groups of interface and features; Expressing of information needs and navigation of search domain, management of resources and selection, and resource consumption. Reviews of the developments in video retrieval approaches and interfaces guided the development of the prototype for Study 2.

CHAPTER THREE – STUDY 1: INVESTIGATING THE VIDEO SEEKING BEHAVIOR OF ADOLESCENT LEARNERS

3.1 Introduction

Following the literature review, this chapter presents Study 1, which explores the video seeking behavior of adolescent learners when performing ES tasks. The chapter begins with the aims of Study 1. The subsequent method section describes the research method and data analysis procedure. The results from the qualitative analysis are presented and concluded with how the findings address RO1 and RO2.

3.2 Aims of the study

Study 1 was designed to capture the nuances of the video seeking behavior of adolescent learners in their execution of exploratory video search tasks for their learning. To identify challenges and salient retrieval interfaces and featured used during the ES process, critical analysis of the video seeking behavior is needed.

Video can be retrieved through the content-based or semantic approach. In content-based approach, videos can be retrieved by matching of sample video clips or content descriptors (Little & Gu, 2001; Napoletano, 2018), whereas the semantic approach requires a description of the actual meaning of the content through the use of the resource metadata (Snoek, Huurnink, et al., 2007; Worring, Snoek, de Rooij, Nguyen, & Smeulders, 2007). Human communication is predominated by words. Hence, it is of a human's nature to put forth their search queries in a textual format, favouring the semantic approach (Amir et al., 2003). This is a possible reason for the popularity of the keyword search bar in the search and retrieval for both unstructured textual and video resources. However, videos are multi-dimensional and complex as it integrates various channels such as moving images, text, and

audio. Video content is also time-based and sequential, with each video frame comprising of pixels, making the indexing of semantics challenging.

Without ready-made course material, self-directed learners search for resources to aid their understanding. As an ES is complex, finding appropriate resources places a cognitive load on the learners. Research has shown that many learners faced difficulties in finding the appropriate resources when learning autonomously (Bouchard, 2009). Hence, in the search for unstructured resources on the Internet, ES are the most challenging for self-directed learners, especially for those who are novice searchers. The proliferation of the Internet has made access to public videos repositories, affording as valuable resources for self-directed learners. The venture into this vast video resource can result in useful videos that support SDL. However, the overloading of information may cause undesirable effects (Swar, Hameed, & Reychav, 2017) in finding appropriate videos.

Despite the complex makeup of videos and the potentially rich metadata that can be extracted and indexed, much of the video retrieval research did not explore beyond the computer science and engineering context. By understanding the video seeking behavior in a situated context, more effective video interfaces can be developed. In SDL, the process of finding and evaluating resources is integral as learners have autonomy over their learning (Bonk, Kim, & Xu, 2016; Butcher & Sumner, 2011). Understanding the video seeking behavior of adolescent learners in a situated context can offer insights to address research question 1 and 3 as put forth in Chapter 1:

RQ1: What is the video seeking behavior of adolescent learners during ES for learning videos?

RQ3: What important video retrieval interfaces or features can better support learners in an ES for learning videos?

3.3 Method

As part of the effort to develop design concepts for a video retrieval platform, this study used an exploratory, task-centric approach to study the video seeking behaviors for adolescent learners. A pilot study was conducted prior to the actual data collection. ES tasks were designed and post-secondary school students from various institutions in Singapore were recruited for this study. Multiple sources of data collection, such as think-aloud technique, observations, and interviews, were used to capture the participant's video seeking behaviors. Thematic analysis was performed to analyse and understand the video seeking behavior and how interactive interface and features are being used in the search process.

3.3.1 Research approach and design

This study undertook an inductive research approach to address the research question. Each participant performed two ES tasks that are related to their course of study as a part of SDL. Triangulation plays an important role in establishing the trustworthiness of the study (Williamson & Johanson, 2013) as the use of multiple sources of information make findings more accurate and convincing. A combination of think-aloud technique with video capture of the screen actions and interviews were used to collect data, providing data collection and data sources triangulation. 14 post-secondary school students from various educational institutes in Singapore were recruited for the study. Eye tracking technology is used by researchers to capture eye movements and gather insights into cognitive process of participants. Eye trackers are not considered in this study as the younger participants might find the setup of eye tracker intrusive and unable to perform the search tasks naturally.

The sample size for studies that uses the think-aloud protocol range vastly from less than ten to several hundred. For instance, the study conducted by Cromley and Wills (2016) used the think-aloud protocol to test process-level prediction with 24 participants while

Hargittai and Young (2012) had 210 participants to perform information seeking tasks while thinking-aloud. Vandavelde, Van Keer, Schellings, and Van Hout-Wolters (2015) recruited eight school children and used the think-aloud protocol to study their self-regulatory learning strategies. Siddiq and Scherer (2017) collected think-aloud protocol data from students to study their collaborative problem solving skills. The sample size of 14 for this study was in the range of similar qualitative studies on search task behavior and learning.

3.3.1.1 Pilot Study

A pilot study was conducted with two post-secondary school students (one from Singapore Polytechnic and one from ITE-College East) to pre-test the study procedure and clarify the questions used in the interview sessions. Recognizing potential problems is pertinent before embarking in the full-scale study. Through the pilot study, a short clip introducing the think-aloud protocol was added as part of the procedure as the pilot participants showed that they were not acquainted with this data collection method. Some of the questions used in the semi-structured interview were reworded to use simpler terms that can be understood at the participants' level.

The technical setup such as the video and voice recording, as well as the Internet bandwidth, was tested to be appropriate in the pilot study. An estimation to the length of the search session was obtained and some interview questions were removed to reduce the chance of participant fatigue. The revised questions for the interview were used in the actual study. Nanyang Technological University's Institutional Review Board (IRB) approved the implementation of Study 1. The approval is found in Appendix 3-1.

3.3.1.2 Search tasks design

This study focused on the video seeking behavior of adolescent learners when finding videos for SDL. Exploratory informational search tasks in learning, especially without help or

guidance from teachers as in the case of self-directed learning, occurs in ill-structured problem spaces and often have open-ended goals. Hence, exploratory video search tasks were designed and used in this study of video seeking behavior.

The literature had ES taking on many definitions. ES in this study is defined to be triggered from a relatively ill-defined problem that invokes uncertainty from the learner in an unfamiliar domain. The ES starts with an unclear search goal that would require the learner to encompass investigative and learning activities. These form the basis of ES in this study as put forth by the literature. It is acknowledged that this definition of ES did not cover all aspects of an ES but it provides a consistent view on the design of an ES search task. The following describes the design of the exploratory search tasks that would initiate an ES.

To ensure that the search tasks were realistic and relevant, as well as to provide some form of motivation when searching, the search tasks were formulated on topics that were related to the participants' courses of study. Hence, the search tasks were designed in consultation with the lecturers teaching the students. To facilitate the development of the search tasks, a search task template was sent to the respective lecturers prior to the study. A copy of the search task template is shown in Appendix 3-2.

A total of two search tasks were developed for each participant to be completed within the session. The first search task was related to a topic that will be taught in the near future. The search task would be within the domain of the course that the participants enrolled in but would be exploratory in nature as the topics were yet to be taught in their course. As the participant did not have sufficient knowledge of the problem domain, these tasks were considered to be open-ended and investigative, involve uncertainty, and invoke learning (Wildemuth & Freund, 2012).

The second search task involved the participant in extending what they have learnt to propose a project. In this task, learning and investigation were required as the participant needed to organize and extend what they have learned to propose a project (Kules & Capra, 2008) and there were no clear indications for when the search task for such information be completed (Athukorala et al., 2016). The task was also open-ended with no clear identification of correct answers. Hence, this search task elicited uncertainty and requires several iterations for decision-making.

3.3.1.3 Participants

Upon the approval from the Nanyang Technological University's IRB, recruitment advertisements were distributed to post-secondary institutions in Singapore where adolescent learners can be found, namely Singapore Polytechnic, Nanyang Polytechnic, and Institute of Technical Education – College West. The advertisement can be found in Appendix 3-3. Beyond the advertisements placed in the institutes, the recruitment was extended through the word-of-mouth and short recruitment talk to students when given the access to one of the lectures in Nanyang Polytechnic. The inclusion criteria of having at least 1 year of experience in video searching in public video repositories were indicated in the advertisement as well as in the recruitment talk conducted at Nanyang Polytechnic. This purposeful inclusion was to ensure that the participants would have sufficient experience that will exhibit their video seeking behavior when applied to their learning needs.

Except for two male participants, all of the participants were under the age of 21 and parental consent was required. A total of 15 students responded to the call for participation in the study. Parental consent was not obtained from one of the students who responded to the call and did not proceed with the study. Hence, there were 14 participants for the study, performing a total of 28 exploratory video search tasks. Participation in the study was

voluntary and the data were kept confidential. Upon completion of the search tasks and interviews, the participants were reimbursed with a SGD10 research incentive payment. All the participants completed the search tasks and interviews. The basic profile of the participants is outlined in Table 3.1.

Table 3.1. Participants profile and their post-secondary courses enrolled

Code	Age	Gender	Institution	Course
F1	21	Female	Nanyang Polytechnic	Diploma in Digital Media (Animation)
M1	22	Male	Temasek Polytechnic	Diploma Game and Entertainment Technology
M2	19	Male	Nanyang Polytechnic	Diploma in Information technology
M3	22	Male	Nanyang Polytechnic	Diploma in Information Technology
M4	18	Male	Singapore Polytechnic	Polytechnic Foundation Programme ^a
M5	18	Male	Nanyang Polytechnic	Diploma in Information Technology
M6	18	Male	Nanyang Polytechnic	Diploma in Information Technology
M7	18	Male	Singapore Polytechnic	Polytechnic Foundation Programme
F2	18	Female	ITE College West	Nitec in Business Services ^b
M8	18	Male	ITE College West	Nitec in Sports Management
M9	18	Male	ITE College West	Nitec in Sports Management
M10	18	Male	Singapore Polytechnic	Polytechnic Foundation Programme
F3	18	Female	ITE College West	Higher Nitec in Service Management ^b
F4	18	Female	ITE College West	Higher Nitec in Service Management

Note. ^aPolytechnic Foundation Programme is a Diploma programme that allows students to specialise into pathways after the first year of study. ^bNitec and Higher Nitec are the vocational certification courses offered in ITE for post-secondary students.

The participants were between the ages of 18 to 22 and were enrolled in a variety of courses. The courses ranged from a foundational program that introduces various diploma pathways to specialized vocational certificates such as Aerospace Engineering and Chemical Process Engineering. The different courses that the participants were enrolled in provided

more insights to the video seeking behavior as compared to having participants from a single institution and only one type of course.

3.3.1.4 Data collection

Observation is an often-used data collection tool in qualitative research (Creswell, 2007). As a user-centered approach to interaction design, observation is useful to understand users' requirements and behavior in context (Sharp, Rogers, & Preece, 2019). The observation was carried out using screen video capture of the video seeking process, including keystrokes and mouse-clicks. This way, usage characteristics can be taken into consideration during systems design. Observation serves well in capturing the actions and to a certain extent, the affective reactions of the participants. However, direct observation has a major limitation. Observation is not able to provide insights and understanding of the cognitive or thinking process of the participants, especially for reasons in making a decision.

A variant of the observation method was used in this study. A concurrent verbal protocol, the think-aloud technique was used, where the participants verbalised their thoughts when performing the search tasks (Cotton & Gresty, 2006). In a study comparing three methods (heuristic, think-aloud, and performance testing) for identifying usability issues, the researchers concluded that the think-aloud method offers the best balance between effectiveness and cost (Virzi, Sorce, & Herbert, 1993). The think-aloud protocol would reveal the dynamics of the participant's video seeking behavior between the information sources and interactions, getting additional information about the participant's thoughts and actions (Sharp et al., 2019). Reflecting on the think-aloud technique to gather data on an e-learning platform, researchers concluded that this method was able to gather insights beyond the observation of actions or log analysis without any verbalization (Cotton & Gresty, 2006).

This technique offers rich insights and understanding of the video seeking behaviors of the participants by attaining additional information about the participants' views and the reason for an action. While thinking aloud when performing a task may seem simple to execute, thinking aloud does not occur naturally to some people. A notable challenge faced by the participants of the think-aloud technique is the "moments of silence" while they continue to perform the actions or tasks (Sharp et al., 2019). To mitigate this, place cards were created and used to remind participants to verbalize their thoughts through the whole search task. Specifically, the place card reminded the participant to verbalize what they were looking at, what they were thinking at the moment, what were their feelings, and the action performed. Place cards were used as it can minimize direct intervention or interruption by the researcher. Hence, a combination of video capture of the screen activity and a voice recording of the participant's verbalization served as the data collection methods and data sources.

Some challenges were encountered during data collection. While the use of place cards served well to remind most of the participants to verbalise their thoughts, some participants were particularly entrenched into the video seeking process and did not notice the place cards. The researcher interrupted the procedure to explicitly remind these participants to verbalise their thoughts. Not all the participants were able to articulate their thought process seamlessly. These participants stopped the seeking process to internalise their thoughts before verbalising. The break off the seeking process and resuming after the verbalisation may have impeded their video seeking behavior. At times, the participants were able to describe their actions aptly, but they did not verbalise their thought process in decision-making. Hence, additional prompting by the researcher was required to elicit this information.

The berrypicking model informed the exploratory search process. The key concepts of *query*, *thoughts* and *query variation* lead to the formulation of search segments and the need to elicit thoughts in the decision making process in sampling and selection. Questions were

asked through each segment of the search process to further elicit the participants' thoughts and ideas on how the video retrieval platform interface and features support the video search tasks. An exit interview was conducted at the end of the video search tasks. The full interview questions are included in Appendix 3-4.

3.3.1.5 Study procedure

All data were collected at the participants' institute of study or a place of their convenience such as their home, using the researcher's laptop. Arrangements were made with the institutes to conduct the study in rooms to minimise or reduce extraneous environmental noise. This was to ensure the voice recording quality and minimize any distractions and interruptions (Easton, McComish, & Greenberg, 2000). The researcher's laptop has been set up to video-capture the participant's video seeking process when performing the search task. The video-capture utility is a built-in feature in Windows 10 that is meant for recording gameplay sessions. The hotkeys of Windows logo key + G will bring up the console and a click on the record button will record all the screen actions. The recorded videos of the screen action were configured to save onto a specific path in the laptop hard drive.

The laptop was installed with popular Internet browsers such as Internet Explorer, Google Chrome and Mozilla Firefox. This allowed the participants to have their preferred choice of browsers for the search session. All Internet access was provided by tethering from the researcher's mobile phone. This was to ensure consistent Internet bandwidth for all the participants. Before the start of the study, participants were requested to submit the informed consent form and the parental consent form if they are below the age of 21. They were then briefed on the purpose of the study, privacy, and confidentiality on the participation in the study. They were also informed that the outcome of this study had no bearing on the course

that they were enrolled in. The data collection session lasted approximately between 30 minutes to 45 minutes.

Upon submission of the consent form, participant information such as the age, institute, and course of study was recorded. The participants watched a 1-minute video on a demonstration of the think-aloud protocol on the laptop. After checking with the participants on their understanding of the think-aloud protocol, the participant proceeded with the first search task.

The participant started the search after a brief introduction to the search task where the participant was free to make any clarifications. The researcher used place cards to remind and prompt the participant to verbalize his or her thoughts through the search process. This was to reduce interruption to the search and verbalisation process as much as possible. However, the researcher paused the search process to make clarifications when required. The search task is broken into three segments, query input, query refinement, and resource selection. Short post-segment interviews were conducted to elicit the participants' thoughts and opinions on desirable interactive features for that they think can better support the video retrieval process.

In the second search task, the participant completed another ES for topics to be used in their final year project, assignment, or proposal for a competition. Using the think-aloud protocol without the post-segment interviews, the second search task looked to minimize interruption. After the second search task, a post-study exit interview was conducted to seek the most salient interface features that the participant had used and/or would like to have. The interview concluded by asking feedback on the search sessions.

3.3.1.6 Data analysis procedure

The coding of the collected data is a key element in qualitative data analysis. Before coding can begin, a transcription of the audio recording, video capture of the search process and notes

taken by the researcher on the search session was prepared. Code is a short phrase or single word that capture the essence and salient meaning in the data collected (Saldaña, 2009) so that it can be used to make comparisons between the categories and help in the development of theoretical concepts (Maxwell, 2013). Through the coding cycles, thematic categories emerged to provide insights to the research questions. Section 3.3.1.9 details the coding procedure that led to the emergence of the thematic categories.

An independent coder was recruited to perform coding with two randomly selected transcripts. The independent coder recruited was a Research Masters student who is has attended the Advanced Qualitative Research methods course and had prior experiences in performing qualitative coding. The random selection of the transcripts provided all the transcripts with equal chance to be selected and this avoided biasness in resulting particular outcome. Using nVivo, the Cohen's Kappa score of 0.82 was achieved (Appendix 3-5).

3.3.1.7 Data transcription

As inadequate data preparation can hinder or negatively affect the analysis process, researchers continue to play a key role in the process of data preparation even with qualitative data analysis software as tools to assist transcription process (McLellan, MacQueen, & Neidig, 2003). By preparing the transcriptions, the researcher started familiarising with the data.

The use of transcription guidelines increased the assurance of consistency in the transcripts generated. Mergenthaler and Stinson (1992) offered seven principles for transcriptions in psychotherapy research to offer quality and reliability. The principles are as follow:

1. *Preserve the morphologic naturalness of transcription.* Word forms, commentaries, and punctuation should be kept as close as possible to the speech presentation.
2. *Preserve the naturalness of transcript structure.* The transcription should be clearly structured by speech markers.
3. *The transcript should be an exact reproduction.* The transcription should be as verbatim as possible.
4. *The transcription rules should be universal.* These rules should support the production of transcript that is suitable for both humans and computers use.
5. *The transcription rules should be complete.* The transcriber should only need these rules to prepare the transcript.
6. *The transcription rules should be independent.* The transcription standards should produce transcriptions that are understandable and applicable by other researchers or third parties.
7. *The transcription rules should be intellectually elegant.* Keep rules simple and easy to learn.

The researchers acknowledged that the principles are ideals that cannot be achieved in practice, hence compromises are necessary (Mergenthaler & Stinson, 1992, p. 130). These principles were used to guide the transcription of data rather than as prescribed rules.

Each participant was assigned a participant code. Male participant code will start with ‘M’ followed by an assigned number, while female participants will start with ‘F’ and an assigned number. The transcriptions were prepared as far as possible, verbatim, to the audio recordings. The audio recordings comprised of the verbal accounts generated from the think-aloud protocol as the participant performed the search tasks, and interview responses that occurred during the study session. The screen actions of the participants that were captured by

the screen video software were embedded into the transcription in parenthesis. The inclusion of actions into the transcripts provided a complementary account of the video seeking behavior as well as to triangulate the verbal accounts. An excerpt of the transcription is as follows:

‘This allows me to give an idea what the video is about. (After mouse over for about ¾ of the video). This is really not what I want to find. Maybe on the ending of the video might have what I want. (clicks onto the tail end of the video). I am trying to find portions of the video that might show the programming code.’

The researcher conducted the study and prepared the transcripts. This reduced some of the pitfalls and challenges of transcribing such as misinterpretation of a word and the use of jargons (Easton et al., 2000). Transcription was done throughout the data collection phase.

3.3.1.8 Codebook development

A codebook serves several purposes in the analysis of qualitative data. Researchers have provided the impetus for development of a codebook for qualitative research including provision of a structure to aid the analysis of textual data, improving intercoder agreement when coding is done by multiple coders (MacQueen, McLellan, Kay, & Milstein, 1998), and to manage and keep track of the changes during analytical process (Saldaña, 2009). The codebook provides a systematic way to formalized operationalization of the codes such that it helps in the analysis of qualitative data (DeCuir-Gunby, Marshall, & McCulloch, 2011; Fereday & Muir-Cochrane, 2006; MacQueen et al., 1998).

The codebook can be developed a priori from existing theory (theory-driven), or they can emerge from the raw data (data-driven) (DeCuir-Gunby et al., 2011). This study’s codebook was developed inductively through the repeated examination of the raw data. The transcriptions were read before coding development starts. This was to familiarize with the

data in searching for meanings and patterns (Braun & Clarke, 2006). The codebook structure contained the code label, a brief description, a full description that explained the inclusion and exclusion criteria, and an example is shown in Table 3.2.

Table 3.2. Extract from codebook for first cycle coding

Code	Brief Description	Full Description	When to use	When not to use	Examples
Search videos from different sources	Find videos from different sources in the Internet.	There are many video platforms in the Internet that users can find videos. Some people may find videos from more than 1 video platform.	When participant indicated the use of more than one type of video sources.	When participant indicated different means of searching for videos. Participant may use generic search engines to search for videos instead of searching in specific video platform. This is using different searching means rather than searching from different sources.	Even for videos, I will not necessary look from YouTube all the time.

3.3.1.9 Coding method

To begin coding, the unit of analysis needs to be defined based on the transcribed responses and observations. A sentence-by-sentence coding system was used in this study. This was to ensure sufficient attention was given to interpret the rich dynamics of data that the participant was trying to communicate and portray through the actions of video seeking (Saldaña, 2009). To aid the selection of coding methods, Saldaña (2009, p. 50) suggested reading a few pages of transcriptions and reflect on the following questions:

- *Is the coding method(s) harmonizing with your study's conceptual or theoretical framework?*
- *Is the coding method(s) relating to or addressing your research questions?*
- *Are you feeling comfortable and confident applying the coding method(s) to your data?*

- *Are the data lending themselves to the coding method(s)?*
- *Is the coding method(s) providing the specificity you need?*
- *Is the coding method(s) leading you toward an analytic pathway?*

Upon reflecting the questions, thematic analysis was selected as the analytic process to identify themes that emerge from data collected as being significant to the phenomenon of interest (Fereday & Muir-Cochrane, 2006). The thematic analysis provides a flexible method that yields a potentially rich and detailed account from the data (Braun & Clarke, 2006). Thematic analysis is useful in qualitative research as it can be used to capture patterns or themes that are essential concerning the research questions. Thematic analysis reveals patterns within the data at a manifest level (Auerbach & Silverstein, 2003). Through reflective inspection across the data, abstract concepts rather than the concrete entities can emerge as important themes that link and interweave the data together. Themes do not emerge out of spontaneity but they are actively identified through the process of logical analysis from the data collected (Braun & Clarke, 2006). The process of thematic analysis synthesizes and combines related patterns that are identified throughout the data collected to form a wide and holistic view. Four criteria were used in this study in defining a theme (DeSantis & Ugarriza, 2000):

- *Emergence from Data.* Themes are from the data. Themes are not imposed a priori by the researcher, then finding the supporting evidence.
- *Abstract Nature.* Although themes can be explicitly expressed, most themes are implicit and require extraction and inference from the data.
- *Iteration.* Themes are implicit or explicit recurrences found in data. Iterations make themes identifiable.

- *Levels of Theme Identification.* Explanatory functions of a theme may occur at various levels such as category, domain, and taxonomy.

The six-phase thematic analysis approach was adopted (Braun & Clarke, 2006). The thematic analysis produced the main themes related to the video seeking behavior and interface features.

- *Familiarizing with the data.* Familiarization started with the data collected as the interview was conducted by the researcher and familiarization continued with the transcription. The transcriptions were read and re-read actively to search for meanings and patterns.
- *Generating initial codes.* The active reading of the transcripts leads to the extraction of ideas that are related to the research questions. This initial list of ideas were consists of meaning units that retained the context highlighted by the interviewees. A total of 62 ideas were extracted.
- *Searching for themes.* This step involved collating the meaning units into potential themes. This step re-focuses the analysis at a more abstract level than the initial codes, considering how the different codes combine to form an overarching theme. Manual visual mapping was used to organize the candidate theme. 17 candidate themes emerged.
- *Reviewing the themes.* This step involved the refinement of the candidate themes. The refinement of the process led to the combination as well as breaking up of candidate themes. The resultant themes had logically consistent meaning and the identifiable distinction between them. Through the review, there were 9 themes established.
- *Defining and naming the themes.* The crux of each theme was identified in this step. This ensured that each theme had an internally consistent account. Sub-

themes within each theme were identified to form a structure that helped in naming the theme.

- *Reporting the themes.* The themes should be reported in a logical, concise and non-repetitive manner.

3.4 Results

The analysis produced 26 codes related to the video seeking behavior of adolescent learners performing an exploratory video search (research question 1) and were assigned to five themes: *selection of resources, query formulation and reformulation, selecting videos for preview, previewing the video* and *decision for search task*. Further, 19 codes were extracted for video retrieval systems interfaces and features used and desired when performing exploratory video searches for learning. This resulted in 2 themes: *supporting query formulation* and *interaction with metadata*.

3.4.1 Video seeking behavior of young adolescents

Five major themes representing the various phases of video seeking were revealed from the data analysis. The problem has been pre-defined in the study. Hence the participants start the search process by the selection of resources.

3.4.1.1 Theme 1 – Selection of resources

With a myriad of information resources available on the Internet that is useful for SDL, the participants used a variety of resources to complete the ES task. YouTube was the most common public video repository selected by the participants, followed by Vimeo, which was used for a more specific learning domain. While the goal of the search task was to find videos to support the learning, a number of participants (M3, M4, M5, M8, M10, F3) started by finding other web resources, such as Wikipedia and search snippets, to close the information gap and have a better idea on the topic of interest. This exhibited the need to reduce the

uncertainty that the participants had about the learning concepts. As commented by some participants:

‘I will first go to Google to search for “how to conduct a customer satisfaction survey” (Types in the search terms into Google and a list of web links returns). I will see how they explain that I want to know. I read to give me a better understanding of what the topic is about, know more about the topic given.’

(F3)

‘Honestly, for such topics that I am not familiar with, and I am just starting out, I will just type in on what I need to find out and see what they have.’ (M8)

‘For me, the first place I will go to is Wikipedia as it is an encyclopaedia on the Internet. As I do not know what some of the search terms actually mean, so I will go and find out.’ (M10)

With YouTube operating as one of Google’s subsidiaries, some participants began the video search task using Google. Perceived as a search engine, the participants believed that Google will provide sources of videos beyond YouTube and other resource media that can help in the search task.

‘I think I will go Google to search for habits of effective people as I think some blogs or articles might also have videos in them. But it will still be keyword search.’ (F2)

‘First I open the browser and I enter the terms into the search engine. I normally use Google as I only need to type in and search...’ (M3)

Prior experience had influenced the selection of sources as the participants tended to begin their search on familiar platforms that they have had positive experiences or have

gathered positive reviews. Using prior experience to determine authoritative and trusted resources, one participant (M7) mentioned: *‘Like this source (WebMD) is more well-known. I clicked on this link because I trusted the source.’* Another participant (F2) related her positive experience with YouTube and equating YouTube to be the Google equivalent for video searching.

On top of prior experience, the existing domain knowledge contributed to the selection of resources where previous searches for similar information led the participants to identify potentially useful resources. Participant F1 commented on the use of Vimeo by many other graphic artists, *‘Usually Google only has got one or two videos that pop up. So I will just click on the first one, then see what else is there on the side. If that fails, then there is Vimeo. Cos Vimeo is really related to what I am looking for. I know have got a lot of artists that use that website.’*

The participants exhibited reasonable cybersecurity awareness and that played a role in resource selection. The participants were careful to avoid click-baits, dubious-looking web resources or web resources that were deemed as commercial advertising sites, as noted by the following:

‘Then they give me websites like top 10 websites. I don’t want to look through them. Usually it’s all click bait.’ (F1)

‘I usually go through everything on Google. Unless it is very evident that it (the link) is a click bait or something, then there is no correlation, then I will go through everything. A lot of click baits, they like to put a lot of titles, hashtags, and this kind of things.’ (M6)

‘I avoid them (the first two links) as they are advertisements..... They have the “Ads” icons by the side.’ (F4)

In general, participants attempted to become more conversant with the topic of interest. By selecting resources informational resources, the participants informed themselves on the topic of interest so that new information is encountered, allowing them to develop new ideas and have a direction for subsequent searches. The participants preferred to use resources that they perceived to be authoritative and they do not mind selecting multiple resources. In the selection of resources, they were wary over clickbait and advertisements.

3.4.1.2 Theme 2 – Query formulation and reformulation

As the *de facto* input method when searching on the Internet, the use of natural language search bar required the participants to formulate their information needs in the form of natural language or semantics. The participants pondered over various aspects of query formulation. More than half of the participants started their search by consulting non-video websites. The exploratory nature of the search tasks prompted some participants to find informational resources. This allowed them to be more acquainted to the topic and to find keywords related to the topic for query formulation.

‘First, I clearly know nothing about cloud computing. Since, I don’t know anything about cloud computing, I search the main thing and see where I can branch out from there.’ (M5)

‘..., but inside these topics, there could be some keywords that I don’t know, then I will search. And I will still use the search bar to find the things I want.’ (M7)

This form of input was seen as easy to use, convenient and natural as the participants were able to retrieval results without any errors or prompts:

‘I usually just use the text search bar. And I am usually able to find what I am looking for.’ (F1)

‘It (keyword search bar) is useful as this is the most direct way. It basically goes to the gist of whatever topic that you are looking for.’ (M1)

‘Maybe when I read up on the topics and see the relevant stuffs that I want to know, I will key them in the search bar. ... It is effective, because it allows me to type in all the things I want to know into one place and search.’ (M7)

Using short queries, like key concepts of the search topic, was preferred by some participants. The participants perceived that the inclusion of concepts of the topic in the query formulation would lead to relevant results. This suggested the level of confidence that the participants had on the search engine’s retrieval precision when inputting with adequate queries.

‘Usually I will just type very short phrases. Because if you go too lengthy or like too detailed into it, the search results kind of get very weird and like not really related to what I am looking for. So I find shorter keywords to be better.’ (F1)

‘I will be going to Google to search on the topic, which is ‘how turbofan engines prevent icing’ (the search topic).’ (M10)

All the participants performed multiple search iterations in the ES tasks. As the tasks were exploratory in nature, the participants might feel obligated to search broader and cover more. This is more so when the initial search did not produce any satisfactory results. A variety of query reformulation strategies were observed. Participant M5 reformulated his search query from the benefits of cloud computing to how cloud computing works. Such a strategy was similarly observed with Participant M10. This exhibited reformulation of the search queries when the initial query gave new ideas and directions to extend the coverage of

a related topic. Employing another query reformulation strategy, participant M2 retained the key concepts in the query and made slight changes in the non-key concepts.

3.4.1.3 Theme 3 – Selecting videos for preview

Upon the submission of a query to the video platform, the participants scour through the video resources listed to select video(s) for a preview. Half of the participants (M2, F2, F4, M6, M7, M8, M10) are more liberal in the selection as they went beyond the first page of the results before performing query reformulation. The rest of the participants (M1, F1, M3, F3, M4, M5, M9) attempted to pick the video resource for preview within the first page of the results. As noted by participant M3, *‘I have some trust in Google, so usually the top few results are usually the closest to what you want to find. I also compare it against other top few results, like within the first page.’* Participants felt that the searching algorithm of the search engine was sufficiently apt in the retrieval. Possibly coupled with the overwhelming number of results pages, participants would explore within the first page of results to get a feel on the relevance before deciding on a reformulation of the query.

The concept of satisficing was prevalent at this stage of the video seeking process. Many participants managed the selection of resources for preview by limiting their cognitive load at this stage. This was noted by the following:

*‘Cos usually when I try to search something, I try to stay on the first page.
If I have to go beyond the 2nd and 3rd search page, usually the results are quite distant already. ... anything that is beyond the first 5 links, I usually discard cos the results usually taper off, the quality of the results usually tapers off from the fifth, from my own experience.’ (M1)*

'I am coming to the end of the first page and I don't usually go into the 2nd page. Because I know that the first page will have the more relevant topics and sometimes the most popular videos.' (M4)

'I normally will not read that much, usually just 3 to 4 (resource links) that has the keywords.' (M5)

The top-down approach was used predominantly to examine the video list for selection. This allowed a systematic manoeuvre to discard or eliminate resources that were deemed less suitable or relevant. Such an approach also afforded a more thorough scan of the retrieved results. This more persistent approach to seek the resource to fulfil the search task was mentioned by the following participants:

'It is just like elimination. ... I will go from the first to the last until I find what I wanted.' (M4)

'Unless it is very evident that it (the link) is a click bait or something, then there is no correlation, then I will go through everything. It suits my way of going through the results top down so that you do not miss anything.' (M6)

The participants used metadata that pertain to the title and the static thumbnail of the video as the main means to discern and select the video resource(s) from the result list for preview. The screen size put a limit to the types of metadata that were presented in the result list. The title of the video is a user-generated metadata while the thumbnail of the video is a content-based metadata where it could be selected by the uploader or automatically selected by the video platform. The participants framed a preliminary perception of the video content and match it against their expected value using these metadata:

'I have some words in my mind. So I will look at the thumbnail and title to see if it matches the words in my mind.' (M2)

‘I will assess the results based on screen cap (thumbnail) and title. I rely a lot on the title actually. ... If the title sounds really not what I am looking for, I will just skip over it immediately.’ (F1)

‘I am looking at videos that interest me on the topic that I have to search. I focus mainly on the title, I also look at the thumbnails sometimes.’ (M7)

The title and thumbnail were metadata that captured the participants’ attention to make a preliminary assessment of the video content. On top of relevance, the participants sought videos that were ‘engaging’, ‘interesting’, and ‘eye-catching’. In order to reduce some of the fuzziness with the ES task, participants hoped to see something familiar when viewing the thumbnails and title as shown by the following:

‘I look at the thumbnail that the video provided and try and figure out what program are they using.’ (M3)

‘I am actually considering quite heavily on this video because it is telling you how to program based on projects (Title indicated “C# Programming Project Based Learning Course Content”) and this is something that we all will be eventually doing.’ (M6)

However, some participants contended that the thumbnail and title were not sufficient cues to make out the content of the video. Participant M9 noted, *‘I glanced at the title and it says “magically connect with anyone”. But now that I am looking at the thumbnail, I saw a magician performing magic, I think it is not very relevant.’* This suggested that the participant’s interpretation of the title might not always resonate the content portrayed by the thumbnail. As the uploader of the video provided the title, an irrelevant title may be unintentionally given or purposefully used to increase views. While these metadata are the closest to what the participants have to perform the initial assessment of the content of the

video, some participants used more metadata as cues to discern the content of the video. The 2-line description of the video can indicate the content of the video. Many participants scanned the brief description together with the title and thumbnail to select the video for a preview. Similar to the title, the uploader provided the brief description and hence, may not fully reflect the content of the video.

Other metadata such as the view counts and date uploaded were used by some participants to judge the quality of the video. A video with higher view count is generally seen as more popular and hence worthwhile to preview. However, participant M6 offered his interpretation of view count based on the factors such as trending topics and producer of the video. He felt that popular topics that have been around for some time, such as Java programming, would generate high view counts. Hence, he felt that the view counts should be interpreted relative to the videos of the same topic rather than an absolute figure. This level of preliminary assessment of video from the result list may lead to several videos being shortlisted for preview. Video seekers may also choose to reformulate their queries if the initial assessment to select videos for preview was not successful.

3.4.1.4 Theme 4 – Previewing the video

The participants performed video previews and assessed the selected video(s) to determine if the video(s) satisfied the search task. Through the use of Internet browsers, many participants opened several browser tabs concurrently, each for a video selected to be previewed. Retaining the result lists allowed switching between the result list and videos to be preview. This enabled the participants to keep track on which video(s) have been viewed, revealing a need for a feature to keep track of the videos that have been reviewed.

‘So I will select this video for viewing later by opening the link on a new tab.

(Goes to the new video). I will pause it as I want to continue to watch the

original video. This way, I will remember that I have something more to cover.'

(M3)

Participants commonly applied video skimming techniques to preview the video. Video skimming was performed by using the arrow keys on the keyboard at a regular interval or by using the mouse clicking on the progress bar of the video where the skimming was more random. In the video viewing page of YouTube, a thumbnail will appear when the mouse is placed over the progress bar. This led to another technique used by some of the participants to skim to various locations in the video with which the thumbnail appeared to be interesting. The purpose of video skimming was to reinforce the content of the video quickly to ascertain the usefulness of the video.

'I will skim through the first 5 minutes, usually. To see if it looks correct. Or if it completely doesn't make sense to me, I might be on the wrong track.' (M1)

'I will fast forward a bit while looking at the thumbnail on the progress bar. (mouse over the progress bar). This allows me to give an idea what the video is about.' (M2)

'What I did was that I hover the mouse over the progress bar and looked at the thumbnails at each point. Based on this, I look at what is interesting and locate the actual practical starting point.' (M3)

'I feel as if browsing the video to get a sense of the video. And I do not think that I will be using this video as the way they presented this is like unusual to me. I am not used to this kind of style of presentation. Looking through just some of the content of this video, I feel that it is not going to be relevant to me.'

(M4)

In the preview stage, the participants had formed an impression on what the video can offer. To track viewed videos, the participants retained the results list page and opened the video view page using separate browser tabs. The previewing of the video using skimming techniques through the content to find scenes that match what they are anticipating from prior assessment during the selection for preview. This allowed the participants to ascertain or disavow their assumptions.

3.4.1.5 Theme 5 – Decision for search task

The participants exhibited several decisions for the search task after the preview of video(s). Socially generated cues, such as video comments, were explored to draw some conclusions to the quality of the video when the participant had an inclination towards the video. As Participant M4 stated, *‘I am looking at the comments for anything interesting and has the keywords from my search. ... The reason for doing this was to reinforce my judgement that this video would actually be useful to what I am doing.’* The socially generated cues presented in the video platform appeared to have a strong influence on the participants as noted in the following:

‘I look at the comments sometimes as it might point out some flaws or relevance.’ (M6)

‘I skim through the comments. Comments can help inform you if the video is informational or a waste of time. get some reassurances from the comments. So like for this video, most of the comments said that this is an informative video.’ (M8)

However, two of the participants (F1, M3) felt that comments may not be very useful as it can be time-consuming reading through it and it could contain irrelevant information. As

noted by participant F1, she would read the comments if she has time to spare as she felt that many comments were not constructive.

The detailed description of the video resource is another metadata that provides more information. There is no fixed format for this user-generated metadata, resulting in varying detail of information. The detailed description was explored by some participant (M3, M4, M6, M7) when making a decision on using the video for the search task as noted in the following:

‘I will first check on the description. (Expands to view the full description). Cos especially when comes to lessons, I find that description is the best way to know the run down version. So I will read the description.’ (M1)

‘Before that I will go and read the description of the video to give me a background overview of the video.’ (M4)

‘I am looking at the description of the video so maybe I can get more info of how to do this. Because they might say some things about how create the thing, or perhaps a link that can lead me to some other resources for better understanding.’ (M7)

If a video was rated positively to fulfil the search task, the participant leveraged on recommendations presented with the video. In YouTube, the ‘Up-Next’ feature was deemed as similar video recommendations by the participants. As commented by the participants:

‘Then for the videos that I think is relevant, I will look at the related videos at the side (Up-Next list).’ (F1)

‘So because I can’t find any other videos from the search list, what I intend to do is to look at the right side of the video, where related videos are recommended.’ (M1)

‘I had scanned through previously and there are like no videos that seems relevant to me. So since I am already here, I will just look at what they have to recommend to me. (Referring to the Up-Next List)’ (M8)

The assessment of the video(s) through video skimming and previews, and consultation of the metadata helped to the participants to decide if the video(s) satisfied the search task. Hence, the participants will then decide if a reformulation of the queries was required or the search goal was fulfilled.

3.4.2 Interface features supporting exploratory video search

There were two themes concerning the interface and feature support for an exploratory video search for learning. They were: help with query formulation and enhanced interaction with video metadata. These themes presented the challenges that manifested during the search task as well as the interfaces and features that were deemed desirable by the participants.

3.4.2.1 Theme 6 – Supporting query formulation

The natural language search bar is commonly found in Internet search engines and video platforms such as YouTube. All the participants formulated queries and used the search bar to perform a search, either on Google or YouTube. The use of natural language search bar was seemingly easy for the participants. However, for an ES task, the participants were observed to encounter challenges when formulating queries. Several participants turned to Google to first find resources to inform themselves on the topic of interest before embarking in the video search. Other participants used the topic of the search task verbatim as the search query. This ensued in poor retrieval results as evidenced by the need for query reformulation.

The participants welcomed help in understanding concepts in the search task through the use of feature snippet. Google provided featured snippet to give a brief definition of for some search terms. This feature is convenient and provided an easy-to-read definition for some of the concepts in the search. As explained by participant M10, *‘this [feature snippet] give a summarized definition to what I am searching for. If such a definition box is not provided, then I will have to go to some of these links (web links) to find out the keywords and understand by myself.’* This was echoed by participant F3: *‘Sometimes it is hard for me to get the information, so I will go Google. Because sometimes Google gives the summary of the thing so it is easier for me to read.’* This suggested that the brief explanation of the concepts in the topic of interest could aid query formulation.

Dynamic search suggestion is another feature that supports and influences query formulation. This was observed by several participants (F1, F3, M5, M9) when they selected from the suggested query list during query formulation. Participant M5 commented, *‘If I try to search for something I don’t know, I will use the suggestions given by the search engine. I am a guy who uses their suggestions.’* When the participants were faced with uncertainty in the ES task, the dynamic query had shown to be useful in aiding the participants in query formulation.

Finding appropriate keywords for the query formulation was a challenged faced by the participants. They felt that a display of hierarchical categories for the topic of interest could be a useful feature in suggesting keywords for the search.

‘I would prefer if there were categories for me to choose from. Such as “education”, “IT”, “Engineering”, then under “education” they have different domains like “IT”, “Engineering”. I would use the categories to complement the keyword search.’ (M2)

‘But I think if there is a feature that is able to break down of the topic for me to choose it will be good. For example in the ECG topic, if there is a breakdown to like “Medical”, etc, perhaps this can help to refine... such breakdown might help narrow the search.’ (M8)

‘If this kind of [categorical] list is provided, it will also make me search about other (related) stuffs as it gives me more ideas.’ (F3)

Participant M9 suggested the use of an interactive question and answer system for more accurate elicitation of queries. He felt that progressive interaction provokes thinking and this leads to better query formulation. However, the design of question and answer system would need to consider factors such as the ease of use as the participants exhibited the desire for easy to use and convenient features.

3.4.2.2 Theme 7 – Interaction with video metadata

The participants interacted with various cues presented by the video platform through the video seeking process, including the selection of video(s) for preview and the viewing of video(s). In the selection of video(s) for preview, the participants commonly assessed metadata such as the static thumbnail and the title of the video. These metadata provided the most direct indication of the video content, allowing the participants to make the preliminary selection of video for preview as noted by the following:

‘One way that I do enjoy filtering by is just looking purely by the thumbnail. Cos sometimes looking at the thumbnail of the video can tell me a lot on the video content.’ (M1)

‘I am looking at thumbnails, titles and all the details about the video. (Scrolling the results). The thumbnail also gives me an idea of the video. So hopefully the thumbnail will help me visualise the DHCP is.’ (M2)

The participants preferred dynamic thumbnail over a static thumbnail as the dynamic thumbnail provided a richer indication of the video content. The dynamic thumbnail is like an abridged preview that offers a content-based assessment as suggested by the participants:

‘What I feel might help me better from Google would be having preview of the clip, say up to a few seconds, when I hover my mouse above the thumbnail.’

(M3)

‘If it can be like some websites when you put your mouse over it (the thumbnail), then the thumbnail changes, then you can also know what you will be watching. Around like, maybe 6 to 10 secs. This can give you an idea on what you watch.’ (M7)

‘Maybe instead of just the thumbnail of the video, they could have a preview of the video. Like when you move the mouse over, it will show some pictures at one go, instead of a stationary picture.’ (M10)

The indexing of video segments using keywords can provide granularity during for video searching. Several participants (F1, M2, M4, M5, M6, M9, M10) indicated this as a desirable feature. They felt that this is a timesaving alternative to video skimming and they can locate salient segments in the video that they are interested in. The following excerpts point to this:

‘I was thinking if they could put some topics they are covering for the video. Like keywords. Not necessary in the title but indicate the keywords to the video.’ (F1)

‘I am trying to find portions of the video that might show the programming code. For me basically, beginners might want to look through from beginning

to the end. But for me, if I am really good at C++ programming, I will just look for the programming practical part.’ (M2)

‘I think it would be very helpful when I click on a video, then when I can search within the video for the segment that contains the keywords that I want. This will reduce my search time.’ (M4)

‘Like having a content page for the resources. Maybe can like have it as a side bar, when you click on it, then it will display the content page, preferably single word being used.’ (M5)

The video thumbnail and title were cues to provide a quick indication for the participants to ‘match’ what they had in their mind. Despite beginning their search with fuzziness, the participants formed an impression on what they wanted basing on the cues when examining the video metadata in the result list. However, some participants suggested more metadata to be displayed. A thorough description would be more useful than a 2-line sentence when attempting to understand the video content.

‘I think more description will be better, like maybe 3 or 4 sentences. Then maybe also got to make it easy to understand.’ (M7)

‘I think a more complete short description would be good because most of the description gets cut off. I think the description shown in the result list is a little too short to give me a good idea on what this video is about.’ (M8)

Social endorsement and socially generated cues related to the video offer insights and influence the decision in a search task. The participants had mixed feelings with comments on the video. At one hand, comments were perceived as a collective perception on the video quality. On the other hand, unmoderated comments were perceived as a nuisance and time-consuming to read. Several participants mentioned:

‘The 1st comment is about the hair, totally useless comment. 2nd one is about liking the portfolio, so I will skim through the video to see how the portfolio is like.’ (F1)

‘Yeah, I can tell that this project is very well-received as majority of the comments are positive. So I will be using this project.’ (M4)

Several participants (M3, M4, M8) felt that there was a need to have a substantial number of comments. This suggested that the participants were using comments to form collective opinions that can influence their decision to use the video for SDL. As the number of comments can be overwhelming, the participants suggested that a summary of the comments with keywords can be useful. Other social endorsement cues include the number of “Likes” and “Dislikes”. Participant M7 felt that this metadata should be included in the results list as it provided information seekers a quick indication of the level of popularity.

Other preferences like the indication of subtitles availability and recency of video uploaded could influence the selection of the video. It appeared that the participants drew existing cues from various metadata to inform themselves over the suitability of a video for the exploratory task in SDL.

3.4.3 Features suggested by participants

Themes 6 and 7 converged to the interfaces and features that supports an ES. The participants had also revealed several desirable video retrieval features that were presented throughout the themes. The features that were cited by the participants include features supporting input, features supporting assessment of video, features supporting video interaction and value-adding features. Table 3.3 shows the list of features and the examples of the features mentioned by the participants.

Table 3.3. List of features and examples cited by the participants

Feature/Utility	Examples
Integration of web resources to facilitate the understanding of search concepts	- Concept snippets
Assistance in supporting query formulation	- Dynamic search suggestions - Provision of related categories
More video metadata in the results list	- Metadata: view counts, indication of subtitle availability and dynamic thumbnails
Indication of social endorsements and cues	- Number of likes/dislikes - Video comments summary
Locate and navigate to specific video segment more effectively	- Video skimming

These features and functions that were desired by the participants were considered in the design of the conceptual prototype. The development of the prototype would be discussed in detailed in Chapter 5.

3.5 Discussions

ES tasks present fuzziness and uncertainty during query formulation. In the attempt to reduce the fuzziness, the learners turned to different web resources that can be conveniently accessed to inform themselves on query formulation that was limited by their initial knowledge. This was aligned with the work from Aula et al. (2010), who found that the users attempted more diverse queries with increased task difficulty. This called for a need to support expressing the information needs in the ES. Click-baits and source credibility influenced the selection of resources by the learners, supporting the findings from Joo and Choi (2015). The choice of sources being consulted was often based on prior positive experience, this may limit and disregard useful sources. However, when the young people search for health-related

information, they tend to place trust in social media information (Lin, Zhang, Song, & Omori, 2016). The berrypicking model broadly depicts that the search iterations were conducted within the *universe of interest*. Serendipitous discovery of the extended domain was suggested in the berrypicking model through area scanning. More specifically, the learners performed the ES through several search iterations with each iteration serving the exploration of different aspects within the domain of interest or extend the search beyond the immediate domain. This suggests a need to support the learner in moving the search to neighbouring domains, balancing serendipitous discovery and the cognitive load on the learner during searching.

The proximity to how a person can express their queries in a conversation and the search input methods adopted by all major web search engines may have shaped the participants' preferred and possibly only query method. This input method appeared to be natural for novice searchers and seemingly easy to use but the query formulation for an ES task remained challenging for many of the learners. Hence, features should be designed to enhance and complement the natural language search bar. This was aligned with evidence found in the literature review where the query formulation is user-centric and had the most potential for advancing interfaces and features (Albertson & Meadows, 2011). The quality of the results list through this method is highly dependent on the query formulation. Features such as thesaurus could support query formulation or reformulation. However, design factors such as the convenience of use should be of primary concern as the study revealed that excessive navigation to use a feature or an obscure feature will tend to be ignored.

This study had shown that the adolescent learners reliance on the commercial search engine such as Google to reach out to a variety resources. Learners had exhibited similar behavior for attaining wider variety of resources, however, the older learners leveraged on their experience to acquire greater breadth of resources to draw information (Given, 2002). This allowed the more the older learners to adopt more complex strategies in acquiring the

resource as compared to the adolescent learners who predominantly relied on the simple query interface. The more complex strategies include technique in varying query reformulation to acquire more resources. The berrypicking model represented focused searching through the variety of query formulations within the search domain. Similarly, a variety of query reformulation strategies were observed in this study. Previous studies found differences in search strategies between gender (Baro & Fyneman, 2009). Information literacy skills affects the how querying done during a search (Islam & Tsuji, 2010). This suggested the need for considering individual differences when developing support features.

The participants exhibited at least two levels of assessment to determine video(s) that satisfies the search task. The first level of assessment is performed on the result list after the query is executed. This assessment to shortlist videos for preview processes cues heuristically. The advancements in precision and recall of retrieval systems have engendered significant trust from the learners as they examine the results list through the top-down approach and seldom going beyond the first page of the result list (Kammerer & Gerjets, 2014). Resource metadata was the primary source of assessment cues used in the selection of videos for preview. With a large number of video resources to consider, it is possible that heuristic-based assessment can allow shortlisting of videos for preview with minimal effort. The current set of metadata presented in a typical video platform such as YouTube was deemed insufficient by the learners to make their selection. The type and quality of metadata presented for learning resources should better describe the resource (Stvilia & Gasser, 2008). After the videos were shortlisted from the result list, the second level of assessment was performed when previewing the video by matching the content of the video to their expectations. Adolescents were found to corroborate or confirm the initial health resources as an important point in satisfying the health information needs (Starling & Cheshire, 2016). This suggests that credibility and trustworthiness of health information resources are deemed to be salient. This

study had shown the adolescent learners employed socially generated cues to shortlist the videos. This strategy is aligned to that of online users who used social element embedded in the resource to evaluate its credibility when fostering adoption (Fang, 2014).

Video skimming techniques were performed to acquaint to the video content and match it to the learner's requirement that was implicitly set. When the video matched strongly with the implicit requirements, the video seeking process stops. When the requirements were not matched strongly, the learners sought more cues, such as socially generated cues, to affirm the selection. Social endorsement cues, such as the number of "Likes" and views, and user-generated cues, such as user comments, influenced the final decision. The socially generated cues are like collective opinions that are seen as to give more neutral stand on the quality of the video. A summary of the comments via word cloud was suggested as a viable feature that allows video seekers to indicate the overall comments. This presents a preference from the video seekers that they want a feature that is convenient to assess and does not require a heavy cognitive load. However, not all videos can generate sufficient cues for a good indication of the collective opinion.

Both levels of assessment suggested that the video seekers sought various cues and metadata that acquaint them with the video's content with as little effort as possible. This is consistent with some studies (Agosto, 2002; Marchionini, 1995; Savolainen, 2007) that suggested some people coped with the overload of information through satisficing. For sequential resource such as video, more effective means to acquaint the video content can lead to better selection of the video resource. The design of interfaces and features that can reflect the video's content as accurately as possible is important. Such features should allow video seekers to complete the assessment with as little cognitive processing as possible. Increased interactivity with retrieval systems suggests that information seekers could be more involved in the process and formulate better queries for ES in SDL.

The learners exhibited similar video seeking through the two search tasks. While the two search tasks were designed from different context, the exploratory nature of the search task is maintained. Three main challenges were identified through the video seeking process. The learners exhibited a need for support to reduce the uncertainty of the learning concepts encountered during the ES tasks. The learners turned to resources beyond the video platform to better understand the domain of interest. The support to reduce uncertainties allowed better query formulation and reformulation. The learners looked for means to more effectively acquaint themselves to the video content during a preview. As a time-based resource, techniques such as video skimming were used extensively by the learners to preliminarily assess the video(s). However, video skimming can result in omitting important segments of the video, rendering the assessment ineffective. The learners heuristically scanned a variety of cues that influenced their decision making to select a video for consumption. Some social endorsement cues such as comments take up much effort and time to peruse. Other socially generated cues such as the number of views and ‘Likes’ were used as a precursor when selecting the videos. Richer forms of cues that do not cognitively load the learners can contribute to a better-informed selection decision.

3.6 Summary of chapter

Study 1 attempted to capture the nuances of the video seeking behavior of adolescent learners when performing ES tasks. This study revealed a total of seven themes through thematic analysis. Five themes were related to the exploratory video seeking behavior of learners. Two other themes concerned the interface and features that support exploratory video search for learning. This study had shown that video seeking behavior of adolescent learners involves query formulation, shortlisting of video for preview, previewing of video, and affirming selection. Query formulation may involve sub-task to improve understanding of concepts and offers the potential for help features to improve query formulation. Heuristic cues and

metadata are used heavily to shortlist and affirm the video. The analysis revealed three challenges encountered by the learners that can be addressed through the design of interface and features to support the video seeking process. These challenges served as inputs to design the interview questions in Study 2.

CHAPTER FOUR – STUDY 2: EXPERTS INTERVIEWS TO ELICIT DESIGN CONCEPTS FOR A VIDEO RETRIEVAL PLATFORM

4.1 Introduction

Following Study 1, this chapter presents Study 2 and describes the development of a conceptual prototype. Study 2 elicits the ideas and opinions from people with experience and skills from various fields to derive design concepts for a video retrieval environment. The chapter begins with the purpose of Study 2. The subsequent method section describes the research method and data analysis procedure. The design concepts for a video retrieval environment in supporting ES are presented.

4.2 Purpose of study

In Study 1, the exploratory video seeking behavior of the learners revealed several challenges that were encountered when performing ES tasks. The learners' feedback regarding video retrieval features' importance was also obtained. Study 2 was aimed to capture the ideas and opinions of experts from various fields into deriving design concepts for a video retrieval environment that supports ES. More specifically, Study 2 was designed to identify salient retrieval interfaces and featured in a video retrieval environment that can mitigate the challenges faced by learners in an ES as revealed in Study 1. Following the findings from Study 1, Study 2 looked to address the following:

RQ2: What video retrieval interfaces or features can mitigate challenges faced by learners in an ES for learning videos?

RQ3: What important video retrieval interfaces or features can better support learners in an ES for learning videos?

4.3 Method

As part of the effort to derive a set of features for a video retrieval environment to support ES for learning, Study 2 used interviews as a method of qualitative empirical research to explore expert knowledge in providing ideas and opinions. Interviews are suitable because they allow the exploration of subjective viewpoints based on one's related experience (Flick, 2018). As an efficient and concentrated method, systematic semi-structured interviews were conducted to elicit ideas and opinions related to video retrieval for learning. In such interviews, the selection of people with the experience and skill depends on the question at issue as well as the field being investigated (Bogner & Menz, 2009). This section details the design of the interview and the data analysis procedure.

4.3.1 Adapting from Expert interviews and research approach

Expert interviews offer an efficient approach to solicit ideas and opinions from people with specific expertise, knowledge and experience. Three dominant forms of expert interviews were distinguished: exploratory, systematizing, and theory-generating (Bogner & Menz, 2009). This study adapted from the systematic expert interview which is orientated towards gaining insights through exclusive knowledge and experience. Interviews were considered for the study as the responses for the questions were open-ended and exploratory. Taking on a semi-structured interview format, the interview focused on addressing the research questions through the interviewee's knowledge of action and experience that was derived from learning and training or through practice as a profession. The semi-structured interview provided sufficient room for the interviewees to explain their thoughts and reflections that were guided by core questions.

This study undertook an inductive research approach without referring to predetermined theories or categories. The inductive data-driven approach used the close examination of the

raw data to derive frequent, central, or major themes inherent in the data without being restrained by preconceptions (Boyatzis, 1998). This is important for the study as being entirely open to ideas and opinions from the interviewees could lead to the development of novel concepts. Nanyang Technological University's IRB approved the implementation of Study 2. The approval is found in Appendix 4-1.

4.3.1.1 Identifying and recruiting interviewees

The success of interview-based investigations considerably depended on the quality of the interviewees. The quality of the interviewees affected the extent to which they meet the expectations in the interview situation. In this study, the interviewees were defined as people who have special knowledge, experience or role that is related to the domain of interest. Two dimensions of expert knowledge were adapted to guide the identification of interviewees for this study. Firstly, the dimension of *technical knowledge* is defined as knowledge containing “information about operations and events governed by rules, application routines that are specific to a field, bureaucratic competencies, and so on” (Bogner & Menz, 2009, p. 52). The *technical knowledge* is distinguished from everyday knowledge as the technical know-how specific for a particular field that could be attained through formal training and learning. The second dimension, *process knowledge*, is defined as knowledge relating “to the inspection of and acquisition of information about sequences of actions, interaction routines, organizational constellations, and past or current events, and where the expert, because of his or her practical activity, is directly involved or about which she or he at least has more precise knowledge because these things are close to his or her field of action” (Bogner & Menz, 2009, p. 52). The *process knowledge*, unlike technical knowledge, is attained through practical experience, most often through one's profession.

This research took a purposeful sample approach due to the deliberate qualities required from the interviewees and did not look to generalize or draw inferences from the sample to the population. Two groups of people were identified for this study. The first group are researchers or academics whose research interest lies within the field of video and multimedia retrieval, interface and interaction, and learning technologies. Their knowledge from their research and training puts them at the forefront of their respective domains. This group of people satisfy the expert knowledge of the technical dimension. The second group are professionals working within the field of video and multimedia, interface and interaction, and learning technologies. They take up professional roles as system developers, web designers, learning designers, and/or user-experience designers. This group of people are motivated by practical market demands and provide insights based on the process knowledge dimension.

The prospective interviewees were recruited in several ways. First, the profiles of the potential interviewees were studied through published sources such as websites (e.g. academic staff profile in institution websites, industry professionals profile in corporate or organization websites). The invitation was extended to academics and experts from the industry who have related experiences with video or multimedia related work. The prospective interviewees were contacted through email with an invitation to participate in the study. The email invitation included a brief introduction of the study, the IRB approval, interview requirements, mode of interview and research contact. Some questions of the interview were appended at the end of the email to allow the invitees to understand the scope of the interview and familiarize with the researcher's position and an assessment of the topic. The recruitment took place over 5 months, from January 2018 to May 2018, in tandem with the interview process. The email template is found in Appendix 4-2.

Following this process, a total of 35 invitations were sent and 20 interviewees were identified and selected for the study. There were 11 experts from the industry and 9 from

academic and research. The highest qualification of the interviewees ranged from Diploma to Doctorate. Table 4.1 lists the basic profile of the interviewees and the corresponding identification code assigned to them. Three quarters of the interviewees had at least a Master's degree. Their domain expertise is within the area of video and multimedia, learning, human-computer interaction and retrieval.

Table 4.1. Basic profile of interviewees

Interviewee Code	Profession	Domain Expertise	Highest Qualifications
IM1 ^a	Media Manager for learning platform developer	Conversion of videos used in blended learning	Master's Degree
IM2	Learning Designer for adult education	Learning design and courseware development	Master's Degree
RM1	Research Engineer	Data Mining for Retrieval Systems	Bachelor Degree
RM2	Researcher	Design, user experience, user interface	PhD
RF3	Academic	Information Science, Image retrieval	PhD
IM3	Project Manager	Instructional designer and content development	Master's Degree
RM4	Post-Doctoral Fellow	Information Visualisation, Human Computer Interaction	PhD
IF4	Senior Digital Learning designer	Instructional design, digital learning design	Master's Degree
IF5	Learning Designer	Learning Design, MOOC developer	Master's Degree
RM5	Academic	Interaction Design, Novel Scenarios, future interaction platforms	PhD
RM6	Academic	Instructional design, Multimedia design	PhD
IM6	Learning Designer	Games Design for learning	Diploma

RM7	Academic	Design thinking, Human Computer Interaction	PhD
IF7	E-Sports trainer	Content creator (Videos)	Bachelor's Degree
RM8	Research Student	Games studies	Masters' Degree
IM8	Lecturer	Digital Art, YouTube Content Creator	Master's Degree
IM9	Senior Lecturer	IP TV, Digital Media, Broadcasting	Master's Degree
IM10	Product Manager	Video Production, Post Production	Bachelor's Degree
RM9	Academic	E-learning, Media Production	PhD
IM11	Lecturer	Technical Management	Bachelor's Degree

^a Interviewee Code: XY#

X denotes whether the interviewee is from industry [I] or academic [R]

Y denotes the gender of the interviewee, male [M] or female [F]

denotes the interview number

4.3.1.2 Role of the interviewer

In expert interviews, the interviewer plays an important role in the quality of the interview.

The level of preparedness and build-up of a knowledge base by the interviewer affects the interaction structure in the interview. The perception of the experts on the interviewer and the competencies ascribed to the interviewer influences the lingo used the interaction structure (Bogner & Menz, 2009). The interaction structure is often formed by the experts through their perception concerning the interviewer's capability, education and training, normative behavior, as well as the domain of interest.

With the aim of the study to elicit ideas and opinions from the people with the experience and skills in their domain, the role undertaken by the interviewer was similar to that of an *accomplice* as described by Bogner and Menz (2009). When viewed as an

accomplice, the interviewer is trusted and the experts will be candid and transparent over their thoughts while providing insights. To be viewed as an *accomplice*, the interviewer's education and training, and domain of interest was revealed through the engagement email. The interviewer's normative orientation, to a certain extent, was suggested through the method of investigation.

4.3.1.3 Interview guide

The semi-structured interviews were conducted with an interview guide to help strike a balance between allowing the interviewees to express their subjective attributions of ideas and keeping within the context of the research (Choak, 2013). The interview guide offered a focused structure to the research questions but need to be followed judiciously, hence allowing flexibility in the discourse. The start of the interview guide provided a template for the interviewer to record the profile of the interviewee.

Aimed to be non-interrogative, the interview guide looked to generate quasi-normal conversations that were as natural as possible. The interview guide included opening questions to allow the interviewees to express their experience and expertise with video and multimedia related work, and at the same time, draw them towards the context of ES. The next section of the interview guide included the core questions used to solicit ideas and opinions on using video retrieval interfaces to mitigate the challenges that were encountered in ES tasks and support video searches for learning. These questions were drawn from the synthesis of the discussion for Study 1. Table 4.2 lists the core questions from the interview guide.

Table 4.2. Core interview questions

1	Videos are multi-dimensional, consisting of audio channel and moving images channel as well as is temporal. Do you think the multi-dimensional makeup of video can have richer interface features to be developed to support exploratory video searches for learning? If so, what are some of such features?
2	With more complex information needs, expressing exploratory searches can be challenging. For example, a user may be looking for a video but cannot properly define the problem, and/or there is no single “correct” video. For instance, the user might want to look for video(s) that shows the design factors for a car to have a balance between stability and speed. What are some new video interface features can allow input and refinement of such exploratory information needs for learning better?
3	Very often, videos can be quite long in duration and there can be many videos presented in the results list. How can video seekers, be acquainted to the content of the video more efficiently and sufficiently so that they can decide whether the video is relevant for their learning?
4	What futuristic interface features can you envisage from the next generation of video retrieval systems?

Optional probe questions were also included in the interview guide. Reminder such as a request for permission to take audio recording and request for recommendations of other interviewees were included in the interview guide. The full interview guide is found in Appendix 4-3.

4.3.1.4 Interview procedure and interaction strategies

The interview began with an introduction of the interviewer and an overview of the research project. The informed consent form was presented and the interviewee was briefed on the purpose of the study, privacy, and confidentiality on the participation in the study. Upon the submission of the informed consent form, the interviewee’s particulars were recorded with permission. Further permission to audio record the session was obtained. The interview proceeded with the flow according to the interview guide, starting with opening questions and followed by design concept questions. At the end of the interview, the recommendations of other experts were sought to be part of this study. The entire interview session lasted approximately 30 and 60 minutes.

The interview setting was an important consideration in this study as the interviewees should feel at ease and comfortable through to interview session when provoking their thoughts for ideas and opinions. Appointments were made with the interviewee and all the interviews were conducted at the location as requested by the interviewee. There were six Skype-based interviews and 14 face-to-face interviews conducted in this study. It is acknowledged that a Skype-based interview without body language reduces interaction richness to largely at the linguistic level. This decline in interaction richness made interview management and interpretation more challenging. For instance, it can be challenging to correctly judge an interaction situation over Skype when the interviewee pauses during the interview.

4.3.2 Data analysis procedure

The data analysis procedure for Study 2 was similar to that of Study 1. Before the start of coding, the audio recording of the interview was transcribed. A total of 12.72 hours of audio recording as collected. The average duration of the interview was 38 minutes. This led to the transcription of a total of over 55,000 words. Following the transcription, a codebook was developed as a guide to ensure consistency in the coding.

Data-driven thematic analysis was performed as an analytical process to identify design concepts. Patterns were recognized within the data and the emergent themes become the categories for the design concepts for the video retrieval platform. Although the data analysis was presented as a linear process that follows a step-by-step operation, the analysis was iterative and reflexive. This allowed an unbiased and neutral view of the ideas and opinions. The data collection and data analysis occurred concurrently.

4.3.2.1 Data transcription

Data transcription is one of the first tasks for data analysis in qualitative research. The interview audio recordings were transcribed manually into textual data. Similar transcription guidelines (Mergenthaler & Stinson, 1992) adopted in Study 1 were used.

Each transcription was assigned an interviewee code (XY#). The X denotes whether the interviewee was from the industry [I] or academic [R] and Y denotes the gender of the interviewee, male [M] or female [F]. # denotes the interview number. Transcriptions were performed by the researcher who conducted the interview and was done through the data collection phase.

4.3.2.2 Coding process

A codebook was developed for this study to offer consistency in coding and to keep track of changes in the analytical process. Similar to that in Study 1, the codebook was developed inductively through the repeated examination of the data and used the same fields.

There is a need to differentiate the code interpretation between Study 1 and Study 2 as they were different types of data. In Study 1, the data collected was as a result of a task-oriented verbalisation through the think-aloud protocol. In Study 2, the data transcripts generated from a semi-structured interview were conversational and choppy. When the conversation takes place over a certain question, the answers can transgress, digress, backtrack and overlap with other questions. Hence, in the semi-structured interviews, sentences or single paragraphs may be too short to capture the full meaning of what an interviewee was saying about a particular theme.

The units of analysis or the portions of text to be coded for semi-structured interviews are often not as a sentence or paragraph and require subjective interpretation of the coder (Campbell, Quincy, Osserman, & Pedersen, 2013). Identifying an appropriate block of text for

a particular code is challenging for semi-structured interviews as the responses are more open-ended and one response can contain several codes simultaneously. Rather than sentence or paragraph, the unit of analysis adopted in this study was a *meaning unit* that retained the context of what the interviewee is saying (Campbell et al., 2013). Krippendorff (2004) indicated that some degree of interpretation is required to discern the meaning of a particular segment of text. The coding of such data requires the coder's subjective interpretation of what interviewee meant in their responses. Hence, the coder required sufficient background knowledge in the subject matter of the interviews. The unitization of the transcripts for semi-structure interviews is subjected to interpretation of the coder posing challenges for intercoder reliability (Campbell et al., 2013). Hence, intercoder reliability was not considered in this study. Instead, a codebook was derived and consulted to ensure consistency and to maintain transparency in the coding process. Similar to that of Study 1, four criteria were used to guide the definition of a theme (DeSantis & Ugarriza, 2000). And the six-phrase thematic analysis approach was adopted (Braun & Clarke, 2006).

The thematic analysis produced the themes that formed the design concepts for a video retrieval environment in supporting an ES for learning. Some of the design concepts were applicable for features through various stages of the search process and some were applicable for the retrieval environment.

4.4 Design concepts for video retrieval environment

The thematic analysis resulted in nine design concepts for video retrieval environment in an ES context. The nine design concepts were, 1) augment knowledge boundaries visually, 2) keywords management, 3) integrate multi-modal input, 4) advanced input options, 5) exploration of relationship between concepts and results, 6) multi-source recommendations,

7) granular interaction, 8) enriched interaction on video content and 9) affiliation of seeker profile. The following sections discuss these design concepts.

4.4.1 Augment knowledge boundaries visually

The interviewees spoke about improving the knowledge on the topic of interest. This stemmed from ideas to extend search through the use of visualizations, visual maps and topical classification. Interviewee IF4 elaborated on her experience on how the use of visualization on a content area had supported her in expanding the search when exploring a new topic. Her experience in the development of multimedia content for learning had allowed her to appreciate how visual organizations supported the extension of knowledge boundaries.

‘[its] some kind of content organizer. A visual framework or conceptual framework that I can see and interact with. That might make it easier for me to see how things are associated... That can help me to drill down to the level and content that I need.’ (IF4)

Other interviewees (IM3, IF5, IM6, RM1, RM5, RM, RM8, RM9) had similar thoughts about using topical knowledge maps to expand the search. RM1 suggested navigation through the knowledge structure of a topic or domain generated based on the initial keywords, while IM3 felt that semantically related concepts are cues to help learners in refining the search.

‘[Using] an example of the car. I want to build a car. So I will just type car and enable this alternate word search. Then I move to assemble car. Then the engine will suggest the tools needed to build the car, space required to build the car, and things like that. Then if I choose space, it will show the workshops available. I think such suggestions can guide me to what I want even though I do not know the technical word ... I can eventually arrive to the video that I need.’ (RM1)

‘For example, when I type “design”. The system could pair me with keywords like “learning”, because of “design learning”, it could also be “Interior design”.’ (IM3)

‘As I type in, it can show the structure of the knowledge in that area based on the words. Semantic web has that kind of idea.’ (RM5)

The presentation of semantically related terms aids the learner to establish new semantic association and to recall semantics that is related. The use of semantic association has been explored by researchers in scholarly knowledge and expertise management (Börner, 2006; Lin et al., 2007). Using the semantic relationships, the learner explores and improves the knowledge through knowledge structures and navigate towards more specific information gaps. This was iterated by RM2 where he suggested the use of concept maps as a modality to navigate the information space. Integrating knowledge structures, such as concept maps, into the video retrieval system allows learners to visualize and explore the semantic relationships within the knowledge boundary for improved query formulation.

‘... to define the key topic that they want to study on a concept map and then use that as a starter to bring them to the right video.’ (RM2)

Interviewees RM6 and IM11 highlighted on the provision of topical classification and categories to support the exploration of the domain of interest. RM6 cited an example using movies exploration.

‘You can setup the pull down menu by topic, and from the topic, you have other processes. For example of movies, you can have first “Hong Kong movies”, or “Taiwan movies”, or “Mainland China movies”. This way, you are having a region. So you have pull-down menu for regions, you have some choices. Or

you could have “Classic” or “Modern” movie. You could also use themes to classify.’ (RM2)

The design concept of *augmenting knowledge boundaries visually* converged when the interviewees were asked for their ideas to mitigate challenges encountered during query formulation in exploratory video searches for learning. Knowledge structures were proposed to bridge knowledge gaps between people with different knowledge levels (Aye, Hattori, & Kuwabara, 2008). Visual representations are an effective way to learn and explore new concepts and domains. The notion behind this design concept is to support the learners in improving their knowledge in the domain of interest through interactive visual means. This help reduces uncertainties and is better informed when formulating queries.

4.4.2 Keywords management

The interviewees offered various ideas about the use and management of keywords for query formulation and refinement. The ideas ranged from handling of linguistic ambiguities to synthesis of keywords.

Interviewee IM3 acknowledged the deficiency in the use of natural language query when the information need is vague and possibly complex. When the searches are conducted in the English language, lexical ambiguities such as homonyms and heteronyms, challenge and confound the search process. Interviewees RF3 and IM6 pointed out these challenges and suggested a need to manage keywords in the search.

‘When you are talking about jaguar, are they interested in the car or the football team or the animal, or the stuff toy? There would be all kinds of possibilities ... So I think anything that allows the user to discard 90% of the materials being presented and focus on the 10% would be really useful.’ (RF3)

‘Another issue that I thought of is when you talk about learners who have a vague idea, it would be the language. Sometimes, the reason that you have difficulties in putting it across is because either you heard about it but not in a language that you are proficient in Maybe the learners may not have a general idea. Say they want to know something about hammering. What kind of hammering? They do not remember the full terms. It could be anything from hammering a nail to driving a stake into the ground, or even a meat tenderiser, which is also a form of hammering. They do not know the correct words.’

(IM6)

Interviewee IM2 suggested that the management of keywords would begin with the recognition and identification of the core concepts or keywords from the initial query. *‘I have very long text as input and the retrieval system is supposed to understand the keywords from the text. From there, the system can pull out certain videos based on the keywords from the long text... the system can decide on the keywords and the system can refine the keywords from the text to what I need’* (IM2). RM1, IF4, RM4 and IM9 responded similarly by suggesting generating semantically close keywords from the initial query string to extend searches. IM6 and RM9 provided the indication of handling synonyms of the core search concept using the idea of a thesaurus. This idea of extending more keywords for further exploration on the topic or domain corresponded to the ES behavior of having investigative and learning activities.

‘..whenever they type a query, it not only shows the search results, it also shows what are the possible related query terms that user could possibly add or change. For example, if you just type the words “video retrieval”, then the system could suggest possible terms like “Educational video retrieval”. As you

start the search for something, the system can generate suggestions of additional terms or replacing the complete existing query.’ (RM4)

‘So if I type in “car”, then other related terms would be “environmental impact”, “car manufacturers”, “car categories”. So now I know what the options that I have about cars are. So if I am interested in environmental impact, then I will click onto that related term. So I think this relational terms are useful.’ (IM9)

‘They can type into a dictionary and see what it gives you. For a layperson, I will start with a dictionary or thesaurus to get some words that are similar or related. So for the first step, you need to be able to key in something. We can use a search engine or an online dictionary to search for similar terms.’ (RM9)

The design concept of *keyword management* was conceived with the responses for addressing the challenges in having complex information needs in ES. Their responses indicated that exploratory on topic or domain can be extended through the management of keywords from the initial search. Lexical ambiguity convolutes the search process (Krovetz & Croft, 1992), especially in an ES when the learner begins with uncertainty. Various techniques were developed to overcome the challenge of lexical ambiguity in a specific language (Jain, Tayal, & Yadav, 2016) and domains (Gao et al., 2015). With keywords management in a retrieval environment, it gives a better context of the search and guides the learner closer to the search goal. The management of keywords using semantic association to guide and provide a context for the learners in an ES. Keywords management is a pertinent design concept in retrieval systems environment that is centred upon the query-response paradigm where the query is performed in words.

4.4.3 Integrate multi-modal input

The interviewees felt that having options beyond the textual input to define the information need was beneficial. Interviewee IM11 related his experience when he had an information need arising in the auditory form. He explained how the situation would be challenging when expressing the information need was expressed in a textual form and construed differently.

‘It was a sound related problem. I was wondering why my motorbike sounds like this. I couldn’t search for the problem as I don’t know what the problem is. So I was asking around in forums, Facebook, etc. I was trying my best to describe the sound, like “it sounded like rubber scratching on metal.” But everybody interpret the description differently.’ (IM11)

Searching by example was suggested by interviewees (IM1, IM6, IM8, IM9). Through the provision of visual and/or audio content as an example from an initially vague information need, learners could browse and select from the resultant list to propagate more resources.

‘So for videos, you can possibly search for a screen or a shot. For instance, you might want to know where you can purchase this sound track or sound effect. So I think currently can really type this out unless you know what you are looking for. So you can search for a video using a stock footage that you know.’ (IM1)

‘You know for music, there can be cases where you hear something in the mall and you can record a 10 sec clip and use this clip to find the song. But for video, I am not sure if there is a need for this kind of search... So you may come across some posters or something and you can take a picture of it and then find the videos related to the content of the posters.’ (IM8)

To a certain extent, using examples can help reduce lexical ambiguities such as homonyms as highlighted by interviewee RF3.

‘When people are talking about using examples, like apple or jaguar. When you are talking about jaguar, are they interested in the car or the football team or the animal, or the stuff toy? There would be all kinds of possibilities.’ (RF3)

The technique of content-based search was highlighted by several interviewees (IF4, RM1, RM2, RM4, RM5). The content can vary in granularity, from an object in an image to segments of video clips.

‘I think there are a lot of opportunities using video frame as a cue, very much like image recognition. You want to find a cat and you upload an image of a cat, then you can find stash of cat images. What if you apply the same idea to videos? For example, when I find a video that I like, if I like this segment of the video that talks about a particular topic. Can I use that segment as an input into the algorithm to pass, say the content of the video textually, the people in the video.’ (RM2)

‘Even like different visual features in the video. We should be able to search by the visual feature. For example, if it is like a lecture, then there is a particular visual feature associated to it. Maybe like someone standing and giving a speech. If it is a movie, then the visual feature will be different. So those visual features will also be taken into account when searching... That forms part of the query. For example, right now you can give an image and you can find similar images to that. I am sure you could also select certain colours and you can get images that are similar to that colour.’ (RM4)

Interviewee RM7 offered an idea that used the enhance interaction of objects within a video to extend and navigate the search. The provision of other resource as a search cue can create a boundary for the ES. As he elaborated:

‘If you have a particular video that you have and in the video, it says something that you don’t know but want to know, then you will be able to interact with the object and it goes to another video that will better explain about that object (concept), regardless if a highlight link is created there or not. You can create a flag that can be toggled for learners to decide if they want exploratory searches. If selected, links will be generated real time, depending on the content of the video, then they can explore the content deeper... If you have other kinds of resources like images or pdfs. You tell the search function to find related videos based on this image or pdf file. That would boost and filter the search function. You don’t even have to give the search term if the search function can understand what the pdf is about as you already have those objects.’ (RM7)

These ideas and experiences shared by the interviewees revealed that the videos retrieval environment can be designed to *integrate multi-modal input* through the provision of options for varied means to query video collection. Content-based search has been researched to improve retrieval efficiency (Jiang et al., 2015; Xia, Xiong, Vasilakos, & Sun, 2017). Rather than used in insolation, the integration of visual and audio as input dimensions supports learners in extending the search when the explication of information need in words is difficult. This integration can also be designed as a form of adaptive filtering of video resources to support a learner when browsing results and sense-making in an ES (Ahn & Brusilovsky, 2013).

4.4.4 Advanced input options

To better support ES, the interviewees suggested the use of multiple search fields and search criterion (IF4, IF5, IM10). Such advanced input options should be used together to streamline the search.

‘If you can search for related video based on an image, potentially that could throw up many videos. So I think you will need to temper that by searching with a few dimensions. So you search by image, as well as keywords and a few other search fields, then you can narrow the search.’ (IF4)

‘I think perhaps like a library database. They actually have advance search features like Title, journal, year. So having options like this, it might be able to help the user... The keywords field is definitely important. The institution is also important. It will hence be easier for them to filter the various institutions.’ (IF5)

To present advanced search options, interviewees IM6, RM7, RM8 and IM10 suggested an indication of performing ES and more options or metadata to be available to streamline the search. An indication of an ES can manifest advanced search options for the learners.

‘I think the metadata that can be for searching or filter the search results will be topic, like physics, chemistry. Then there will be sub-topic, like quantum physics, HCI. I would also think that the name of the teacher, the author, and experts in the field. But you might be exploring, so you may not know who the experts are. Depending on the topic or domain, date might be relevant for some. For the more timeless subjects, like complexity, then you don’t really need the date produced. But for tutorials for Angular, the date will be useful as different versions come up at different time.’ (RM7)

‘Most users don’t know the end product that they are looking for, they do not know which is the most seminal video that they are going to need. So it would be helpful if the video platform allow me to highlight that I am performing an exploratory search, and when I am doing that, the way that the search terms and the data retrieval interacts, it would provide me a very broad range of videos.’ (RM8)

Interviewee IM10 felt the need to guide users on the advanced search syntax as he felt that syntax consistency is lacking across the retrieval systems. The inconsistency without guidance may put off people in using the advanced options or features.

‘One of the problems that I had was that all of the search engines have different criteria on how to do the searches. None of them seems to give you guidance on what the criteria is. For example when I put an exclamation mark around two words, does that mean I get search results for both of those words in that order. And I use an underscore between the words, does that mean I get the results based on the words order? When I leave a space between the words, do I get results for both words in any order? All these are not clear. So I think the search engine needs to provide feedback to the searcher about what is the basis with which the searches give you the answers.’ (IM10)

The use of advanced input options has been incorporated into many search and retrieval systems. It is often used as filters to narrow the scope of the search and to increase the relevance of the results. The BM25F was developed as an extension of the BM25 algorithm in semi-structured retrieval to consider other fields of relevance in the ranking of retrieval (Robertson, Zaragoza, & Taylor, 2004). The design of advanced search options can be a bridge between expert and novice searchers with the provision of more options. While it

remains an integral feature in the search and retrieval systems, it is often revealed to the searchers only when explicitly called upon. The presentation of the advanced search options should be done with the identification of the seeker profile or an indication of ES to present advanced input options.

4.4.5 Exploration of relationship between concepts and results

With the query-response paradigm being the dominant model adopted in today's information retrieval platform, there is a relationship between a query issued and the corresponding result list. Interviewee IM1 suggested visualizing the relationships between the videos in the results list and the associated keywords. Interviewee IF4 similarly suggested using the relationship between the search query and resultant list to explore more keywords to the related videos. The exploration of relationships between the query and results had allowed the searcher to identify keywords for reformulation.

'I suspect that [exploration of result list] could be slightly improved with visualisation of the data. So right now, it is always list. When you search for videos, you get a whole page of thumbnails, and the list is ranked according to some metrics. You don't actually see the relation between the videos... It will then be interesting to see what are the relationships between them. How are the videos related to each other apart from having same keywords.' (IM1)

'When I search for a video, I am looking at the topic "Urban Farming" and I am totally not familiar with that. I only have 1 keyword, which is urban farming, or perhaps "green spaces". So I will look for that and pushes me one video. And a certain number of keywords that are associated with that video, other videos are also listed. There is a whole running list of videos.' (IF4)

Interviewees IM2, IM6, IM9 suggested other techniques and criterion for making the relationships between the resultant video lists more explicit. In a search for learning videos, IM2 and IM9 opinioned that the list could be grouped by the video's level of difficulty. Grouping and indication results similarity would also allow exploration of the results list to be more effective as explained by RM1, RF3 and IM6. The idea was to identify any form of diversity between the results so that the searcher could pick diverse paths for further exploration.

'So if somebody is doing a search and not sure what they are looking for and they are shown 20 things that are similar isn't very helpful. But showing 20 different things that presents different aspects might be helpful. Because they could pick up the one or two that point them to the right direction and start drilling down from there. So I think finding a video system that expresses the diversity of the materials available so that they can select the area or the subset of the dataset that is relevant would be useful.' (RF3)

Other interviewees (IM9, IM10) proposed presenting dynamic updates in the results list when search concepts change. This allowed the searcher to make sense of the effect of change and better refine the query through improved interactivity.

'Sometimes search fields give you instant results as you type. And that gives some guidance to the user about the validity of what they are typing. For example, in my own product. If you are searching in the media database and I type in "dog". I neatly get all the answers that have dog in the media or dog in the filename. And if I type in "big dog", the list becomes shorter and I type in "dog barking", the list becomes shorter. The list dynamically changes as I type. As I type the different search criteria, I get a feeling of whether I am

getting some sorts of results or not. And maybe it doesn't get me the exact results at first, but at least the feedback, because it is so fast, and almost direct into my typing, I do get better interactivity.' (IM10)

These ideas reflected upon the significance of presenting the relationships between query and results presented. Previous work on results visualization based on topical facet had shown improvement in browsing efficiency (Jiang, Wang, Wang, Liu, & Ngo, 2016). Through the metaphor of a solar system, researchers presented semantic relationships between a query and relevant web pages to improve the interactivity of searchers, changing the searcher's subject of interest dynamically (Nguyen & Zhang, 2006). Providing a presentation of the relationship enables the video seekers to form a paradigm on how a query concept affects the results and they can develop better-informed queries.

4.4.6 Multi-sources recommendations

Content-based recommendations have found its way into many e-commerce platforms and formed an integral part of decision making. Three of the interviewees (IM1, IM2, RM1) explained how recommendations can play a part to support ES. In the exploration of a new domain, authoritative recommendations provide for quality resources. Interviewee IM1 felt that such authoritative recommendations were able to guide searchers to more reliable resources while IM2 would request help from people in an unfamiliar domain area.

'It falls back to recommendations made by experts. Say if you want to find something related to chemistry and the scientist says that these are the top 10 things that you would need to know, because of the nature of their work and credentials, there is more reliability to the accurate results that might be given.' (IM1)

‘[for the lack of domain knowledge] I will ask people. I ask people to give me a few recommendations, for a few video websites to search. But of course, I also realise that when I do a search in Google, they also introduce a lot of websites that you can retrieve videos from.’ (IM2)

Other than authoritative recommendations, peer recommendations were also suggested by the interviewees (IM1, IM2). Interviewee RM1 gave an idea of peer recommendation collated using digital footprints of learner with similar profiles. Peer recommendations may be closer to the information needs of the learner as compared to authoritative recommendations.

‘Say, I am doing a topic about Chemistry and I know nothing about Chemistry. There will be other people within this community that has some understanding. So what they point me to would be quite valuable. So if I am searching on “how to build a bridge”, something that I have zero understanding, there will be people out there with this interest and they will be able to tell you that when you are looking at something like this, these are the people to look into and these are the possible videos that you might be interested in. So it becomes something more social where you rely on peer-to-peer recommendations.’ (IM1)

‘It is about using the data of the people watching the video. If this video is viewed predominantly by viewers who are aged 20, and you are also within that age group, then this video might be more relevant for you... If you are a user with a profile of 20 year old, searching around the same geographic region, who is also searching for things like “Fried Chicken”, the search engine can assume that you are also searching for the same thing and provide you with the same search results that other users have verified useful.’ (RM1)

Recommendation systems have been useful in situations where the number of choices is overwhelming. Recommendation techniques were developed to provide users with personalised content in the context of search in various domains (Kim, Lee, & Chung, 2014; Zhu et al., 2015). Providing recommendations from two perspectives, one from expert opinion and another from a peer-to-peer network allow for more diverse views and encourage a serendipitous discovery of resources. The way recommendations are proposed in the retrieval environment should be transparent to the video seekers so that they will know the perspective with which the recommendations are made. For instance, Amazon books indicated that the recommended books are books that were purchased as a bundle. Having a clear header to indicate the list of recommendations, such as who proposed the recommendations, serves as a means to inform the video seekers on how the recommendations were made.

4.4.7 Granular interaction

The temporal dimension of videos led 14 of the interviewees (IM2, IF5, IM8, IM9, IM10, IM11, RM1, RM2, RF3, RM4, RM5, RM7, RM8, RM9) proposing various recommendations for more granular video interaction. Interviewees RM1, IM2, RM2, RM8, IM9, RM9, IM11 proposed that the search and retrieval can be made more granular when video segments are indexed. The granular retrieval allows the learner to locate specific video segments that pinpoint a concept more effectively during an ES.

‘... the interface brings you directly to the parts of the video that talks about aerodynamic. So instead of spending time watching the whole video, you can jump directly to those parts. You can find parts of the video that talks about this very easily, by identifying visual cues that shows aerodynamics.’ (RM2)

‘Let’s say for some science topic. I want to see a segment where they are logging of trees, or water pollution. Will the video retrieval be so smart to be

able to go through the ½ hour clip and only show segments of the water pollution scene? That will be useful.’ (RM9)

With videos being segmented, the interviewees put forth ideas that support the exploration of the videos more granularly. Interviewees (RM1, RM4, IM8, IM10) proposed to indicate the segments within the video that a representative of the concept of interest.

‘If you search for educational videos on “sentiment analysis for social media”, and you are searching for a lecture or part of a lecture. Maybe a video might not only contain sentiment analysis but other things as well. The system could highlight the parts that only talk about “sentiment analysis” in the search results. In some way, you could imagine that there is a bar underneath each thumbnail, and you could highlight the parts where this particular sentiment term appear or the person talking about sentiment analysis. You could imagine that to be like a band and you have these red marks where it highlights the terms.’ (RM4)

Other forms of interaction include saving or bookmarking video segments (IF5, RM8) and keeping track of videos segments that have been watched (RM7). Such interactions lead to better management of video resources for learning. Interviewee RM8 further proposed the indication of most-viewed segments as an extension of the most-watched video concept that incorporates social metric.

The design concept of *granular interaction* can be applied across the various stages of exploratory video retrieval. The responses from the interviewees indicated that when the interactions were granular, it alleviated the temporal dimension challenges encountered with lengthy videos. Automated video segmentation techniques have been applied on movies based on logical story units (Hanjalic, Lagendijk, & Biemond, 1999) and more work is required for

sub-topic segmentation for learning videos. Granular video interaction is useful, especially in the latter stage of an ES when the uncertainty is reduced and the learner becomes more specific with the information need.

4.4.8 Enriched interaction with video content

A digital video commonly comprises of moving frames and audio. This multi-modal nature of videos had the interviewees proposing richer forms of interaction in the search process. Interviewees RF3, RM4, IF5 and IM9 suggested the generation of more content-based metadata to facilitate as a signpost for more interactive searches.

‘There is also the possibility of using keyframes. Of course the video is made up of a number of fast moving frames and individual frame becomes searchable. People have also used words or text in the video because character recognition is very good in pulling out the text, signpost or whatever in the video and using those for retrieval. In this case I am talking about the words found in the video. So, a lot of text in our world that people view and the systems are pretty good at pulling it out.’ (RF3)

‘Even like different visual features in the video. We should be able to search by the visual feature. For example, if it is like a lecture, then there is a particular visual feature associated to it. Maybe like someone standing and giving a speech. If it is a movie, then the visual feature will be different. So those visual features will also be taken into account when searching.’ (RM4)

‘Cataloguing in terms of recognizing and generating the metadata, the indexing of places, indexing of faces. For example, if the video has Big Ben behind, you will know that it is London. But if you don’t key in the piece of metadata, it cannot be searched.’ (IM9)

Interviewees IM3, RF3, RM4 and IM8 provided the idea of using voice-to-text transcriptions to create closed captions that can be made searchable and be better acquainted to the video content.

‘What can be improved would be in terms of audio and transcripts. That can actually help in searching. If there is a way to develop a voice-to-text transcript, then the system can search through the transcript instead of relying on keywords.’ (IM3)

‘... searching via the close caption that YouTube automatically generates. So I wonder if it is possible when you are looking for videos to teach salmon cooking, you type “how to cook a salmon”. If the presenter in the video actually mentions “today we will learn how to cook salmon”. Just based on the things said, it could be possible for the search to be done on the subtitles and use that to check for the relevancy of the video.’ (IM8)

Provision of a video content summary was suggested by several interviewees (RM1, IM2, IM6, RM6, RM7, RM9). The interviewees opinioned differently in how the content should be summarized. Interviewee RM6 believed that textual summary could provide for the abstract of the video. The rest of interviewees felt that beyond summarizing the video content as textual descriptions, a video summary should carry the salient points or key takeaways that one could appreciate from watching the video, like a storyboard.

‘It will be a textual form. It is not a video preview because a preview can only capture certain parts. And certain bits and pieces do not give me the whole picture. Using text, the video can be summarised in 2-sentences. I am not convinced that a couple of seconds of the video can give me the whole picture. [A video summary] May give me some highlights, but when I watched some of

the previews, it doesn't turn me on. This means that the preview did not do their job, it doesn't give me the big picture, it provides certain part of the details.' (RM6)

'From a learning design perspective, I would use the preview to show the snippets and key points. If the video is focusing on 6 or 7 different key points, then very short sequence of these key points can be shown. So the learners can very quickly see what is in the video.' (IM6)

These ideas converged to making *enriched interaction with video content*. The multi-modal nature of videos affords richer forms of interaction for learners to understand the video content more effectively. Video surrogates were enriched by integrating video visual metadata with semantic data and had higher utility compared to a storyboard (Mu & Marchionini, 2003). The interaction with video content can be enriched by integrating the various modalities found in the video.

4.4.9 Affiliation of seeker profile

When asked about how the learners can acquaint themselves with the video more effectively in order to select video(s) for their learning, the interviewees (IM1, IF4, IF5, IM8, IM9, IM10, RM1, RF3, RM6, RM7) felt the need to consider the learner profile in the search process. The consideration of the learner profile results in the retrieval of more effective resources.

Interviewee IM8 shared his experience with the profile of ITE students:

'... this is coming from the profile of ITE students. Their attention span is actually very short. I find that whenever I am going through a presentation or lecture in the classroom, I will lose them in 10-15 minutes, then I have to get them back again to continue my lesson. This whole process of teaching and

getting back their attention is quite time consuming. And at the end of the day, I am not sure whether everything has been received.' (IM8)

The integration of seeker profile into the video retrieval environment allowed the profiling of the learner when searching for learning videos. This was deemed important as the fundamental knowledge and training of the learner different for various disciplines. As explained by interviewee RM6:

'Learning videos are just the source of the information. The information can be in the video format, can be in the text format. So to me, whether they have no major differences. But the process, what are the factors? In our field, it is called analysing the learner. Who are the learners? Generally speaking, what are their characteristics, their background? In each discipline, they have their own training. For example, in Chemistry, they teach processes, chemical name, etc.' (RM6)

The inclusion of the seeker profile allows the coupling with other design concepts such as the advanced input options and multi-source recommendations. Automatic construction of user profile was done with the analysis of the user's browsing history using collaborative filtering (Sugiyama, Hatano, & Yoshikawa, 2004). By considering an automatically constructed profile, the researchers found improvement in retrieval accuracy. By considering the seeker profile, the search results can be more aligned to the cognitive level and information needs of the seeker. However, to maintain effectiveness in an ES, the integration of the design concept of *affiliation of seeker profile* into the video retrieval environment will need to consider means to maintain search diversity.

4.5 Design concepts and features

The design concepts derived through the thematic analysis of the expert interviews is a set abstract guideline for features development. Salient features to support exploratory video search in for learning was distilled from these guidelines. Further, some experts provided examples of features to illustrate their ideas. Table 4.3 presents the summary of the design concepts and the possible feature for the design concepts.

Table 4.3. Design concepts, features and intended effects

S/No.	Design concept	Description	An example for the feature design	Intended effect
1	Augment knowledge boundaries visually	To support learners in improving their knowledge in the domain of interest so that better queries can be formulated for ES.	Presenting a visual map based on key concepts from the initial query.	To support exploration of topical space to reduce uncertainty.
2	Keywords management	To provide support for handling keywords challenges such as synonyms and related terms.	Suggest topical keywords related to the initial query.	To support semantic association and mitigates language ambiguity to reduce uncertainty.
3	Integrate multi-modal input	Options for varied means to query the video collection by taking advantage of multi-modal nature of video.	Integrate audio, video and image as input fields with keyword input.	To act as a delimiter to the results that are defined by the keyword search facility which reduces the effort required to explore the results.
4	Advanced input options	Provide ES with advanced search fields and dimensions.	Presenting additional search fields to complement keyword search	To achieve a more streamlined retrieval
5	Relationship between concepts and results	Making sense of the video lists and query relationship to allow the exploration of resources more effectively.	Show the relationships between the search concepts and videos list.	To improve query reformulation
6	Multi-source recommendations	To include different sources of recommendations so that different perspectives can be formed for serendipitous discovery.	Provide two lists of recommendations from different perspectives.	To allow for diversity in video resources and encourage serendipitous discovery.
7	Granular interaction	To have more granular video interaction for more focused sense-making of video content and decision making.	Retrieval interfaces that leverage on video segments.	To attain a more specific and focused retrieval.
8	Enriched interaction with video content	Multimodal nature of video offers various means of interaction to cognize video content effectively.	Provision to enrich search on video close caption and content-based metadata.	To attain a more focused retrieval based on video content and improve acquaintance to video content.
9	Affiliation of seeker profile	Affiliating user profile provides support to the preference and possibly context of search.	Creation of a user profile and personalised search.	To personalise features for video seekers with disparate needs

4.6 Summary

In this chapter, Study 2 adopted interviews to capture the ideas and opinions from experts of various fields on how the interface and features can be designed to better support exploratory video search for learning. This study revealed a total of nine design concepts for a video retrieval platform through a thematic analysis of the collected data.

The berrypicking model supports the change in search strategy. Several design concepts conceived in this research suggested the elements in the shift in search strategy. The design concept of *Augment knowledge boundary visually* supports the change in search strategy during query formulation through the incorporation of the visual element in the VIR environment. The concept of *relationships between concept and results* creates synergy between the iterations of search to establish a better strategy in query formulation.

The design concepts were used to derive a set of video retrieval features. These features are proposed to mitigate challenges faced by learners in their exploratory video searches and better support the ES for learning videos. Some of the design concepts will be useful for general learners in their exploratory video searches. Particularly, the design concept of *augment knowledge boundary visually* and *granular interaction* can be helpful for younger learners due to their poor digital literacy skills in performing complex searches (Kodama, Jean, Subramaniam, & Taylor, 2017). The *affiliation of seeker profile* can customise features to better support the younger learners. The design concept of showing *relationships between concepts and results* will be able to support the younger learners in processing the search results (Wu & Cai, 2016).

This set of features constituted to the solutions for the second and third research questions. This set of feature, together with the features described in section 3.4.3 of Chapter

3, were considered in the development of the web-based video retrieval conceptual prototype to be evaluated. The next chapter details the development of the prototype.

CHAPTER FIVE – PROTOTYPE DERIVATION, DEVELOPMENT AND EVALUATION

5.1 Introduction

Following Study 1 and Study 2, a set of design concepts and potential features to support the ES for learning videos were derived. Discussions with two additional information retrieval experts were conducted to cogitate the design concepts and potential features that were derived and further elicit features for the development of the video retrieval prototype. Consequently, a set of video retrieval platform features were derived and finalised for the prototype development. The evaluation methodology and the evaluation of the prototype concluded the chapter.

5.2 Features to support exploratory video search

Through Study 1 a list of desirable features from the users' point of view to support the exploratory video process was compiled (Section 3.4.3 of Chapter 3). In Study 2, a set of video retrieval platform design concepts were derived from the experts' point of view in response to the users' feedback in Study 1 as well as their own expert opinion of additional important features to support learners in an exploratory video search (Section 4.4.10 of Chapter 4). The domain experts and practitioners' interviewees in Study 2 provided further examples of the features in explicating these ideas.

As there are a number of options and approaches to implement these individual features, it would be necessary to optimise and limit the features to be included and eventually tested in the developed prototype. In this respect, discussion sessions with two information retrieval experts (IE1 and IE2) was employed as a means to identify and finalise the set of prototype features to be developed and tested.

5.2.1 Discussions with Information Retrieval experts

Discussion sessions with two Information Retrieval experts were held. The discussion sessions provided opportunities to ruminate upon the design concepts and further elicit features to be developed for the conceptual prototype. The discussions with the information retrieval experts, IE1 and IE2, took place over several sessions from May 2018 to Oct 2018. IE1 is a Professor of Information Science and has over 30 years of research and teaching experience in the field of information retrieval. IE2 is an Associate Professor and has over 30 years of research and teaching experience in the field of information searching and retrieval.

The findings of Studies 1 and 2 were presented to the information retrieval experts for their ranking in order of importance and practicality in terms of usage by users. In so doing, 3 out of the 9 design concepts were dropped from the findings of Study 2 for the prototype development in preference to study the remaining concepts which are more specific and related to SDL ES. The three design concepts omitted were 1) *Advanced input options*, 2) *Affiliation of seeker profile* and 3) *Integrate multi-modal input*.

Some search advanced search features are common across search engines while some advanced search features may vary in different search engines (Lucrédio, Fortes, & Whittle, 2008). Advanced search options have been part of the search engine and are utilised more heavily by advanced users (White & Morris, 2007) to tackle complex search tasks by expert searchers. Zhang and Fei (2010) found that regular searches had outperformed searches using advanced search features. The utility of advanced search options requires learning and this increases the cognitive load for the searchers. As such, this feature has been omitted in the prototype development and study as this warrants a more detailed study to better understand the usefulness and usability of advanced features in the context of self-directed learning.

Search profile and personalization has been a heavily researched area in web search (Cai, Wang, & de Rijke, 2017; Mor, Riva, Nath, & Kubiawicz, 2015). Search profile and personalization is effective in supporting search through the effects of individual relevance in ranking and provision of context for typical search tasks. For ES, personalisation may be less important due to the need for exploration and serendipity that relate to new domains for learning that are less familiar or new to users. While search profile and personalization is efficacious for searches, more research is needed to extend its usefulness to ES.

Multi-modal input for web searching has been researched to improve on effectiveness and efficiency (Goel, Giangreco, Rossetto, Tănase, & Schuldt, 2017; Pinho, Godinho, Valente, & Costa, 2017; Xu et al., 2015). As the efficiency and effectiveness of multi-modal retrieval improves, there is potential for an interface design to better integrate the multi-modal input. As such, this design concept will be left for future follow on research.

The remaining features were further discussed and refined for development and evaluation. Table 5.1 summarises the list of features and utilities to be included in the conceptual prototype and were grouped by their utility. The descriptions of the features and utilities are detailed in the following section.

Table 5.1. List of features and utilities for conceptual prototype development

S/No.	Feature/Utility	Adopting Design Concepts derived from Study 2	Suggested in Study 1	Feature Group
1	Concept map	• Augment knowledge boundaries visually • Keywords management • Exploration of relationships between concept and results	• Understanding of concepts	Concept Map
2	Concept snippet	• Keywords management	• Understanding of concepts • Use of concept snippet	
3	Concept map navigation	• Exploration of relationships between concepts and results	-	
4	Video segments for concept of interest	• Granular interaction • Enriched interaction to discern video content	• Locate video segments • Video skimming	Granular Interaction
5	Video segments for high interactivity	• Granular interaction • Enriched interaction to discern video content	• Locate video segments • Video skimming • Social endorsements	
6	Video segments container ¹	• Granular interaction • Enriched interaction to discern video content	-	
7	Video metadata in results list	• Exploration of relationships between concept and results • Enriched interaction to discern video content	• More metadata: View counts, Closed Caption, Social cues	Video Metadata
8	Video metadata in video view	• Exploration of relationships between concept and results	• More metadata: View counts, Closed Caption, Social cues	
9	Session history ¹	• Exploration of relationships between concept and results	-	Value-adding
10	Comments visualization ²	-	• Video comments summarization	
11	Expert and Viewers recommendations	• Multi-sources recommendations	-	

¹ Feature conceived through discussions with the information retrieval experts

² A variant of the feature was conceived through the discussions with the information retrieval experts

5.3 The features to support exploratory video search environment

These four groups of features were represented in a conceptually-designed mock-up environment and not a working system. The digital product design tool InVision was used for the prototype development. The YouTube interface layout was adopted for the prototype due to its popularity and familiarity to video seekers. The conceptual prototype presented the features and its functionality to allow the evaluation of these features. This meets the last research objective of *deriving a list of design features to be included in a video retrieval environment based on the evaluation findings* as discussed in section 1.3. The following sections describe the conceptual features developed.

5.3.1 Concept Map group

The features in the Concept Map group support the learner during the ES through knowledge construction and representation. These are meant to reduce the uncertainty faced by the learners during ES. It also serves to provide an overview of the domain area which might be new or unfamiliar to the user. The concept map group consists of three features, 1) the concept map, 2) the concept snippet and 3) the navigation between related concepts in the chosen domain.

Visual knowledge maps are widely used to support knowledge construction and representation. Different visual tools use different techniques to achieve a better understanding and representation of the knowledge area. The common visual tools include concept maps, mind maps, conceptual diagrams and visual metaphors (Eppler, 2006). The concept map was used as the visual map in the video retrieval environment as it is effective in showing the relationships among sub-concepts to the core concept of interest (Novak & Cañas, 2008). This effectively creates a visual boundary for the learners where expert knowledge is modelled and used as a learning resource (Coffey, Hoffman, Cañas, & Ford,

2002). The boundary of related concepts presents a context and this offers a form of keywords management to manage language ambiguity such as synonyms.

The query-response paradigm is retained in the design of the conceptual prototype.

When a learner begins an exploratory video search task by formulating a query, the key concept that forms the topic of interest is identified from the query. A concept map for the key concept, which can be optionally toggled off by the user as necessary, is then displayed with the corresponding list of results. Figure 5.1 shows an example of a concept map after a query string is processed. A list of corresponding video resources (i.e. ranked result list) that is tagged to these individual concepts is shown below the map.

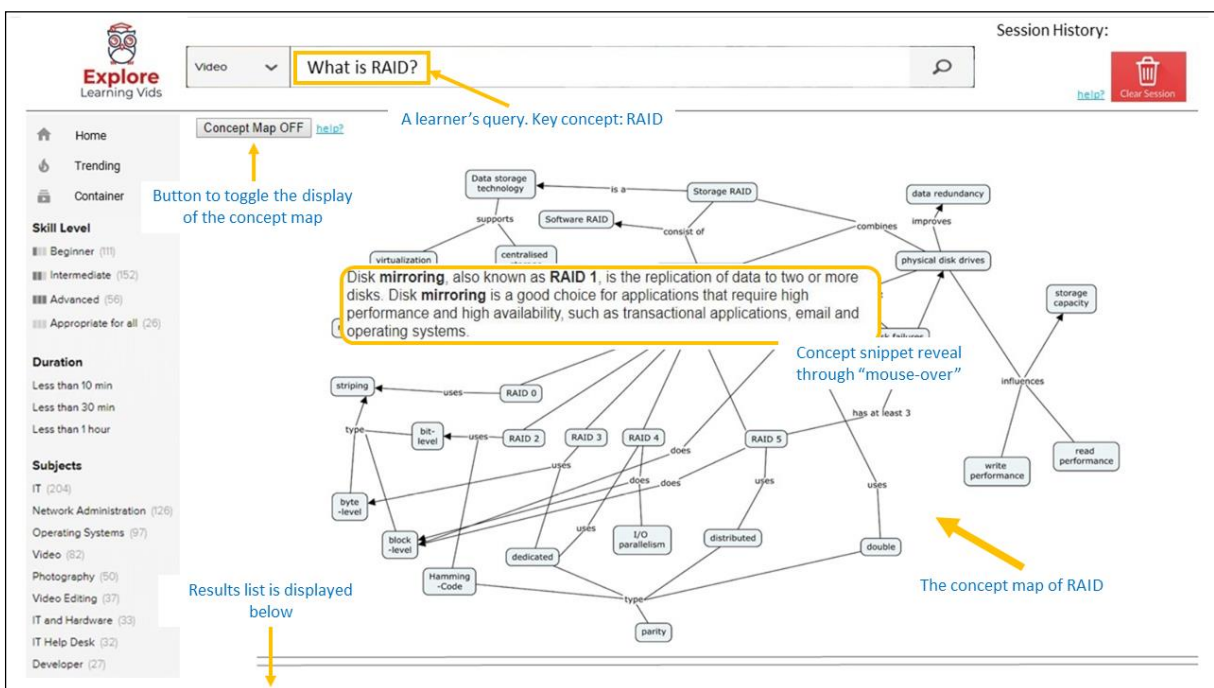


Figure 5.1. Concept map from the query (results list is not shown)

The concept snippet was developed to enhance keywords management and to promote understanding of new concepts. The definition of the concept overlays the concept map when a learner points the mouse tip over the concept. The use of a concept map for web search navigation was proposed due to a concept map's semantic and topological characteristics

(Cañas et al., 2005). The learner can explore the topic by clicking on the concepts presented. When the learner clicks on a concept in the map, the concept map and results list will update accordingly. The refreshed concept map and results list allow learners to discern the changes in the result list concerning the selected concept.

5.3.2 Granular interaction group

Video is a temporal media and there is much work in the area of segmenting videos to improve interaction. The segmenting of video allows more granular interaction and in video retrieval, it supports a more focused and specific retrieval. Various recognition techniques such as objects identification (Jain & Grauman, 2016; Wang, Luo, & Jodoin, 2017), and event and activities identification (Kuehne, Gall, & Serre, 2016) were developed to segment videos. Two types of video segmentation were developed for the prototype, 1) segments containing the concept of interest and 2) segments with high interactivity. The interactive features for each of the segment types, such as dynamic segment thumbnails and in-video segment navigation, are supported on the results list as well as in the video view interface.

To segment videos according to the concept of interest, there is a need to identify and contextualise the search concept in the video. Using recognition techniques, the search concepts can be identified within a video (Liu et al., 2018). This forms the basis of segmentation by concepts. The video slices containing the concept of interest within the video will be segmented and indexed. The video segments, hence, are associated with metadata and search terms.

The learning video resource in the video retrieval platform is assumed to be segmented by sub-topics and concepts as a learning video is likely to discuss more than one concept. Each concept is represented by a start and end time and stored as part of the video content metadata. For instance, a video that teaches enterprise storage solutions would likely discuss

storage concepts such as RAID as well as the different variants of storage solutions such as Storage Area Network and Network Attached Storage. Hence the video can be segmented according to these mentioned concepts. When the learner searches using a certain key concept, the segments that contain the key concept will be highlighted in blue in the timeline of the video as part of the results list. As the ES progresses, another concept may be used and the same video that was retrieved in the previous search iteration may also be part of the result list. Hence for the same video, the blue timeline may appear different for both searches.

Figure 5.2 shows the presentation of the same resource from two search iterations using different key concepts.

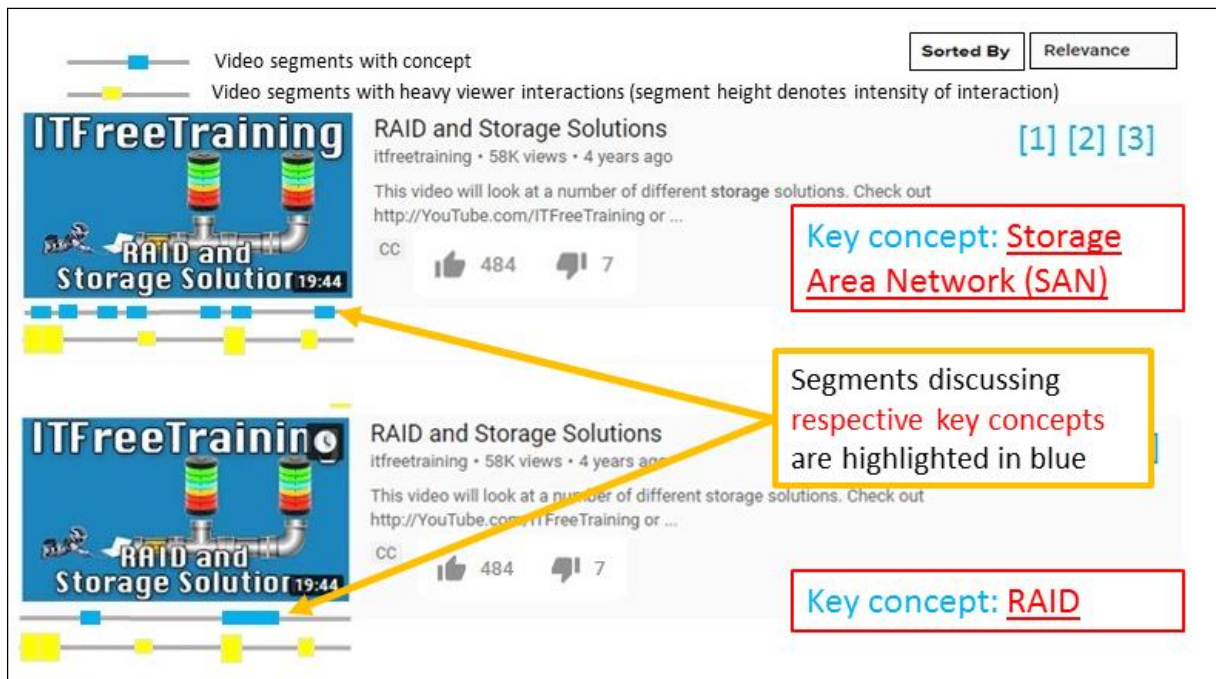


Figure 5.2. The same video resource with different search concepts highlighted

The video segments with high interactivity, such as view counts, are highlighted in yellow in another timeline when different thresholds are exceeded. Different thresholds could be set for varying levels of interactivity. In practice, interactivity counts for a video should reflect continuous interactions with 'valleys', 'peaks' and 'plateaus'. To depict the concept of the feature clearer, the different level of interactivity is presented in segment height units as

shown in Figure 5.3. For instance, when a segment exceeds the interactivity count of 500, the segment would be highlighted in one height unit on the timeline. When the segment exceeds the interactivity count of 750, two height units are highlighted. In the prototype, arbitrary numbers were used for the interactivity count thresholds. More work is required to determine the suitable interactivity counts in a working system. The recency of a video, such as videos that were available in a much earlier period, will affect the accumulation of the interaction count and skew the visual representation. To take into account the recency of a video, one possible solution is to consider the accumulation of the interactivity count taken for the last 3 months at the point of last interaction. Unlike the segments for the concept of interest, the same segments of high interactivity are highlighted in the same video despite different search concepts. This is because the segments of high interactivity are highlighted due to interaction rather than search concepts (see Figure 5.3).

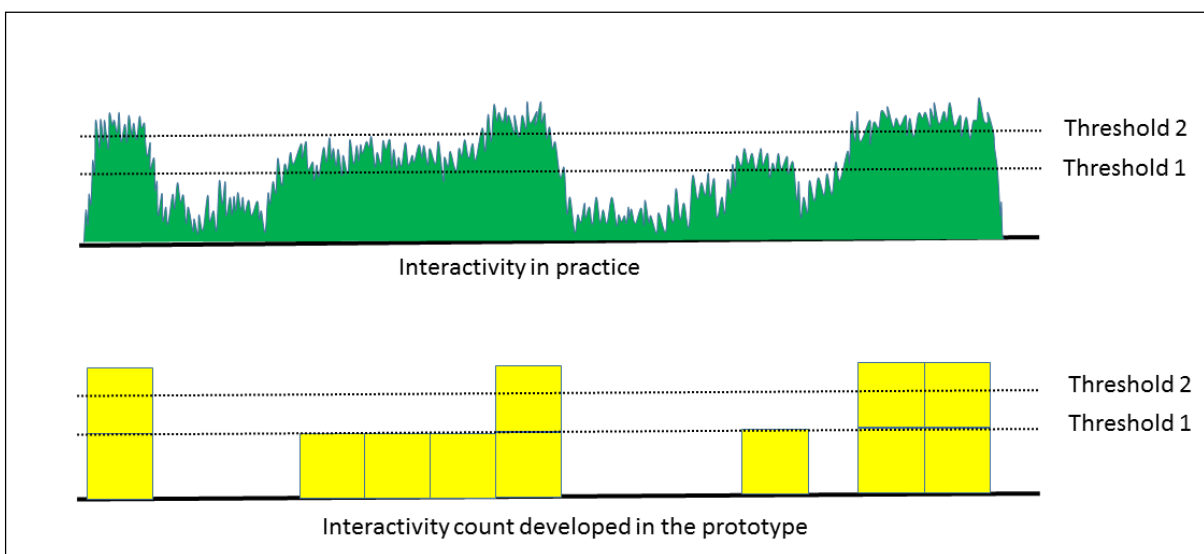


Figure 5.3. The mapping of segments of high interactivity between practice and prototype

For both types of segments, a segment preview will be shown when a learner places the mouse tip over the segment. This dynamic thumbnail allows the learner to preview the segment content. Clicking on the segment will bring the learner into the video view interface and the video will start playing from the point where the segment is. Within the video view, a

learner can click on the segments to navigate around the video. Figure 5.4 depicts the segment navigation feature. The dynamic segment thumbnail allows the learner to preview the video content with more *granularity*. The segment navigation supported *richer interaction with the video content* that can lead to more focused retrieval.



Figure 5.4. Navigating the video to the point of the selected segment

The segmentation of videos through different concepts helps to identify those segments of videos that are most relevant and useful to enable an efficient means to explore and review concepts covered in videos. This is particularly useful for long duration videos that are embedded with multiple concepts which are difficult to locate and explore using the traditional slider tool or fast forward mechanisms. The discussions with the information retrieval experts led to the conception of the video segment container feature. The video segment container is a logical container with which a learner can create to hold and retain useful video segments for viewing and sharing. Figure 5.5 shows the creation of a segment container. A video segment container is first created in the video view. Then the learner can populate the container by “dragging” the selected video segment(s) and “dropping” the segment(s) into the container. Techniques to automatically detect events and select relevant video snippets were developed (Gan, Sun, & Nevatia, 2017). Through the ES, learners may

discover useful segments from different videos. Learners are given the autonomy to select video segments from a multitude of videos using the video segment container feature to create a video for their learning.

The populated video segment container can contain selected segments from more than one video. Through the video segment container interaction page, the learner will be able to see the video resources with which the segments were selected (see Figure 5.6). The selection of segments is currently restricted to the segments containing the concept of interest (blue segments) and segments of high interactivity (yellow segments) in the prototype. More work is required to include the selection of segments containing other concepts into the container.

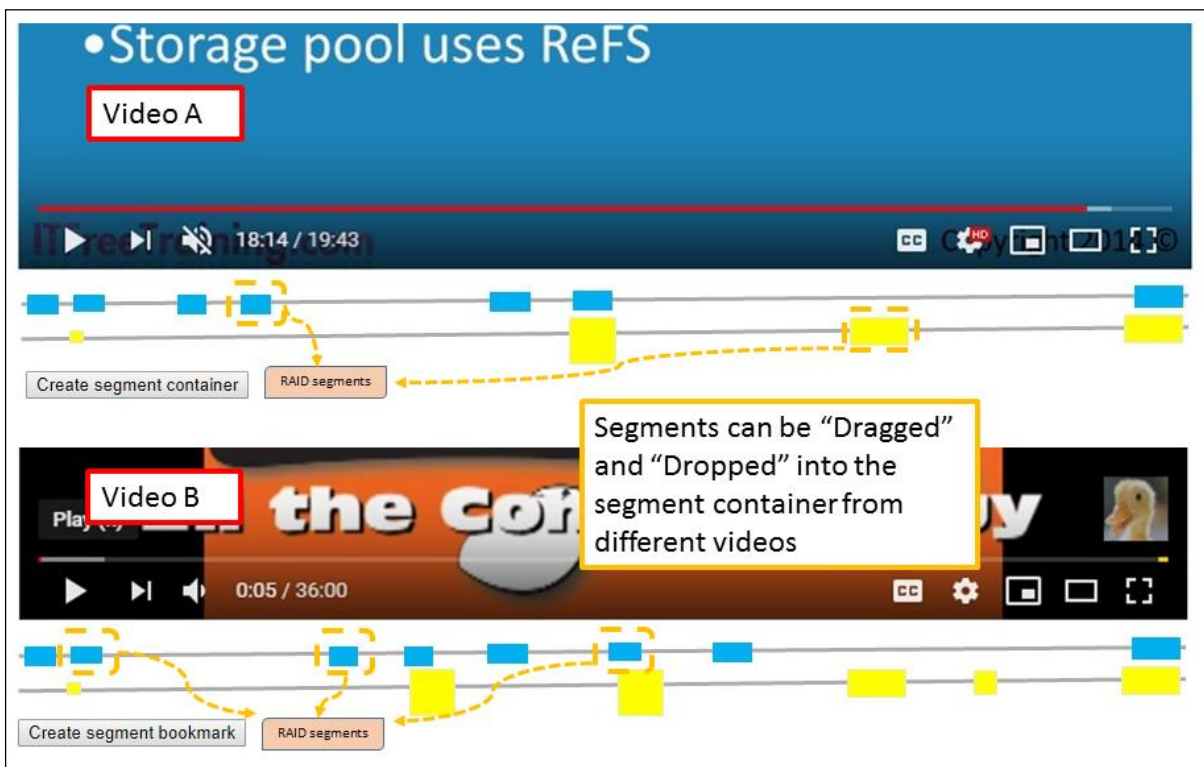


Figure 5.5. Populating the video segment container from two videos

The 'drag' and 'drop' method of populating the segment container may not result in a video with an optimal or logical sequence during playback. The video segments sequence can be reshuffled to the learner's preference using the similar 'drag' and 'drop' technique. Figure

5.6 depicts the change in segment sequence for the video created using the video segment container. This feature uses the design guideline of *granular interaction* and *enriched interaction to discern video content*. The utility to share the user created video segment container through social media creates the potential for the user to seek clarity on the concept of interest, thereby fostering collaborative learning. Inadequacies in the collection of videos can be pointed through sharing, and feedback can be sought to improve on the quality of the collection.

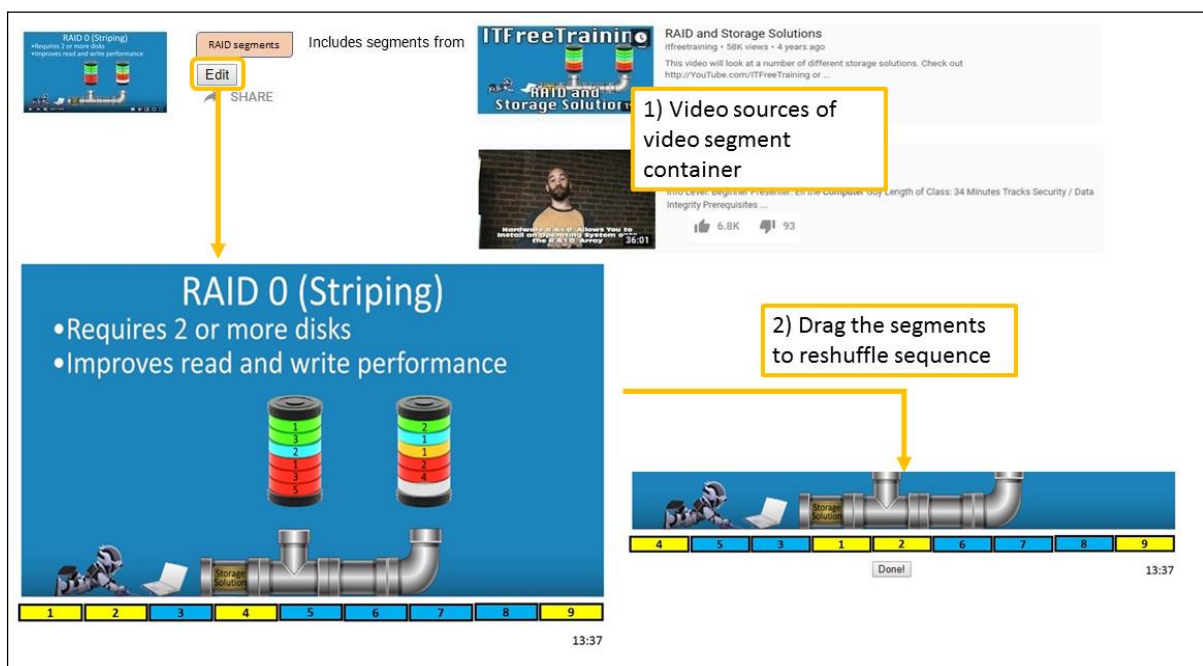


Figure 5.6. Video segment container page and the sequencing of video segments

5.3.3 Metadata group

Resource metadata plays an important in search engine results pages. The types of resource metadata presented and the structure of the results list influence the resource selection (Höchstötter & Lewandowski, 2009; Jackson, Lin, Milligan, & Ruest, 2016). In the development of the conceptual prototype, the types of resource metadata presented were being investigated. Hence, the results list in the conceptual prototype follows the structure of YouTube results list, differing in the type of metadata presented. Azzopardi et al. (2018)

examined the utility of different element types, such as advertisements in the results, images, and news, in the search engine result list while Schymik, Corral, Schuff, and St Louis (2015) showed that when a search was enhanced with metadata, the success rate was improved in an enterprise document search.

The typical metadata found in YouTube's results list includes the video title, brief description, video thumbnail, date uploaded, authorship, length of video and number of views. Most of the metadata is also commonly found in other popular video platforms. In Study 1, the learners demonstrated the socially generated cues and social endorsements had influenced their decision making. Coupled with suggestions from the learners, the space in the results list is optimised to include more metadata so that there is *enriched interaction to discern the video content* to support resource selection. The increased in metadata also support the better *exploration of the relationship between concept and results*. The conceptual prototype included the following in the results list:

1. Highlight of social cue (Likes/Dislike ratio) when threshold is exceeded
2. Dynamic thumbnail for segments containing concept of interest and high interactivity (with mouse-over)
3. Session history numbers (feature to be explained in detail in section 5.3.4)
4. Indicate whether closed-captions are available for the video
5. Comments visualizations (feature to be explained in detail in section 5.3.4)

These metadata and features are integrated into the video play interface. This facilitates the learner to recall the cues used to decide the selection. Figure 5.7 shows the additional metadata in the result list and superimposed with the video play interface. The additional metadata is numbered accordingly.

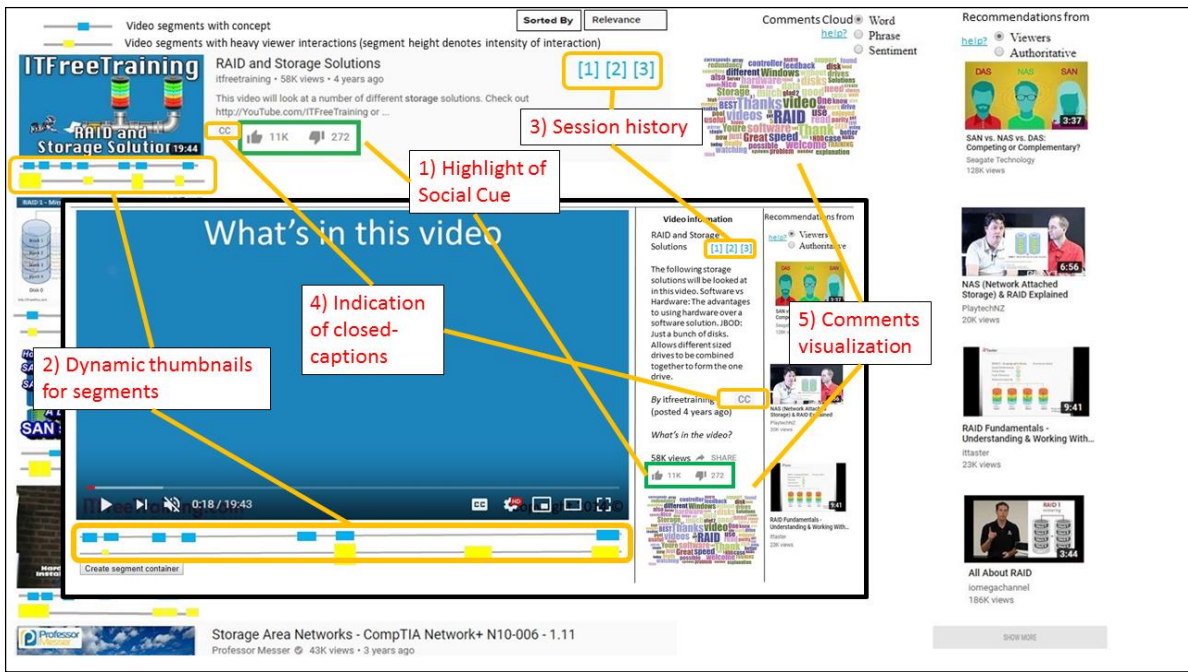


Figure 5.7. Additional metadata included in the results list and video play view

5.3.4 Value-adding group

Some features in a video retrieval environment add value to the ES process. Three value-adding features, 1) session history, 2) comments visualization, and 3) experts and viewer recommendations, were developed for the conceptual prototype.

Search history was used to create personalization in searches (Matthijs & Radlinski, 2011) and improve search accuracy (Tan, Shen, & Zhai, 2006). However, users can often diverge from such search profiles (Eickhoff, Collins-Thompson, Bennett, & Dumais, 2013) such as when performing ES. Search history allows the searcher to recall what was searched previously. By using history within an ES session, users can navigate through concepts that were previously explored and recall the search results for each of the concepts being searched.

At the start of the ES, each search iteration is recorded as a session and assigned with a session number. The session history is displayed at the top right corner of the by the means of the session numbers. This is also indicative of the number of search iterations that a learner

had performed for the ES. The session history for an ES can be cleared clicking on the “Clear History” button, removing all the recorded sessions. The session number(s) may appear beside a video resource in the result list if the video resource had been retrieved in prior search iterations. This is indicative of how many of the searched concepts are included in the video resource. For instance, if there were three search sessions conducted for the ES and the core concept for each session were 1) RAID, 2) SAN, and 3) Parity. The video resource that discussed all the three concepts will be in all the three results list. Then this video resource will have all the three-session numbers presented. For another video that discussed only on ‘Parity’ will have only session number 3 presented. Figure 5.8 shows the session history and the session history numbers indicated in the result list.

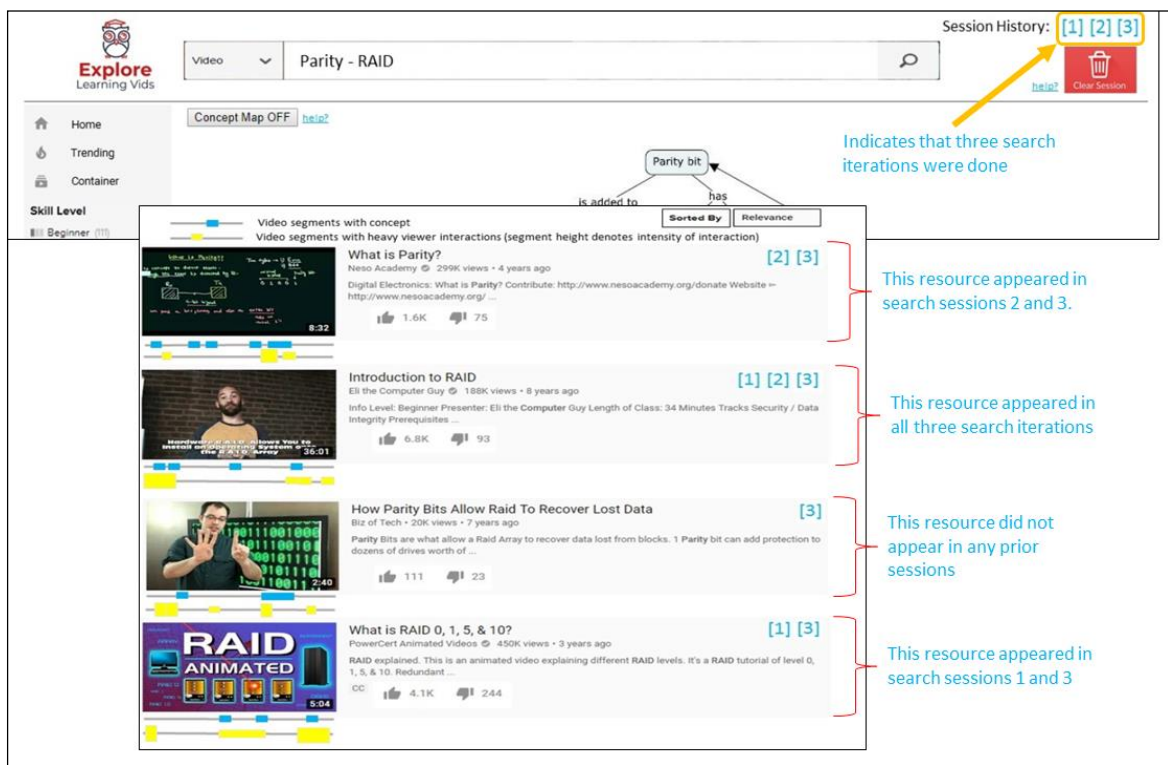


Figure 5.8. Session history and session history numbers for video resources

User commenting is a key facility that leverages on social interconnectivity for communication through the resource. Numerous studies have shown the influence of the

valence in user comments on the resource credibility (Gao, Tian, & Tu, 2015; Waddell, 2018) and used such social comments to make predictions on the content credibility and popularity of various media (He, Gao, Kan, Liu, & Sugiyama, 2014; Kakol, Nielek, & Wierzbicki, 2017). It offers the potential to support decision making for resource selection.

In Study 1, the learners examined socially generated cues as part of the selection process to discern the usefulness and quality of the resource. Social opinions, such as resource comments, are part of the social cues adopted by the learners in the selection process. The learners exhibited concerns over the time and cognitive load spent on the resource comments. Comments visualizations are developed to provide a summary of the comments for the video resource and an indication on the salient points of the comments. Three types of comments visualizations (Word cloud, Phrase cloud and Sentiment meter) for the comments on the video resource are generated for the prototype. The three types of comments visualizations provide different levels of information richness and are integrated with the video resources in the result list. The comments visualization to be displayed can be toggled using the radio buttons located at the top of the result list. The visualization is magnified to give a clearer view when the mouse tip is placed over the visualization. Figure 5.9 presents the three types of comments visualizations that are integrated with the results list.

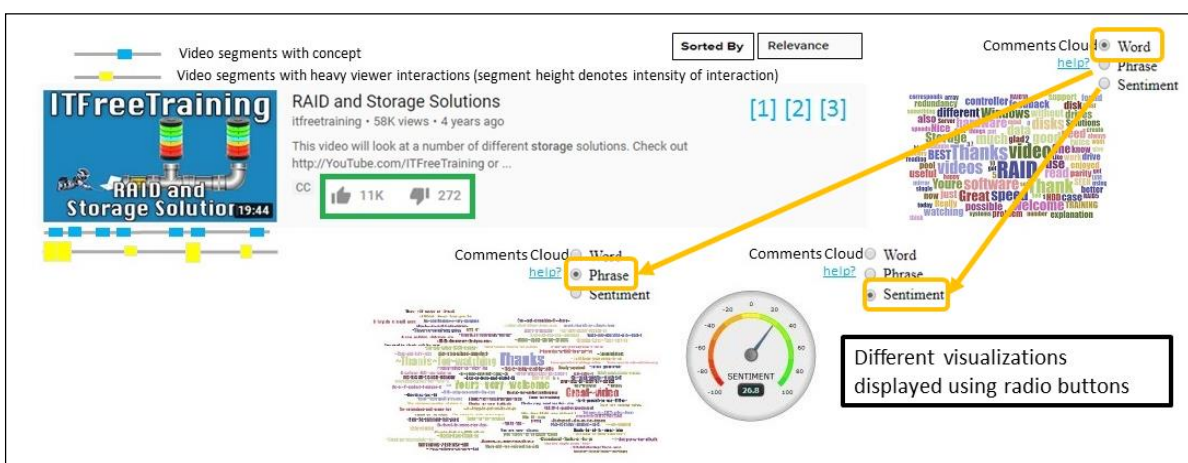


Figure 5.9. A view on the types of comments visualization for a video resource

All the visualizations are generated by aggregating the 100 most recent comments. In this prototype, when the number of comments is less than 100, the space meant for the visualization is left blank. The word cloud shows the commonly mentioned terms in the comments where the frequencies of occurrence determine the size of the word in the cloud. A phrase cloud is similar to that of a word cloud but depicts sentences rather than words. For a phrase cloud, key phrases from the comments are extracted (Zhang, Wang, Gong, & Huang, 2016) and computed based on frequencies of occurrence to determine the size of the key phrase. The sentiment meter allows a quick gauge of the overall sentiment orientation of the comments where a rating of between +100 (very positive) to -100 (very negative) is allocated. The sentiments ratings are obtained by parsing the comments into a web application plug-in such as Daniel Soper's sentiment analyser (Soper, 2019) and Konstanz Information Miner's sentiment classifier (Miner, 2019). The sentiments rating differ from the "Likes/Dislike" social cue as it provides a reading on the valence of the comments while the social cue provides a dichotomous preference of the viewers' preference.

Recommendations have become a staple in many search systems where more personalised content can be discovered. YouTube, a large scale video platform, used a two-stage approach to identify candidate recommendations and rank them to recommend personalized and engaging videos from a large corpus (Covington, Adams, & Sargin, 2016). A recommendation system was developed using various expert identification and selection techniques to provide expert recommendations (Fazel-Zarandi, Devlin, Huang, & Contractor, 2011). Review-based recommender systems analysed consumers' reviews and prioritized the consumers' level of expertise to derive recommendations (Aciar, Zhang, Simoff, & Debenham, 2007).

Multiple sources of recommendations were proposed to allow users wider perspectives of the resources related to the subject of interest. Two types of recommendations are

integrated with the results list. Using similar technique as the review-based recommendations, the first list of recommendations is collated from fellow users of the video retrieval environment searching on a similar topic. Another list of recommendations is from experts as with the expert recommendations system. It is assumed that the recommendations system generating both lists are responsive enough to model updated content as well as incorporate latest recommendations from both groups. The learners can toggle between the two lists of recommendations using the radio button. This feature included in the conceptual prototype based on the design concept of *multi-sources recommendations*.

5.4 General design of conceptual prototype evaluation

The overall objective of the conceptual prototype evaluation was to assess the users' perception and expectations of the concepts and features proposed in this chapter. Through this evaluation, a list of design features that is deemed desirable by users can be derived and recommended to be included for the development of future video retrieval systems for self-directed learning. The evaluation study, Study 3, was designed to address the research objective RO3, *to derive a list of design features to be included in a video retrieval environment based on the evaluation findings*.

5.4.1 Prototype evaluation methodology

A task-based approach was adopted for the prototype evaluation. This involved the user following a task guide to perform an exploratory task on the conceptual prototype. The task guide was designed to ensure that all the aforementioned features were shown or used by the evaluators in a logical manner typical of a real like scenario. This allowed the user to perceive how will the feature be used and interacted in an operational system. At the same time, the users were reminded of the purpose of the evaluation was on the conceptual design considerations throughout the study rather than the actual effectiveness of the features.

A pilot with two polytechnic students was conducted to pre-test the data collection procedure and collection instruments used. The task instructions were updated based on the feedback from the pilot participants on readability and clarity. The pilot study also provided an estimation to the length of the survey.

5.4.2 Participants

The selection and recruitment of participants whose background and abilities should be representative of what the video retrieval environment is intended for. As such, the participants for this study are of the same profile as the participants in Study 1 aged between 16 and 22, currently enrolled in a post-secondary vocational based education. The study adopted purposive sampling, a non-probability sampling approach, as the research did not aim to make generalizations of the results (Etikan, Musa, & Alkassim, 2016) but to explore the opinions and expectations of the participants.

The recruitment of the participants begin upon the approval from the Nanyang Technological University's IRB to implement the study. The IRB approval is found in Appendix 5-1. The recruitment and data collection took place over three months, from April 2019 to June 2019. Recruitment advertisements were distributed to post-secondary institutions in Singapore, namely Nanyang Polytechnic, Ngee Ann Polytechnic and Institute of Technical Education. The advertisement is found in Appendix 5-2. Additionally, more participants were recruited through the word-of-mouth from existing participants and recruitment sessions to students when given the access to the lectures.

5.4.3 Instrumentation and Material

The material and instrument used in the study include the study information sheet and Consent form, task guide and questionnaire. The questionnaire was prepared in Qualtrics and

uploaded into APPLE IPAD for the participants for offline input while the task guide and consent form were in the paper and print format.

Study information sheet and Consent form

The study information sheet and consent form (Appendix 5-5) contained brief information about the study, including objective and procedure. It also explained the participant rights, confidentiality of personal records, contact information and the form of compensation in the participation. The last part of the form was to obtain the participant's consent and parental consent if the participant is below the age of 21.

Task guide

ES in this study is defined through two aspects by using search tasks. Firstly, ES is triggered by setting the task in an advanced topic in the domain of information technology. This ensured that the ES task is unfamiliar to the participants. Although some of the participants are enrolled in courses related to information technology, the topic in the task guide is of an advanced level beyond the curriculum of the course. Secondly, the ES needed to encompass investigative activities and involves learning where knowledge is increased, allowing the search to evolve. The interaction guided by the task guide enables investigation of the advanced topic through several ES strategies.

The task guide needs to support the ES strategies in the execution of the ES task on the conceptual prototype in the form of a cognitive walkthrough. Using a conceptual prototype can limit the type of ES strategies that can otherwise be freely explored and used by them. While the participants were guided through the ES process which could have inhibited the use of some preferred strategies, nevertheless, the participants were reminded to turn their focus on how they think the features can affect the ES scenario.

Hence, the task guide (Appendix 5-3) was created to provide the exploratory search task scenario and the step-by-step instructions for using the features of the video retrieval environment when completing the search task. The search task scenario was created for the participants to form an impression on ES for learning. This is followed by a list of features to be encountered through the search process, and the series of steps to complete the search task.

The participant begins the task with a search query in the query text box. The first feature, the concept map will be displayed as shown in Figure 5.10. The concept map further reveals concept snippets when the participant hovers the mouse over the concept bubble. The participant then navigates to a related concept using the concept map by clicking on the concept. The participant is then asked to interact with the session history using the session links.

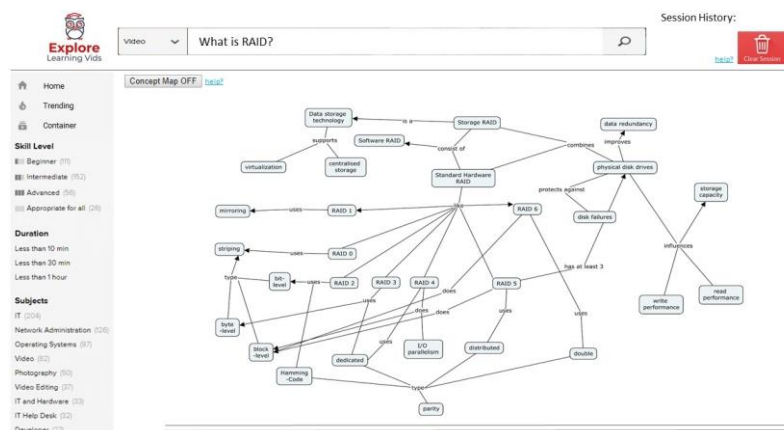


Figure 5.10. The display of the concept map

The task moves on to the next group of features relating to the examination of the result list. The participant first interacts with the Concept video segment (blue), including the navigation to video segment and segment preview. The participant then repeats the interaction for the View Count video segment (yellow). Figure 5.11 shows the two types of video segments in the prototype. The participant then proceeds to examine the three types of video comments visualizations.

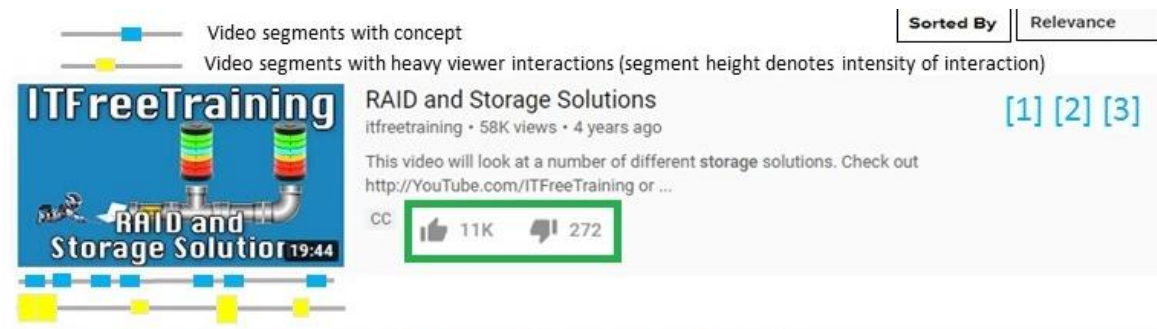


Figure 5.11. The Concept and View Count video segments

The final part of the task includes the customization of the video segments and the creation of segment containers. This part of the task allows the participant to choose the relevant video segments from a variety of videos and put the segments into a container (see Figure 5.12.).



Figure 5.12. Video segment container that has video segments from two videos

Questionnaire

The participant questionnaire (Appendix 5-4) was designed to be used together with the task guide to gather background information and the experience over the usage of the features in performing an ES task. The first part of the questionnaire finds out the participants' background information, such as gender, age and the course that they are enrolled in. They were also asked to rate their experience with video retrieval systems using a 7-point Likert-like scale. Such information allowed the creation of profiles for the participants in the evaluation setting.

The second part of the questionnaire consisted of a set of questions to be done in conjunction with the task guide. The participants were asked to rate their perception on features based on the ease of use, the related functionalities, the importance of the feature in the success of the search task, and the likely intention to use. A 5-point Likert-like scale (1-Strongly disagree, 2-Somewhat disagree, 3-Neither agree nor disagree, 4-Somewhat agree, 5-Strongly agree) was employed to measure the participant's responses. Items rated with a lower score represents a bias towards disagreement while higher rated items represented a tendency towards agreement. The participants can optionally provide qualitative comments on what do they like or do not like about the feature. Where appropriate, the participants were asked to rank their preference for certain variants of the features.

5.4.4 Data collection

Appointments were scheduled with the participants who responded to the recruitment of the study and the study information sheet and consent form were sent to the participants upon the confirmation of an appointment. The participants were requested to read the study information sheet and complete the consent form prior the appointment. The data were collected at the participants' respective institutes upon scheduled appointments.

The participant consent form was collected from the participant at the start of the session. The participant was briefed on the study procedure as well as the instruments and material used in the procedure. There was a maximum of two participants for each session. The web-based conceptual prototype was deployed onto two laptops and two IPADs were used for the questionnaire. For sessions with two participants, they were requested to sit separately and performed the procedure independently. The participant was presented with the laptop, IPAD and the task guide and proceeded with the evaluation through the instructions found on the task guide and questionnaire at his or her own pace. The researcher was onsite to

answer any queries from the participant. The whole procedure took about 60 to 90 minutes to complete. Upon the completion of the survey, the researcher checked that the responses for all the questions were collected.

5.4.5 Data analysis procedure

The data was stored locally in the IPADs and uploaded into Qualtrics cloud (password protected) at the end of each data collection day and subsequently downloaded in IBM SPSS format for processing. At the closure of the data collection phase, all the data collected was downloaded in the IBM SPSS format.

The quantitative data measuring the participants' perceptions on the features was analysed through descriptive statistics. The mean and standard deviation was computed as measures of central tendency. Agreement percentage for each of the Likert-like scale was computed as part of the descriptive statistics. The response values of 'Strongly agree' and 'Somewhat agree' were considered for the calculation of agreement percentages. These descriptive statistics represented the participants' perception, acceptance and satisfaction with regards to the features to support exploratory video search for learning. This forms the basis to support the design guidelines for a video retrieval environment for a learning context.

The qualitative comments were exported into MS Excel for thematic analysis (Braun & Clarke, 2006). The thematic analysis of the subjective descriptions from the participants served to report their experiences and perceptions as they encounter the features. The unit of analysis for the coding was identified as a meaning unit, similar to that of Study 2. The qualitative comments for each feature were coded and placed into themes. Similar to that in Study 2, coding of textual data would require some degree of interpretation for meaning to emerge. The comments in this study were substantially shorter and focused, affording less

room for subjective interpretation. The comments were coded iteratively to help ensure that the coding scheme is consistent. This complemented the results from the quantitative analysis.

5.5 Summary

Prior studies resulted in a set of design guidelines and potential features for a video retrieval environment to support exploratory video searches. Discussions with two information retrieval experts were conducted to ruminate the design concepts and potential features and a resultant set of features were derived. These features are proposed to mitigate challenges faced by learners in their ES and better support the ES for learning videos. This set of features constituted to the solutions for the second and third research questions which is to find the video retrieval features that mitigate the challenges and better support learners in exploratory video searches for learning videos. A web-based video retrieval prototype was developed that conceptually portrayed the set of features. It is a web-based platform consisting of a series of mock-ups that follow through the exploratory video retrieval process. Study 3, an evaluation of the set of features was conducted with adolescent learners using task walk-through to derive the set of features that needs to be included in a video retrieval environment. The results of the evaluation are presented in the next chapter.

CHAPTER SIX – STUDY 3: USER PROTOTYPE EVALUATION FINDINGS

6.1 Introduction

This research sought to understand how post-secondary learners performing ES on a video retrieval environment could be enhanced through a set of tools and features. The overall objective of the conceptual prototype evaluation was to assess the users' perceptions and expectations of the concepts and features conceived in the previous chapter. Through this evaluation, a list of design features that are deemed essential and desirable by users can be derived and be included in future video retrieval environment.

This chapter presents the results of the evaluations carried out in Study 3. The profile of the participants is presented first. Then the findings and results are presented in the same grouping introduced in Chapter 5. This chapter is restricted to the presentation and analysis of the evaluation data without drawing conclusions. The discussion of the findings within the context of prior literature is presented in the Chapter 7.

6.2 Evaluation results and findings

The section starts with a presentation of the participants' profile. The results are presented in logical groupings of the features as shown in Table 6.1. The descriptive statistics for the features are then presented. Qualitative comments were summarised thematically to corroborate the descriptive statistics on the participants' preferences and opinions on the features.

Table 6.1. Logical grouping of features for results reporting

Feature	Logical grouping	Description
Concept map	Concept Map	Features related to utility of the concept map.
Concept snippets		
Concept map navigation		
Video timeline – Segments for Concept of interest	Granular interaction	Features that uses video segmentation.
Video timeline – Segments for high interactivity		
Video segment container		
Video information – Results list	Metadata	Features related to the utility of video metadata.
Video information – Video view		
Session history	Value adding	Features that add value to the video seeking process.
Visualization of video comments		
Recommendations		

6.2.1 Participants' profile

Based on the recruitment process outlined in Section 5.4.2 of Chapter 5, a total of 89 respondents were approached for the study. Subsequently, 85 participants completed the face-to-face evaluation sessions conducted by the researcher. The average time for the data collection is 65 minutes. There were 43 male participants (50.6%) and 42 female participants (49.4%). Majority of the participants (57 or 67.1%) were enrolled in a polytechnic course. The participants were enrolled in a wide range of courses with more than half of the participants (49 or 57.6%) enrolled in STEM courses. Table 6.2 shows the breakdown of the participants by the course that they were enrolled in. Appendix 6-1 presents the participants' profile summary.

Table 6.2. Breakdown on the number of participants by course

	Course	Number
Non-STEM	Accountancy/Finance	5
	Business Studies	11
	Customer Experience Management	1
	Early Childhood Education	6
	Finance Services	2
	Hospitality Operations	2
	Interaction Design	1
	Mass Communications	4
	Supply Chain Management	1
	Tourism and Resort Management	3
	Sub-total	36
STEM	IT Application Development	2
	Biomedical Engineering	3
	Business/Financial Informatics	5
	Common Engineering Program	1
	Computer Engineering	3
	Cyber and Network/Infocomm Security	8
	Digital Audio, Video Production	1
	Digital Game Art and Design	1
	Electronics Engineering	5
	Energy Systems and Management Engineering	3
	Control and Automation Engineering	1
	Games Programming and Development	1
	Information/Multimedia/Network Technology	10
	Optometry	1
	Veterinary Technology	4
	Sub-total	49
Total		85

Most of the participants reported that they were familiar, proficient and comfortable in using video retrieval platforms. In a 7-point Likert-like scale, the mean scores of 5.92 (familiar), 5.49 (proficient) and 5.89 (comfortable) were recorded. 95.3% of the participants had at least “*somewhat agree*” that they were familiar with video retrieval platforms. There were 89.4% of the participants had at least *somewhat agreed* that they were comfortable with video retrieval platforms and 87.1% of the participants had at least *somewhat agreed* that they

were proficient. All the participants had used YouTube with 78.8% of them accessing YouTube daily.

6.2.2 Concept Map group

The features in the Concept map group consist of the Concept map, the Concept snippet and navigating the search using the concept map. Table 6.3 lists the mean score, standard deviation and percentage agreement for the Concept map group. There was a missing response to one of the questions. Imputation was not considered for this instance as the exclusion did not reduce the amount of response significantly.

Table 6.3. Descriptive statistics and agreement percentage for the Concept map group

	Mean (SD)	Percentage Agreement/Disagreement				
		Strongly Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Strongly Disagree
Concept Map						
Is easy to use.	4.45 (.61)	49.40 ^a	47.10	2.40	1.20	0.00
Enables me to explore the domain of interest.	4.59 (.58)	63.50	31.80	4.70	0.00	0.00
Allows new information to be discovered.	4.67 (.57)	70.60	27.10	1.20	1.20	0.00
Is useful for my learning.	4.53 (.63)	58.80	36.50	3.50	1.20	0.00
Can help me formulate new search queries.	4.51 (.70)	60.00	32.90	4.70	2.40	0.00
Is important in the success of the search task.	4.14 (.73)	32.10	52.40	13.10	2.40	0.00
I intend to use this feature to search for videos for my learning.	4.20 (.77)	40.40	41.20	17.60	1.20	0.00
Concept Snippet						
Enables me to understand the concepts in domain of interest.	4.74 (.47)	75.30	23.50	1.20	0.00	0.00
Allows new information to be discovered.	4.75 (.43)	75.30	24.70	0.00	0.00	0.00
Is useful for my learning.	4.76 (.55)	81.20	15.30	2.40	1.20	0.00

Can help me to formulate new search queries.	4.51 (.63)	55.30	42.40	0.00	2.40	0.00
Is important in the success of the search task.	4.56 (.65)	64.70	27.10	8.20	0.00	0.00
I intend to use this feature to search for videos for my learning.	4.51 (.63)	57.60	35.30	7.10	0.00	0.00
Concept Map Navigation						
Enables me to explore the domain of interest effectively.	4.82 (.38)	82.40	17.60	0.00	0.00	0.00
Allows new information to be discovered.	4.82 (.46)	87.10	9.40	3.50	0.00	0.00
Is useful for discovering new videos for learning.	4.80 (.43)	81.20	17.60	1.20	0.00	0.00
Is important in the success of the search task.	4.75 (.49)	77.60	20.00	2.40	0.00	0.00
I intend to use this feature to search for videos for my learning.	4.72 (.55)	76.50	18.80	4.70	0.00	0.00

^aHighest agreement percentage is bolded

The participants responded favourably to the questions for the Concept map grouping. The mean score for all the questions was above 4.1. There was no *Strongly Disagree* scores in this group. All the questions had the highest percentage (highlighted in bold) for *Strongly Agree*, except for two questions for the Concept map feature. This was evident as the participants found the features in this group to be useful and are important in the success of an ES task. Highest agreement percentages were obtained for the Concept Map navigation feature with the *Strongly Agree* percentage ranging from 76.50% to 87.10%.

Concept Map

The participants generally felt positive over the utility of the Concept map in exploring the domain of interest, discovery of new information, and formulation of new search queries, with the agreement percentage of 95.30%, 97.70% and 95.30% respectively. This was supported by the subjective comments provided by the participants. Appendix 6-2 shows the themes derived for the concept map group and corresponding sample quote(s) for the theme.

A total of 213 comments were collected for the concept map feature. For this feature, the participants liked its utility to support query formulation (29.6% of the total comments for this feature), domain exploration (22.5%) and ease in usage (7.0%). The Concept map was able to support query formulation through *helping the participants understand the domain* (25 instances), *extend beyond the domain* (19 instances), *being informative* (10 instances) and *ideas creation* (9 instances).

The Concept map presents associated concepts and shows how the concepts are related. This improved the understanding of the domain as highlighted by P60, '*It shows information that is related to the thing that I am searching which allows me to better understand the concepts and how they are related*'. P5 felt that the Concept map helped in extended the domain by '*widening the search radiuses*'. The Concept map was informative as explained by P83, '*The concept map is pretty detailed with its information which enables people with zero knowledge to understand the basics*'. The Concept map provided a topic overview (P47) and helped in organizing information (P17). Participant P58 responded that the feature aided in domain exploration as it showed different related nodes and this created a summary of the domain of interest. This utility was further attributed in creating a virtual boundary for exploration that could otherwise overwhelm the learner without one (P74). Such an overview provided a context for the search (P41) and handles synonyms (P67). Participant P46 felt that the use of the Concept map would be helpful in exploratory work.

However, while they had strong agreement with what the feature can help them learn and extend the knowledge on the topic, they had only somewhat agreed that this feature was important to the task success (52.40%). While the 96.50% of the participants agreed (sum of *Strongly Agree* and *Agree* percentages) that Concept map feature was easy to use, the intention to use this feature to search for videos for their future learning was lower (81.20%) or was undecided whether to use this feature (17.20%). Participant P44 commented that the

Concept map feature's simplicity and ease of use made it suitable for novice users. The ease of use was attributed to how the Concept map relates the main concept of interest to related concepts visually, aiding in the exploration and understanding of the domain of interest.

For the Concept map, the participants felt that the maps were messy (20 instances), confusing (16 instances), complex (13 instances) and cluttered (5 instances), resulting in *poor map presentation* (25.3% of the total comments for this feature). They commented that the concept map had a *low level of informativeness* (7.5%), had *weak map structure* (4.2%) and *did not consider user characteristics* (3.8%). Participant P42 commented that he would appreciate more information to handle unknown terms that were encountered in the Concept map. Improving the presentation of the Concept map may yield better usability of the feature and improve the intention to use. Confessed to being a visual learner, participant P43 felt that the Concept map is too wordy and visuals in the form of pictures can complement the concept map for better exploration of the domain. Participant P85 further mentioned about the lack of consideration of the user's initial knowledge may impede the usefulness of this feature.

Concept Snippet

The Concept snippet feature held favourable responses with more than half of the participants selecting *Strongly Agree* for all the questions. They particularly *strongly agreed* that the Concept snippet was able to help them in their learning (81.20%), allowing new information to be discovered (75.30%) and enable them to understand the concepts (75.30%). There was no disagreement from the participants on Concept snippet being able to support the discovery of new information. This resulted in an agreement percentage of 92.90% for the intention to use this feature with the remaining 7.10% of the participants staying neutral with their intention.

A total of 145 comments were collect for the concept snippet feature. Participants provided 59 comments (or 40.7% of the total comments for this feature) on how the use of the Concept snippet could *improve the understanding of the search domain*. The participants found the concept snippet *easy to use* (24.8%) and *helps extend the search* (7.6%). Participant P12 felt that with the Concept snippet, he could quickly discern if that was something relevant to what he needs to know. Participant P4 welcomed the convenience for not having to “Google” for the definitions. It helped that bite-size definition was used in the Concept snippet as it was easy to digest (P16). This feature helped the participants in extending the search through the discovery of concepts (P25) and extension of ideas (P78).

However, the participants felt that the concept snippet has a *low level of informativeness* (12.4% of the total comments for this feature), *did not consider existing user knowledge* (9.0%) and *needs improvement in interaction* (5.5%). The views from the participants in terms of the level of informativeness were divided. While there were participants who felt that the level of information was positive, some participants felt that some form of context (P79) could enhance the informativeness of the feature. This had suggested the consideration of current user knowledge as some participants cited the snippets could be too wordy (P53), confusing (P18) and need some form of support (P6). There were suggestions to improve the level of interaction with the Concept snippet such as having more control over the display (P50), highlighting of the boundary (P13) and inclusion of other resources (P24).

Concept Map Navigation

The Concept map navigation had high mean scores of at least 4.72 across all the questions and had no disagreement percentage for this feature. They particularly felt that this feature allowed them to discover new information ($M=4.82$, $SD=0.46$) and had 87.10% of the participants responding to *Strongly Agree*. There was 100% agreement that this feature had

enabled the participants to explore the domain of interest effectively. The overall high agreement percentages had led to the agreement percentage of 95.30% for the intention to use among the features in this group.

A total of 113 comments were collated for the concept map navigation utility. The concept map navigation provided a context for the search (44.2%) and allows the participants to extend exploration of the domain (22.1%) through the provision of an information structure (4.4%) for the domain of interest. The participants, however, felt that navigation may be confusing (9.7%).

All the participants agreed or felt neutral when asked about the importance of the Concept snippet and Concept map navigation to the success of the ES task. This suggested the significance of these features in the ES task. This was supported by the null disagreement percentages for the intention to use question.

6.2.3 Granular interaction group

The features in the granular interaction group consist of segments with the concept of interest in the video timeline, segments with high interactivity in the video timeline and video segment container. Table 6.4 lists the mean score, standard deviation and percentage agreement for the Granular interaction group.

Table 6.4. Descriptive statistics and agreement percentage for the Video segment group

	Mean (SD)	Percentage Agreement/Disagreement				
		Strongly Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Strongly Disagree
Video timeline – Segments with concept of interest						
Is easy to use.	4.67 (.52)	69.40 ^a	28.20	2.40	0.00	0.00
Enables me to locate segments of interest easily.	4.88 (.36)	89.40	9.40	1.20	0.00	0.00
Helps me to identify important video.	4.88 (.36)	89.40	9.40	1.20	0.00	0.00
Allows me to make an assessment of the video.	4.66 (.63)	72.90	21.20	4.70	1.20	0.00
Helps me to select videos for the search task.	4.64 (.57)	67.10	30.60	1.20	1.20	0.00
Is important in the success of the search task.	4.56 (.68)	64.70	29.40	3.50	2.40	0.00
I intend to use this feature to search for videos for my learning.	4.68 (.64)	75.30	20.00	2.40	2.40	0.00
Video timeline – Segments with high interactivity						
Is easy to use.	4.51 (.67)	58.80	34.10	5.90	1.20	0.00
Enables me to locate segments of interest easily.	4.20 (.81)	40.00	43.50	14.10	1.20	1.20
Helps me to identify popular video segments more easily.	4.65 (.74)	75.30	17.60	4.70	1.20	1.20
Allows me to make an assessment of the video content more easily.	4.01 (.93)	35.30	37.60	21.20	4.70	1.20
Helps me to select videos for the search task	3.98 (.98)	35.30	36.50	20.00	7.10	1.20
Is important in the success of the search task.	3.81 (1.09)	32.10	32.10	23.80	8.30	3.60
I intend to use this feature to search for videos for my learning.	4.81 (1.11)	32.90	30.60	25.90	5.90	4.70
Video Segment Container						
Enables me to remember useful video segments.	4.86 (.38)	87.10	11.80	1.20	0.00	0.00
Allows me to create suitable videos for my learning.	4.80 (.43)	81.20	17.60	1.20	0.00	0.00
I intend to use this feature to search for videos for my learning.	4.69 (.60)	76.50	16.50	7.10	0.00	0.00

^aHighest agreement percentage is bolded

Video timeline – Segment with concept of interest and Segment Container

The participants responded favourably to the questions for video segments with the concept of interest and video segment container, with all the questions scoring mean scores above 4.56. There was no *Strongly Disagree* score for these two features. Both of the features had the highest percentage for *Strongly Agree*. The participants agreed strongly that the segmentation for the concept of interest allowed them to locate the segments of interest easily (M=4.88, SD=0.36) (89.40%) and allowed them to identify important videos (M=4.88, SD=0.36) (89.40%).

This was corroborated by the comments given by the participants on the segment with the concept of interest and segment container. The themes derived from the qualitative analysis of the participants' comments for the granular interaction group are summarised in Appendix 6-3. A total of 149 and 114 comments were collated for the segment with concept of interest and segment container features respectively. For the segments with concept of interest feature, the participants felt positively for the utility to *identify the video coverage* (35.6% of the total comments for this feature), efficient *utility* (30.3%) and the ability for *in-video navigation* (13.1%). For the video segment container, the participants appreciated the *autonomy in selection of learning video segments* (50.0% of the total comments for this feature) and the *management of video segments* (24.6%).

The participants appreciated the level of granularity offered by video segments to identify the video coverage. The segmentation of concepts allowed participants to identify important segments (P69) and pinpoints focal information within the video (P19). This aided in locating relevant content and helped the participants to identify the video coverage better, supporting the quantitative finding. The in-video navigation using the concept segments supported locating specific concepts and topics covered in the video. P36 felt that this feature

allowed him to examine the topic of interest with ease and need not spend the effort on unrelated or unimportant parts within the video.

Although still responding favourably, the participants felt that the segments with the concept of interest feature are less useful in helping them in selecting videos for the search task (67.10%). While only 64.10% of them strongly agreed that this feature is important for the search task only 75.30% of them had strong intentions to use this feature in the future.

There was no disagreement percentage for the video segment container feature. The participants felt strongly that the video segment container to be useful in helping them remember useful video segments (87.1%) and had strong intentions to use this feature to search for learning videos (76.5%). When asked if the segment container feature allowed the participants to create a suitable video for learning, more than 98% of the participants responded positively.

Video timeline – Segment with high interactivity

The segments with high interactivity gather the least favourable responses in the granular interaction group. This feature had the highest agreement percentage across *Strongly Agree* and *Somewhat Agree*. Although the participants felt *strongly* that this feature allowed them to identify popular video segments (75.30%), the feature is less likely (*somewhat strongly*) to help them locate the segments of interest (43.50%). This 32.90% of the participants had strong intentions to use this feature to search for learning videos.

This feature gathered a total of 102 comments. The participants had various opinions on the utility of the segments with high interactivity. For the segments with high interactivity, the participants liked the feature for *revealing various video segments* (31.4% of the total comments for this feature), *exploring through other perspectives* (27.5%) and *supporting video selection* (6.9%). Among those participants who liked the feature for revealing various

video segments, many felt these were useful segments (21 instances) that reveal salient parts of the video while some felt that these segments were popular (9 instances). P3 commented on the high view counts increases his interest to view the particular segment of the video while P51 felt that '*potential problem areas*' of the topic could be identified through this feature.

The negatives

Poor presentation and usage was the common negative theme across the features in this group. The participants were also concerned over the *inadequacies in segment identification* for the video timeline features. Also, the participants were *doubtful over the utility of segments* with high interactivity (17.6% of the total comments for this feature). Different levels of trust were observed over the participants on the identification of segments. While some participants felt that the segment features enabled them to locate relevant segments, other participants expressed concerns over missing important information with the reliance of segment features. Some of the comments made by the participants were:

'It might missed out information of the key word that I am searching for before the blue bar for example, and this might reduce my understanding of the concept I'm searching for.' (P60)

'It helps save time but there is still the fear that information may be missed out.' (P76)

'This feature can be a potential drawback as people can simply write scripts or make playlists and leave devices replaying to make the whole video have high user interaction. This defeats the purpose of such a feature.' (P12)

There were 17 instances (or 14.9% of the total comments for this feature) recorded on *poor usability* for the segment container function. This was attributed to the steep learning

curve (4 instances) and complexity in usage (13 instances). P10 was concerned with the use of drag and drop technique, which can be complicated to use and difficult to undo mistakes.

Other participants felt the need for a richer utility such as renaming of the container and include transitions between segments collected.

6.2.4 Metadata Group

The features on the Metadata group consist of video information in results list and video information in video view. Table 6.5 lists the mean score, standard deviation and percentage agreement for the Metadata group.

Table 6.5. Descriptive statistics and agreement percentage for the Metadata group

	Mean (SD)	Percentage Agreement/Disagreement				
		Strongly Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Strongly Disagree
Video information – Results list						
Enables me to know what others feel about the video.	4.68 (.49)	69.40 ^a	29.40	1.20	0.00	0.00
Allows me to make an assessment on the suitability of the video before viewing the video.	4.44 (.78)	57.60	31.80	7.10	3.50	0.00
Helps me to know the quality of the video content more easily before viewing the video.	4.44 (.82)	60.00	27.10	10.60	1.20	1.20
Help me to select videos for the search task	4.41 (.70)	51.80	38.80	8.20	1.20	0.00
Is important in the success of the search task.	4.29 (.83)	48.20	36.50	12.90	1.20	1.20
I intend to use this feature to search for videos for my learning.	4.45 (.76)	60.00	25.90	12.90	1.20	0.00
Video information – Video view						
Enables me to recall to why the video is selected.	4.42 (.78)	56.50	32.90	7.10	3.50	0.00
Allows me to make an assessment on the suitability of the video before viewing the video.	4.25 (.71)	38.80	48.20	11.80	1.20	0.00

Helps me to know the quality of the video content more easily.	4.11 (.91)	36.50	44.70	15.30	0.00	3.50
Is important in the success of the search task.	4.20 (.88)	46.40	31.00	19.00	3.60	0.00
I intend to use this feature to search for videos for my learning.	4.29 (.83)	50.60	30.60	16.50	2.40	0.00

^aHighest agreement percentage is bolded

Video information in results list

The participants responded favourably to the video information in the results list, with a mean score of at least 4.29 and had agreement percentage from 84.70% to 98.80%. *Strongly Agree* gathered the highest agreement percentage for all the questions under this feature. The typical SERP format was retained in the presentation of the metadata. The participants felt that the video metadata in the results list enabled them to know what others felt about the video, gathering the highest agreement percentage of 98.8%.

The social cue and social endorsement included the result list, such as the “Like” and “Dislike” votes and the comments visualization had been perceived as sufficient to serve the purpose of informing about other’s opinion. The metadata included in the result list had gathered 90.60% of their responses distributed over *Strongly Agree* and *Agree* in supporting the participants in selecting the videos for the search task. While still recording a positive agreement percentage of 84.70%, the participants felt that the video information found in the results list were less important to the task success ($M = 4.29$, $SD = 0.83$).

This feature collated a total of 136 comments. Among the *positive metadata* (44.1% of the total comments for this feature), the participants appreciated the presence of social cues (33 instances) in the results list as the social cues provided a clear representation of other viewer’s opinions on the video (P62). Appendix 6-4 shows the themes for the qualitative comments for the metadata group. Presenting and highlighting the Like/Dislike count in the results list was deemed interesting and guided in the video selection (P70). The indication of

the availability of closed caption (20 instances) for the video resource was another positive metadata. The metadata presented can *influence the perception* (21.3%) of the participants on the video. This supports video selection (12 instances), helps in video assessment (11 instances) and allowed the participants to learn about the video (6 instances).

Video information in Video view

The video information in the video view had recorded favourable responses with a mean score of at least 4.11 and had agreement percentages from 77.40% to 89.40%. While the types of video information were the same from that found in the results list, the agreement percentage was lower for the common questions between the two metadata group features. More than half of the participants *strongly agreed* ($M = 4.42$, $SD = 0.78$) (56.50%) that the video information found in the video view had enabled them to recall why they had selected the video. Less than half of the participants *agreed* ($M = 4.11$, $SD = 0.91$) (44.70%) that this helped them in knowing the quality of the video content more easily, with 3.50% of the participants *Strongly Disagreeing*.

The use of social cues and learn more about the video so that videos can be selected from the results list corroborated the high percentage agreement obtained from the participants' responses. A total of 101 comments were collected for this feature. The participants liked the metadata presented in the video view for *supporting video assessment* (22.8% of the total comments for this feature) by enabling them to recall the reasons for selecting the video for watching (18 instances) and aids in the perception of video quality (4 instances). The metadata allowed P54 to gauge the quality of the video, '*It allows me to me to know the quality of the video and the effectiveness of it after I watched it and it will help me in my studies after I watch the video and I know that I am on the right track*'. The participants liked the *video information* (29.7%) in the video view as they felt that it provided a summary

of the video (15 instances) and was informative (9 instances). Adopting the look and design from YouTube, the participants were happy with the *familiar interface and layout* (6.9%) of the video view.

The negatives

However, some participants expressed their doubts over the veracity of the social metadata. Some participants highlighted that social cues may not reflect the usefulness of the video. As P58 commented, '[social cues] *might not be a fair representation of videos in a sense that not all viewers might rate videos so even if some videos have great contents, viewers might not rate it and this leaves the videos at the bottom ranking*'. There was also more metadata desired by the participants, such as the indication of language available, inclusion of more detailed video description and the utility to perform annotation. Not all the participants liked the highlight of the "Like/Dislike" votes as it could be distracting and can overwhelm new users (P41, P56). Similarly, the video information in the video view was deemed overwhelming by some participants (27.7% of the total comments for this feature). They did not like the placement of the metadata (15 instances) as it was messy and had too much metadata (9 instances) that can be confusing.

6.2.5 Value-adding group

The features in the value-adding group consist of session history, visualization of video comments and expert and viewers recommendations. Table 6.6 lists the mean score, standard deviation and percentage agreement for the Value-adding group. The features with multiple options were indicated by their acronyms in the column header.

Session history

The participants responded positively to the session history feature, with all the questions recording mean scores above 4.36. There was high agreement (93.00%) on the utility of the session history to recall previous searches ($M=4.55$, $SD=0.76$). All participants agreed (85.90%) or felt neutral (14.10%) about the session history feature is important to the success of the search task. This was supported by the comments given by the participants. Appendix 6-5 shows the themes derived from the participants' comments for the features in the value-adding group.

Table 6.6. Descriptive statistics and agreement percentage for the Value adding group

	Mean (SD)			Percentage Agreement/Disagreement														
				Strongly Agree			Somewhat Agree			Neither Agree nor Disagree			Somewhat Disagree			Strongly Disagree		
Session history																		
Is easy to use.	4.53 (.72)			62.40 ^a			31.80			2.40			3.50			0.00		
Enables me to recall my previous searches effectively.	4.55 (.76)			67.10			25.90			2.40			4.70			0.00		
Is important in the success of the search task.	4.36 (.72)			50.60			35.30			14.10			0.00			0.00		
I intend to use this feature to search for videos for my learning.	4.45 (.85)			63.50			21.20			12.90			1.20			1.20		
Visualization of comments	¹ WC	PC	SM	WC	PC	SM	WC	PC	SM	WC	PC	SM	WC	PC	SM	WC	PC	SM
Enables me to know what others feel about the video.	4.19 (.95)	4.22 (.71)	4.52 (.67)	45.20	37.60	60.00	39.30	48.20	32.90	4.80	12.90	5.90	10.70	1.20	1.20	0.00	0.00	0.00
Helps me to know the quality of the video content easily.	3.93 (1.01)	3.98 (.94)	4.27 (.84)	32.10	31.80	48.20	41.70	43.50	34.10	15.50	16.50	14.10	8.30	7.10	3.50	2.40	1.20	0.00
Helps me to select videos for the search task.	3.69 (1.12)	3.76 (1.01)	4.14 (.90)	28.60	23.50	41.20	32.10	44.70	37.60	21.40	18.80	16.50	15.50	10.60	3.50	2.40	2.40	1.20
Is important in the success of the search task.	3.52 (1.17)	3.47 (1.14)	3.82 (1.04)	23.80	22.40	28.20	29.80	27.10	38.80	27.40	30.60	24.70	13.10	15.30	3.50	6.00	4.70	4.70

I intend to use this feature to search for videos for my learning.	3.59 (1.21)	3.56 (1.17)	4.06 (1.04)	26.50	23.50	42.40	33.70	35.30	31.80	18.10	21.20	18.80	15.70	14.10	3.50	6.00	5.90	3.50
Recommendations	² FV	ES		FV	ES		FV	ES		FV	ES		FV	ES		FV	ES	
Helps me to know the quality of the video content easily.	4.12 (.79)	4.47 (.67)		34.10	55.30		47.10	37.60		15.30	5.90		3.50	1.20		0.00		0.00
Find useful videos in the list.	4.44 (.66)	4.68 (.52)		51.80	70.60		41.20	27.10		5.90	2.40		1.20	0.00		0.00		0.00
Helps me to select videos for the search task.	4.40 (.62)	4.49 (.67)		46.40	57.10		48.80	35.70		3.60	6.00		1.20	1.20		0.00		0.00
Is important in the success of the search task.	4.09 (.85)	4.22 (.86)		37.60	44.70		37.60	37.60		21.20	14.10		3.50	2.40		0.00		1.20
I intend to use this feature to search for videos for my learning.	4.31 (.76)	4.45 (.68)		47.10	55.30		37.60	34.10		14.10	10.60		1.20	0.00		0.00		0.00

^aHighest agreement percentage is bolded

¹Three options for comments visualization: WC = World Cloud, PC = Phrase Cloud, SM = Sentiment Meter

²Two options for recommendations: FV = Fellow Viewers, ES = Experts

Other utilities to supporting tracking searches feedback by the participants include navigating and organizing searches. P85 felt that the session history feature allowed easy navigation to the previous search and helped in identify videos with common content.

Despite being grouped as a value-adding feature, this suggested that the session history feature is essential for ES tasks. 94.20% of the participants had at least agreed that this feature was easy to use. However, the session history feature had only 84.70% of agreement percentage, with 63.50% of the participants rating *Strongly Agree* and 21.20% rating *Agree*, for the intention to use for future learning video searches. The intention to use ($M=4.45$, $SD=0.85$) the session history had a wide spread of the responses with participants registering responses over all the agreement.

The participants had commented positively on the session history feature for its *support in video selection* (16.4%). The participants felt that the session history feature integrated into the results list supported in video judgement as the common results were shown:

‘Enable to see which video actually covers the relevant topic in the navigations so that it produce the best result.’ (P20)

‘It is useful and effective so that I will be able to know that the video is related to what I am doing for and will help me in my learning.’ (P54)

‘That it shows links to what was searched previously, as well as the common result of all the searches.’ (P59)

However, some of the participants felt that the manner with which the sessions were *presented was inadequate* (22.1% of the total comments for this feature). The participants felt that the use of numbers to represent the sessions may not be effective and can be messy, especially when the number of sessions increases. This resulted in *poor usability* (7.1%) for the feature:

‘I do not know which session belongs to what topic. Probably text instead of numbers would be better.’ (P1)

‘It does not have words. It's numbered based on the session history. That in itself is not a problem. I might however, forget what concept is bounded to which number. Having a tooltip that indicates what concept the session number is would be valuable.’ (P12)

‘By writing only the session number I won't know what that session is and therefore still have to keep clicking until I get the right one.’ (P53)

‘The session history feature is convenient and easy to navigate when there are a few sessions however once the learner gets deep into their session they might not remember what exactly each session was. When there are too many sessions going on I feel like this feature will not be as useful anymore.’ (P47)

Comments visualization

For the three types of comments visualizations, majority of the participants recorded agreement for all the questions with the exception for Phrase Cloud where 49.50% of the participants agreed (22.40% registering *Strongly Agree* and 27.10% registering *Agree*) that Phrase cloud comment visualization was important for the success of the ES task. Table 6.7 summarizes the agreement percentages for the three comment visualizations. Among the three types of comment visualizations, the sentiment meter had the most favourable responses from the participants across the questions. High agreement scores from 78.80% to 92.90% were recorded for the utility of the sentiment meter. However, the participants felt such utilities were not as important to the success of the search task, with a substantially lower agreement percentage of 67.00%.

Table 6.7. Agreement percentage of the participants for the comments visualization

	Agreement percentage		
Visualization of comments	WC	PC	SM
Enables me to know what others feel about the video.	84.5	85.8	92.9
Helps me to know the quality of the video content easily.	73.8	75.3	82.3
Helps me to select videos for the search task.	60.7	68.2	78.8
Is important in the success of the search task.	53.6	49.5	67.0
I intend to use this feature to search for videos for my learning.	60.2	59.0	74.2

Through the 138 qualitative feedback collected for this feature, some participants felt that the *relationship between the video comments and search task is weak* (18.1% of the total comments for this feature). They indicated that comments were not useful in searches (14 instances) As commented by P84, *‘It might not show words that are directly related to the context of the video and the concept that I am searching for, so it might become unnecessary information that I will spend time going through the research process.’* There were participants who indicated that they were not influenced by comments in their search (8 instances). A few participants felt that there could be missing information where useful comments may not show up in the visualizations (3 instances). The perceived weak relationship between the resource comments and search task may have contributed to the participants rating the comments visualization feature moderately in terms of importance to task success.

The comments visualization’s utility for enabling them to know what others feel about the video and to know the quality of the video content had gathered favourable responses with the sentiment meter gathering 92.90% and 82.30% agreement respectively. This was supported by the participants’ qualitative comments where they felt that the *opinions were gathered* (24.6% of the total comments for this feature) through the visualizations. It can provide an overview of the opinions (26 instances) and supported the quick assessment of

comments (8 instances). As mentioned by P16, *‘I like that it gives me an overview of how people feel about the video and that it gives a rough measure of whether the video was helpful or not.’*, and P36, *‘It is able to give a brief feel to the user whether people found the video useful and maybe make a quick judgement on whether they may find this video useful.’* As the number of comments for on a video resource require substantial time and effort to construe, the participants felt that comments visualizations offer a means to gather the opinions of others regarding the resource.

The comments visualization gathered agreement percentages of 60.70% (WC), 68.20% (PC) and 78.80% (SM) when the participants were asked if the comments visualization can help them in the selection of videos for the search task. This reflected moderate agreement with a few participants disagreeing to this utility. The participants felt that the comments visualizations were useful in *supporting video assessment* (21.7%) where they could use the comments visualizations to judge a video (16 instances), identify suitable video (6 instance), find keywords to represent the video (6 instances) or even identify interesting content (2 instances). The moderate agreement may be due to the participants feeling doubtful over the veracity of the comments. Some participants commented that there could be off-topic comments, misleading comments or comments that are scripted:

‘In the world of online comments, there is many possibility of off topic comments that may cause a throw in the grading. It could do harm instead of help based on the current features.’ (P20)

‘It can be misleading at times as the words picked up might not be related to the content of the video.’ (P22)

‘I find that the sentiment is not relevant as there might be bots spamming causing the result to be inaccurate.’ (P43)

Among the comments visualizations, the participants felt less so that Word Cloud and Phrase Cloud can help them in the *selection of video* for the search task. This was reflected in the participants' responses when the Word Cloud and Phrase Cloud had lower agreement percentage of 53.60% and 49.50% respectively for the *importance of the feature* in the success of the search task. The participants provided relatively diverse agreement on their perception on the *importance of comments visualization on the task success* and their *intention to use* comments visualization in the search for learning videos, with the Word Cloud having the most spread in the responses.

The participants recorded 85.80%, 75.30% and 68.20% agreement for the questions on the utility of the Phrase Cloud. The agreement percentages of the utility questions for the Word Cloud were lower, with the participants registering 84.50%, 73.80% and 60.70%. However, the participants felt that the Word Cloud was more important in the success of the search task (53.60% versus 49.50%) and slightly more participants intended to use the Word Cloud than the Phrase Cloud (60.20% versus 59.00%) for their search for learning videos.

The participants were asked to rank (1, 2, 3) the three comments visualizations in terms of helpfulness, ease of usage and satisfaction and provide reasons for their ranking. Table 6.8 shows the top placed count for each comments visualization.

Table 6.8. Counts for comments visualizations

Comments visualisation	Word Cloud	Phrase Cloud	Sentiment Meter
	Number of top placed counts (percentage)		
Helpfulness	30 (35.3%)	26	29
Ease of use	25	9	51 (60.0%)
Satisfaction	23	19	43 (50.6%)

While the Word Cloud has 1 vote higher than the Sentiment Meter in terms of helpfulness, the Sentiment Meter had votes from more than half of the participants for the ease of use and satisfaction. This suggested that the number-based depiction of the comments

sentiments was easy to read and the participants were happy with this simpler interface which offers less information. Similar reasons were provided by the participants for this preference. 13 comments on the Sentiment Meter being easy to read were recorded and some participants mentioned that this provided them with an overall impression of the comments. The participants also mentioned that the Sentiment Meter had in some way influenced their perception of the video quality.

Experts and Fellow viewers recommendations

The participants' overall judgement of the two recommendation lists was quite positive with the mean scores of at least 4.09 for all the questions. There were no participants rating *Strongly Disagree* except for one participant who *Strongly Disagreed* that the Expert recommendations were important for the success of the search task.

A total of 111 comments were collated from the participants regarding this feature. The comments from the participants indicated that they appreciated the *dual perspectives* (32.4% of the total comments for this feature) offered by the Expert and Fellow viewers lists of recommendations. The participants cited they liked the lists that offered alternative views (17 instances), offering options for different purposes (13 instances) and they were able to leverage on other references (6 instances):

'I like there being officially sourced videos from established sites while still having viewership popularity in the recommended list.' (P79)

'I like that there are two variations, one for a more casual search and one for more informative purpose.' (P72)

'I like that it is spilt into two kind of recommendations as you get a better perspective from others as well as the authorities.' (P41)

The participants felt that they could find videos of *trusted quality* (27.0%) through this feature. The participants mentioned that the related videos (13 instances) were trustworthy (11 instances) and with known quality (6 instances). The recommendation lists were trusted by the participants to provide quality videos:

‘Shows reliable and trustworthy sources that help in exploratory tasks.’ (P32)

‘The recommendations feature is able to direct to me to related videos publicly perceived as positive and useful.’ (P62)

However, there were concerns over the recommendations’ neutrality. P8 highlighted about inaccurate recommendations and the possibility of how both recommendations lists can cross-check with each other, while P64 stressed on potential scams or fake recommendations may be introduced into the lists.

The participants reacted positively for Experts recommendations, with Experts recommendations scoring higher in *Strongly Agree* across all the questions. However, the computation of the agreement percentages (Table 6.9) shows that the Fellow viewer recommendations were rated marginally better for two of the three utility questions. This did not alter the perceptions of the participants on agreeing that the Expert recommendations were more important in the success of the search task and the participants had a higher agreement in their intention to use the Experts recommendations in the search for learning videos.

Table 6.9. Agreement percentage of the participants for recommendations

Recommendations	Agreement percentage	
	FV	ES
Helps me to know the quality of the video content easily.	81.20	92.90
Find useful videos in the list.	93.00	91.70
Helps me to select videos for the search task.	95.20	92.80
Is important in the success of the search task.	75.20	82.30
I intend to use this feature to search for videos for my learning.	84.70	89.40

The participants were asked to state their preference between the two types of recommendations in terms of helpfulness and satisfaction and to provide reasons for their preference. Table 6.10 lists the number of counts given to each recommendation.

Table 6.10. Counts for recommendations

Recommendations	FV	ES
	Preference count (percentage)	
Helpfulness	29	56 (65.9%)
Satisfaction	40	45 (52.9%)

Over 65% of the participants preferred the recommendations from the Experts over Fellow viewers in terms of helpfulness. The reasons provided by the participants on this were that the Experts recommendations felt to be more helpful (15.7%) and more reliable and trustworthy (20.5%). However, some participants felt that the recommendations from the Fellow viewers could resonate better them due to possibly having similar gaps in the domain.

6.3 Findings Summary

The focus of the research was on how the design considerations for a video retrieval environment can mitigate the challenges faced by the learners as well as the important video retrieval interfaces and features can better support learners in ES. While there might be bias in the evaluation data collected, the learners were reminded of the purpose of the evaluation was their perceptions on the conceptual design considerations rather than the actual effectiveness of the features.

In this study, a total of eleven features were developed in a conceptual prototype and evaluated. The findings of the features were presented in four groups, the Concept map group, the Granular interaction group, the Metadata group and the Value-adding group.

The evaluation study yielded positive results for all the features. In particular, concept map navigation had the most positive ratings for its utility and intention to use by the

participants. This followed closely by the segment container feature and segments for concept of interest features. The remaining features (Concept snippet and Concept map) within the Concept map group were found to have higher positive ratings. The next group of features had slightly lower positive ratings. The features include session history, video information in the results list, recommendations and video information in the video view.

The qualitative comments were generally positive on the utility of the features. This substantiated the positive results and allowed a deeper understanding of the aspects that the participants felt positive about. A number of qualitative feedback was also provided by the participants on improving some of these various features and functions.

The evaluation findings helped confirm on the list of salient features to be included in a video retrieval environment that the post-secondary students use for supporting exploratory video search for their learning.

CHAPTER SEVEN – DISCUSSION AND CONCLUSION

7.1 Discussion of evaluation findings

This chapter discusses the evaluation findings presented in the previous chapter. The discussion is presented in four sub-sections, with each sub-section representing the evaluation group used in the previous chapter. The discussion on the evaluation findings confirmed the list of essential and desirable video retrieval features to support the exploratory search for learning videos (RO3).

7.1.1 Concept Map Group

The concept map was adopted to augment the knowledge boundaries of the search concept. Together with the use of concept snippet, the concept map manages keywords in the new domain by providing definitions and context and hence reduces the uncertainties for the search. The concept map depicts the relationships between the concepts while the concept map snippets provided a brief explanation of the concepts in the concept map. These reinforce the understanding of the topic or domain area and supports learning. In particular, the participants felt that the concept snippet was helpful in discovering new information. This becomes important during the exploration of a new topic or domain as the concepts encountered would likely be foreign and new to the participants. The visual inspection of the knowledge boundaries afforded the reduction of uncertainty and improving the thought process. The concept map support richer interaction to enhance the backward and forward chaining strategies. This allowed new strategies for query formulation as depicted in the berrypicking model. The participants awarded high agreement scores across all the features' utility in the concept map group. One of the utilities that the participants have found largely useful is the ability to discover new information in the domain of interest with the concept map (Section 6.2.2 of Chapter 6).

The DataTone project (Gao et al., 2015) was developed to manage natural language ambiguity where the natural language input query was modelled into a visualization that allowed users to make selections that reduced ambiguity in the English language. Jiang et al. (2016) developed a prototype that visualized the search results in a hierarchical manner according to Wikipedia articles, allowing users to understand the multiple facets of the query topic. These studies share a common approach with the study findings that the visualization of the domain structure enabled the participants to understand the domain within a context and helps formulate new queries for the exploratory search.

The participants found the concept map and concept snippet provided new information to be discovered and agreed that these features are useful for their learning. Integrating concept maps as a knowledge structure in an augmented reality application scaffolded elementary students in their learning and aided in organizing their learning (Chen et al., 2016). Concept maps were similarly used by pediatric residents in their training to improve knowledge organization and deepen medical knowledge (Cutrer et al., 2011). Consistent with the literature (Krishnan et al., 2017), the current study found that the presentation of a visual knowledge structure, such as a concept map, from the search query helped the participants in extending their understanding beyond that of the query and provided a macro view of the topic in the exploratory search. This connected the participants' prior knowledge to new information to formed ideas in creating queries. Incorporating the concept snippet into the concept map further enhances the usefulness of the knowledge structure by defining the concepts with which the participants might not be acquainted to.

The participants found that the navigation of search using concept maps had supported the exploration of the relationships between search concept and results. The concept map organizes information about a domain with relationship links between the concepts. This allows logical navigation to associated concepts within a topic with the provision of semantics

of the topic macrostructure. The participants recognised that navigation with concept map encouraged the discovery of new information in a new domain and can navigate beyond the initial topic in discovering other videos, supporting serendipitous discoveries in exploratory searches.

Serendipitous information encountering has been associated as an exploratory search strategy (Foster, 2003; White & Roth, 2009; Xu et al., 2011). By clicking on concepts within a concept map, a related concept map with a new set of resources is presented. The navigation allowed the participant to explore new concepts that are bounded within the context of the topic or domain. However, the design and complexity of the concept map may convolute the navigation and information encountering process.

Millard et al. (2005) discussed designing complementary concept maps for navigation and orientation within a topical domain in e-learning. Researchers found that the navigation with concept maps in a non-linear information environment led to better learning outcome (Amadiou & Salmerón, 2014; Puntambekar, Stylianou, & Hübscher, 2003). It can be argued that the design of the concept maps plays a crucial role in the effectiveness of the concept map navigation utility and designing the concept map that caters to the appropriate level of difficulty in a topic remains a challenge. A possible enhancement could be the selection of the number of levels of relationships for the concept map to represent the various levels of topical difficulty.

The findings from the concept map group highlight the importance of extending learning beyond the existing topic for exploratory searches. The participants recognised the features' importance for task success and had the intention to use the features for future exploratory searches. Overall, the overwhelming participants' agreement on the features' utility, importance to task success and their desirability to use the features for future exploratory video searches suggested that the features in the concept map group should be

considered in the design of a video retrieval environment. Other visual structures that provide representation and exploration of concepts may be investigated on their effectiveness in identifying suitable search terms for query and retrieval.

7.1.2 Granular Interaction Group

The video resources should be segmented to design features that enabled granular and enriched interaction to support the participants in discerning the video content more effectively. This allowed discovering salient or high interactivity video segments within a time-based resource and assist in the selection of video resource in an exploratory search. This granular interaction invoked micro-strategies for finding specific concepts and content within the video. This is an enhanced form of subject searching strategy described in the berrypicking model.

Highlighting the video segments containing the concept of interest on a video timeline had was found to be an important part of a video retrieval environment as it reduces the effort in locating and identifying the salient parts of a video. The highlighted segments are where the concept of interest can be found and the number of highlighted segments within a video resource is indicative of how often the concept of interest is mentioned. The participants felt that this allowed them to assess the video better and subsequently make a selection of the video for the search task. The ability to identify video coverage through the concept of interest is deemed an important utility in the success of an exploratory search task. The participants appreciated the granular interaction offered by having the video segmented according to concepts where they could pinpoint and navigate to the focal information in the video, allowing the allocation of cognitive resources to the more relevant parts of the video as highlighted in Section 6.2.3 of Chapter 6.

Several studies had similarly leveraged on the identification of concepts in videos to provide a better utility of the video resource. According to an item's frequency of appearance, Lin et al. (2007) proposed a framework to classify news videos by concepts. Similar to the current feature, video digest was developed to overcome the challenges of browsing and skimming the content of long informational videos (Pavel et al., 2014). This is useful for a temporal resource such as videos where the video can cover a wide variety of content and objectives. By applying a similar idea in segmenting a video, accentuating the segments with the concept of interest allows the semantics of the segment to be identifiable. In addressing video segmentation in heterogeneous datasets, researchers had promising results when applying zero-shot learning¹ to discover semantic concepts (Chang et al., 2015). Such previous studies are particularly important as a substantial number of participants indicated their concerns over the identification of segments.

The segments with high interactivity utilised similar segmentation technique but highlight segments that have high user interaction counts. This feature is similar to an extension of a common social cue, view counts, found in video platforms. When applied to video segments rather than the whole video resource, it supported a more granular assessment of the video. This level of interactivity offered a lens to other viewers' activities on the video. While the participants appreciated this, they viewed this feature less favourably as compared to the segments with the concept of interest. Although the participants agreed that they could single out popular video segments easily, this feature is deemed less crucial to the success of an exploratory search task (Section 6.2.3 of Chapter 6).

Socially generated cues or activity provide a preliminary form of quality evaluation. Salas et al. (2013) proposed a collective evaluation of Internet videos through crowdsourcing

¹ Zero-shot learning refers to training in recognizing objects whose instances may not been seen before or have a lack of labelled training data.

where they found the crowdsourced subjective evaluation to be consistent with formal subjective evaluation scores. Chen, Zhou, and Chiu (2013) attempted to model the video browsing behavior and found many users exited from the video before completion and performed seeking action within the video. They attributed this behavior to the need for sampling through a large collection of videos to find an interesting video. Al-Hajri et al. (2014) visualised the browsing history of videos to help video viewers manage the quality of videos. This interaction signifies different levels of interactivity within a video.

These studies highlighted the usefulness of interactivity in quality evaluation. However, the current research evaluation findings showed that the participants were less keen to use such a feature as they had concerns over missing out important information. It appears that the participants had various interpretations on the segment's level of interactivity and had a moderate level of confidence in segments identification. Hence, these undermined the participants' perception of the feature's usefulness in an exploratory search and their intention to use this feature.

The video timelines that were used to feature both segment types were deliberately placed adjacent to each other to allow comparison of the segments that were contained the concept of interest and have high interactivity. However, no participant made use of such comparison between the timelines. Instead, some participants were confused by the adjacent timelines even when the segments were differentiated by colours.

The autonomy in collecting and collating video segments was opinioned favourably among the participants as highlighted in Section 6.2.3 of Chapter 6. Traditionally, people save video resources using the "Favourites" option. Rather than bookmarking the whole video, the video segment container supported a granular form of video collection. The participants appreciated that they were empowered to select the segments and create a video sequence

according to their selection. By retaining only the part of the video(s) that were deemed useful by the participants, they saved time and used less effort when they need to review the video.

Several education scholars have argued for the reuse of learning objects, including re-assembling of objects through collection or sequencing, to create meaningful learning outcomes (Koper, 2003; Yu et al., 2015). The video segment container supports the reuse of learning objects through the creation of video sequence with video segments selected by the participants. It is acknowledged that this has several potential drawbacks such as the coherence in transitions between segments, pedagogical soundness and the permission for video segment reuse. Despite these drawbacks, the majority of the participants expressed their appreciation for this feature and had strong intentions to use it for future search for learning videos (Section 6.2.3 of Chapter 6).

Overall, all three features in the granular interaction group gathered favourable responses. Even though the participants had some issues with the presentation of the features, they felt that the utilities afforded by the features were important in an exploratory search. However, the video timeline for segments with high interactivity had the lowest rating in the group. The participants voiced their preference over the similarly designed video timeline for segments with the concept of interest and highlighted that having two similar timelines might bring upon confusion. This suggested more design work is needed to present segments with high interactivity. Hence, the features video timeline for segments with the concept of interest and video segment container should be considered in the design of a video retrieval environment.

7.1.3 Metadata Group

Metadata forms an important role in the SERP for users to learn about the resource. The metadata presented in the prototype allowed the exploration of relationships between the

search concept and SERP as well as enriching interaction to help discern video content.

Similar metadata was integrated into the video play interface to facilitate recall of resource selection.

The evaluation results in Section 6.2.4 of Chapter 6 suggested that the participants appreciated the metadata on the SERP was helping them discern over the video content. The video metadata in the SERP was presented in a similar structure of the YouTube results list. Integrating more metadata in a familiar layout presentation might have a positive influence on the perception of the metadata's utility. Willson and Given (2010) had similarly found that their participants tend towards familiar web resources and adopted an identical search strategy on different search platforms. YouTube first realised the impact of having specific interfaces and services for dedicated categories ("Google launches YouTube Gaming to challenge Amazon-owned Twitch," 2015). Recognising a sizable gaming community that uses YouTube for gaming videos, YouTube developed interface features and services that cater specifically to the needs of gamers. However, the largely different interface led to confusion to the community. That led YouTube switching back to a familiar interface with enhanced feature to support the gaming community. With the popularity of the Internet search engine SERP, it is not surprising that the participants felt at ease with this feature. The design of an interface that is familiar increases the acceptance level and confidence from the participants and they were positive in using the video information in SERP.

Typical metadata such as the video title and description is insufficient for the search as users seek to discern the resource content to make a selection. In addition to the typical video metadata found in video platforms, the participants generally welcomed having social cues in representing the opinions of the other viewers. The inclusion of the social cues or endorsements were similar to the "word-of-mouth" for the video resource that exerted influences resource selection. The influence of social endorsements has been raised in

previous consumer decision and social media studies (Messing & Westwood, 2014; Wood & Hayes, 2012). The study, however, revealed some scepticism over the trustworthiness of social endorsements (Section 3.4.1.4 of Chapter 3 and Section 6.2.4 of Chapter 6). Despite the scepticism, the participants wanted more metadata to inform them over video selection.

The participants used the metadata to determine the quality of the video content and select videos for the exploratory task. There was work done in the developing metadata for video content (Balasubramanian et al., 2016; Thomas et al., 2017). It appears that while the participants were satisfied with the metadata presented in the SERP, video metadata such as video synopsis, better describe the video content can be developed to improve video retrieval.

The inclusion of the same set of metadata in the video view was intended to trigger recall of decision made in video selection. Based on the participants' responses, this utility was fulfilled. Interestingly, the metadata presented alongside the video view enabled them to corroborate the conceptions that they had while playing the video. Similar to that of the results view, adopting a familiar view from YouTube might have a positive influence on the participants' opinion.

7.1.4 Value-Adding Group

The retrieval environment should enhance the video retrieval process by integrating value-adding features. The three value-adding features introduced in the conceptual environment helped in search navigation recall, provided comments summarization and video recommendations. The use of social cues in the ES process has emerged as a new form of strategy in the berrypicking model. The collective wisdom and opinions enabled by the social media technology play a pivotal role in the creation of interactive features to support such strategy.

The session history was primarily used to recall previous search sessions and supported the navigation to the sessions. This is useful in exploratory searches where several iterations of searches are needed to reduce uncertainty and explore the domain. Several studies argued for the utility of browsing history in supporting searchers in exploratory searches. Morris, Ringel Morris, and Venolia (2008) developed SearchBar to use query and browsing histories to support multi-session searches as people tend to be interrupted or get distracted over long and complex searches. According to Chen and Teng (2009), search sessions of a user in an exploratory search may not all be relevant and the search history can be utilised to review previous search activities as well as to elucidate further search iterations. As highlighted in Section 6.2.5 of Chapter 6, the participants found the feature effective for recall and navigate to previous searched concepts.

However, there were some concerns over the use of numbers to indicate the sessions. The use of session numbers was intended for simplicity in representation. This resulted in a loss of information that could undermine the effectiveness of this feature, especially when there is a large number of sessions. This may result in users unable to recall what concept does the number represents. This suggested that the participants appreciated what the session history can offer but wanted refinements to improve this feature. The refinement could be, for instance, to label the session using the concept name rather than numbers to provide richer information on the session.

The evaluation results show that session history is useful for recall and navigation in an exploratory search. The session history offered another utility of exploration of relationships between the search concepts and results through the indication of session numbers beside the video resource. This allowed the participant to make sense of their search and supported in their selection of videos. Golovchinsky, Diriye, and Dunnigan (2012) developed a search system that provided explicit views of search history to help make sense of the search process.

Zhang et al. (2016) asserted using graphical representation of query history and clicks to support sense-making in exploratory searches. These studies demonstrated the value of browsing history beyond recall and navigation.

The strong responses from the participants' intention to use the session history in future exploratory searches and the importance of this feature indicated the potential for the session history to be an integral feature for an exploratory search system (Section 6.2.5 of Chapter 6). The feature, however, would need some refinements to improve its utility in handling larger search iterations while not compromising its usability.

Video resource user comments serve as a form of communication medium that can be related or unrelated to the video content. Comments visualizations serve to provide a summarization of the user comments for easier consumption. All three comments visualizations were developed on different techniques with the intention to assist participants in determining how others feel about the video, to discern the quality of the video and to select videos in the exploratory task. Participants found that the comments visualizations useful in enabling them to know what others feel about the video but less so for determining the quality of the video and selection of video (Section 6.2.5 of Chapter 6). The usefulness of socially generated cues or comments may be limited by doubts over the veracity of comments. Social user comments on social media vary on its quality and veracity due to the lack of gatekeepers. The variation in the social comments' veracity can often be detected from the linguistic signal (Jiang & Wilson, 2018), leading to scepticism in its authenticity.

Studies by Houston, Hansen, and Nisbett (2011) and Winter et al. (2015) highlighted the influence of user comments in perceptions of online resources. Social comments exert influence on user perceptions and hence can affect decision making. In an attempt to classify YouTube video comments, Madden, Ruthven, and McMenemy (2013) found that there were a substantial number of non-video contented categories. This suggested that a dilution in video

content related comments for participants to use the visualizations to determine video quality. With more research to detect and identify misleading social comments (Derczynski et al., 2017; Viviani & Pasi, 2017), the quality of comments visualization can be improved to instil more trust from the users.

The simple gauge-like interface of the sentiment meter gathers the most favourable responses from the participants (Section 6.2.5 of Chapter 6). The aggregation of the comments into a numeric gauge provided a quick impression on the overall impression of the comments. As a value-adding feature in the video search process, the usage of the interface should be easy and take little cognitive load. Sentiment analysis was used on user comments to provide insights for understanding context and decision-making (Dong, O'Mahony, Schaal, McCarthy, & Smyth, 2016; Young & Gavade, 2018). The inclusion of comment sentiments in the selection of video adds value to the video seeking process and the design of the comment sentiments should require minimal cognitive resources to use.

Resource recommendations have been a staple in search systems and online shopping platforms. A multiple recommendation environment was found to be important to the success of the exploratory search task. The participants were pleased with having two variants of recommendations (Section 6.2.5 of Chapter 6). They felt that videos in the recommendation lists will contain useful videos and can eventually find a suitable video to fulfil the search task. These indicated the confidence that the participants had on recommendations and were comfortable to select resources from the list. The header for the recommendations was indicated for the participants to know sources. This is important as the participants perceived the dual recommendations to offer video resources from different views and trusted the video quality from the recommendations.

Several studies had highlighted the positive impact of recommendations in exploratory searches (Hendahewa & Shah, 2017; Nanni & Feltrim, 2015; Tsai & Brusilovsky, 2018). Recommendations provided to directions for the participants in selecting videos during an exploratory search with which the participants may lack the domain knowledge. The dual recommendations increase diversity in the exploratory search. Although the evaluation results showed that the participants preferred the Experts recommendations as they were deemed more authoritative and this instilled higher confidence, they were felt that they were able to resonate better with the videos from fellow viewers list. Given the strong appreciation for dual perspectives offered by the multiple recommendations list, the Experts and Viewers recommendations value-adding feature is deemed essential in exploratory video searches.

Overall, all the value-adding features gathered favourable responses for their utility, importance to the search task and their intention to use. Even though the participants had some concerns over the Phrase Cloud comment visualization, the Sentiment meter comment visualization was still deemed to be important for the exploratory search task. Session history was found to be largely useful and desired by the participants (Section 6.2.5 of Chapter 6). This highlights the importance of being able to provide features that can help make sense of the searches made.

7.1.5 Summary of the recommended features

Based on the evaluation, Table 7.1 provides a summary of the recommended features to be included in the development of video retrieval systems to support learning. The idea of concept mapping is not new, having wide adoption within the educational context for knowledge creation. However, the incorporation of a concept map in search systems to provide for topical boundaries and to support the learning of has not been adopted in any of the commercial video retrieval systems.

Another novel feature is the video segment container. There are work in logical segmentation of videos (see Gan, Sun, & Nevatia (2017)). While the concept of learning objects is prevalent in educational research, the self collation of video segments as learning objects as part of a video retrieval system has not been noted in the learning video systems.

There has been much work in the use of search history to support searches in sense-making, and tracking and navigation (see Ringel Morris, and Venolia (2008), Golovchinsky, Diriye, and Dunnigan (2012), and Zhang et al. (2016)). The use of session history in this work included supporting the exploration of relationships between the search concept and results. This is a novel concept that is not found in the related systems explored.

Table 7.1. Summary of the recommended features

Concept Map		
Concept Map	Concept Snippet	Concept Map Navigation
1) Support the exploration of the domain of interest and reinforce the understanding of the topic of interest. 2) Depicts a manageable boundary for the domain of interest through the visualization of the domain structure. 3) Support the discovery of new information and connect prior knowledge with new information. 4) Support the formulation new search queries. 5) Support the exploration of relationships between search concept and search results. 6) Provide a context for the search.	1) Support the understanding of concepts found in the concept map and hence reduces uncertainties in the exploratory search. 2) Support keywords management through the definition of the concept.	1) Support the discovery of new videos for the exploratory search. 2) Support serendipitous discoveries. 3) Facilitate the exploration of relationships between concepts and results.
Granular Interaction		
Video timeline for segments with concept of interest	Video segment container	
1) Support granular and enriched interaction to discern the video content. 2) Support segments identification that contains the search concept. 3) Support comparison on the concept 4) Support video skimming or in-video navigation to the points of interest.	1) Support the reuse of learning objects. 2) Support collation of useful video segments. 3) Support the creation of videos for learning. 4) Support the management of video segments.	
Video Information		
Video information in results list and video view		
1) Be presented in a familiar layout. 2) Include social cues and endorsements. 3) Include metadata that support the assessment on the video content.		

Value Adding		
<i>Session History</i>	<i>Comments visualization – Sentiment meter</i>	<i>Experts and Viewers recommendations</i>
1) Support the tracking and navigation to previous search sessions. 2) Be labelled with concept name rather than numbers to provide richer information on the session. 3) Support the exploration of relationships between the search concept and results. 4) Support sense-making and provide a direction of the search progress.	1) Be easy to interpret that requires low cognitive load. 2) Provide an overview of the opinions on the video. 3) Help users to discern on the video quality	1) Clearly indicate the source of the recommendations. 2) Allow easy access to both list of recommendations. 3) Support alternate perspectives and options for the users.

The implementation of these novel features into a fully functional video retrieval system is challenging. The development of a feature requires further research and development from their respective domain. For instance, the auto-generation of the concept map based on key concepts extracted from a natural search query is not currently available. The utility of a concept map is that of collaborative knowledge creation. In order for a concept map to be automatically populated for the use of navigation and learning would likely require work from the area of education and computer engineering. For the feature of granular interaction, the advancements for detecting the concept of interest for segmentation or marking of segment may not be mature. One current technique involves the detection of scene transition. For learning videos, this technique might not be feasible as scene changes may be non-existence. Hence, there is a need for the advancements and collaboration from other areas of research to manifest a fully functional video retrieval system.

7.2 Summary of Research

In Chapter 1, a research opportunity was recognised in the inadequacies of a query-response paradigm in supporting a video exploratory search in a learning context. Enhanced user interface design creates interaction between the user and the IR platform in supporting exploratory searches. This led to the first research objective (RO1) to *understand the video seeking behavior of learners and their interaction with the IR platform during exploratory searches for learning videos*.

RO1 was accomplished through Study 1, with which 14 post-secondary students performed a total of 28 exploratory video search tasks. The study utilised the think-aloud protocol to capture the nuances of the video seeking behavior of the adolescent learners when they perform the exploratory search tasks on public video retrieval platforms. The synthesis of the data gained insights of how the adolescent learners select their online resources, how query

formulation and reformulation were performed, what influenced the selection of videos for preview, the actions taken during video preview, and what decisions were made on the search tasks. The study also revealed the challenges faced by the adolescent learners in query formulation and their interaction with the video metadata during the exploratory video search tasks. This led to features desired by adolescent learners to support exploratory searches, including the integration of web resources to facilitate understanding of search concepts and inclusion of social cues and endorsement as part of the video metadata.

The next stage of the research was to *derive conceptual design features in a video retrieval environment that supports the way adolescent learners perform exploratory video searches in their learning* (RO2). This stage of the research was concerned with how an interface can be designed to mitigate the challenges faced by the adolescent learners during exploratory searches and to explore what important video retrieval interfaces or features can better support the learners in the exploratory search.

To accomplish this, expert interviews were conducted with academic and industry experts in the domain of multimedia, retrieval and learning technology. Nine design concepts were uncovered as presented in Section 4.5 of Chapter 4. Further discussions with information retrieval experts lead to lead to the formalisation of 11 video retrieval system features in meeting RO2. The 11 video retrieval system features were logically placed into four groups, the concept map group, the granular interaction group, the metadata group and the value-adding group.

A conceptual prototype was developed to present the features and to allow an evaluation of the features. This was to meet the final research objective (RO3) of *deriving a list of design features to be included in a video retrieval environment based on the evaluation findings*. Study 3, the user evaluation study, was conducted with 85 post-secondary students using an exploratory task walk-through on the conceptual prototype based on the four groups of features.

This study helped in understanding the perceptions and preferences of adolescent learners in the video retrieval environment in an exploratory video search setting. Overall, the features satisfied the adolescent learners with the video timeline showing segments of high interactivity.

7.3 Contributions to knowledge and practice

Study 1 undertook an exploratory approach to investigate exploratory video seeking behavior in a learning context using the think-aloud technique. This approach provides for method triangulation for other studies in the investigation of video seeking behavior. Anchoring upon exploratory search model, the study identified the steps that young learners take and the challenges they encountered when they perform exploratory searches for videos to support their learning. The study provided valuable insights into the exploratory video seeking process as well as the interactions that young learners take when they search for videos to support their learning. These findings add to the understanding of video information seeking behavior adopted by adolescents in a learning context as compared to other contexts such as health information seeking (Lin, Zhang, Song, & Omori, 2016). Video seeking in the learning context had adhered to the exploratory seeking behavior described in the berrypicking model. The challenges faced by the younger learners during exploratory video searches were identified. These contribute to the stream of studies dedicated to video retrieval and seeking behavior.

Study 2 presented an in-depth analysis of experts interviews to which a set of video retrieval design concepts was derived. Addressing both the challenges identified as well as the video retrieval process, the use of experts interviews allowed drawing vital perspectives from a variety of related fields and domains to propose a set of design concepts that are deemed important to support learning through videos. The design concepts *Augment knowledge boundaries visually*, *Relationship between concepts and results* and *Granular interaction* are novel design concepts for video retrieval system design. This led to the conception of several

novel features and utilities that support exploratory video searches for learning, including the integration of *Concept map* and *Concept Snippet*, indicating *Video segments for concept of interest*, and *comments visualization*. The conception of these features and utilities had enhanced the various strategies depicted in the berrypicking model. This contributes to the literature in the field of interactive design and retrieval system design studies.

The evaluation study facilitated the confirmation of the design concepts from prior studies. The study supported the understanding in which and why were the features desired by the adolescent learners as it points to several open issues on the feature design. It should be noted that the experimental population used in this study was not intended to be generalized to other young adults. The participants were not systematically sampled to support generalization and had a small sample size. Even though the sample size is relatively small for generalization, it lays a foundation for further research.

This study presents practical implications for video retrieval systems interface designers and end-users. The number of self-directed learners using public repositories to support their learning is increasing. The findings of the study present design guidelines to help develop dedicated interfaces and services for this group of young self-directed learners to improve their search for video learning resources. This opens up further investigations to develop interface features to meet other users through a user-centred approach. Several novel design concepts, such as the use of concept map in a search system and the self-collation of video segments were manifested from this research and can potentially be developed as learning technologies to improve learning. The evaluation study confirmed the desirability of the features and utilities to the young learners.

Young self-directed learners, such as post-secondary students, will find video retrieval more effective with the implementation of these interface features. These features support

interactions in a video seeking behavior of these learners and are desirable by them. This can support better query formulation and ease the cognitive load while performing video seeking activities that support learning.

7.4 Limitations

While this research yielded interesting insights and provided practical guidelines to the design of video retrieval interfaces to support exploratory searches, it nonetheless has a number of limitations that could be addressed as part of future work:

- Study 1 was conducted using desktop or laptop computers. In Singapore, a report found an upward trend that residents aged 15-24 used smartphones to access the Internet than using laptops and desktop computers (*Annual survey on infocomm usage in households and by individuals for 2018*, 2018). User behavior using mobile devices may differ from that of when using a laptop or desktop computers. Hence, the video seeking behavior on mobile devices will warrant separate studies.
- Overall, the research was limited to post-secondary students who are enrolled in diploma and Nitec certification courses. These students are seeking videos that are of more practical in nature. Other post-secondary students, such as Junior College students, or undergraduates where the learning needs may result in different search behavior and challenges.
- In order to address the challenges identified in Study 1 and to obtain a list of design concepts that can support exploratory video searches for learning, experts interviews were conducted to elicit ideas and opinions. The experts gave their responses with respect to their domain expertise and this resulted in a list of design concepts. Together with the inputs from Study 1 and the discussion sessions with the IE, a final list of video

retrieval features was derived. It would be more insightful if the experts could be asked to vote or poll on how useful each feature is.

- In Study 3, self-assessment measures and feedback provided by participants were subjective and might be biased. Hence, this would not be a totally accurate representation of what the features can afford for the participants as compared to an objective evaluation.
- The evaluation of the conceptual prototype was on the conceptual design considerations throughout the study rather than the actual effectiveness of the features.
- The lengthy evaluation procedure for Study 3 averaged 65 minutes and the cognitive load needed to follow the task guide to complete all the features could affect the participants' experience in the environment. Hence, the participants were allowed to pace themselves for the survey and this explained the wide range of time (differences of 33%) taken to complete the procedure between the participants.
- User interface design principles, for instance, the use of certain colours and placement of features were not strictly applied in the prototype and hence not specifically tested. The general layout and design of the prototype was drawn from YouTube, a popular video retrieval platform. This could have an effect on the participant's perception on the feature.

Another limitation of this research relates to the use of conceptual prototype for the evaluation. The use of a conceptual prototype rather than a working system enabled participants to evaluate the features based on their overall understanding of how the features were designed and how their utility supported an exploratory video search. This led to the use of an instructional walk-through to use the features in the conceptual prototype. Although the instructional walk-through was designed based on the video seeking behavior in Study 1, the level of realism may not be as good compared to an operational video platform. With the

evaluation done on a fully functional system, users could perform the exploratory search task according to their natural seeking behavior. It would be better for users to gain more in-depth understandings of the features' design and utility when performing the evaluation.

7.5 Directions for future work

The scope of this thesis focuses on the identification of important features that can support exploratory video searches for learning. Through the three studies, features that have utility across all the stages of video retrieval were identified and evaluated. Various feedback on the features were also proposed during the evaluation. This research highlighted the directions for future work:

- The study 1 explored a key set of video retrieval features desired by adolescents in their learning. The study can be extended with a larger group of participants in a similar study context to validate the findings.
- Develop a fully functional platform that incorporated the feedback from the current research to allow evaluation in actual exploratory search scenarios for different context or domain of interest. A fully functional platform would allow a more realist evaluation environment and to support objective measures beyond participants' self-assessments.
- Include the design features (Advanced input options and Integrate multi-modal input) omitted in this study for future evaluation.
- Study 1 suggested that different searching strategies were used by different participants. Examine if individual characteristics, such as gender, types of course enrolled in, level of education, system experience, affect the users' perception of the features.
- Implement a mobile version of the features and repeat the evaluation to detect if the findings would differ significantly. The affordances of a mobile device are significantly different from that of a laptop or workstation. It is hence important to extend this research to mobile devices.

- Augmented reality provides real world immersive experiences that exploit more of human's senses in improving engagement and learning. The design concepts of the VIR derived from this research can be applied to an augmented reality environment to detect if the immersive experience would generate different search behaviors and outcome. For instance, the marking of the most viewed segments can be adopted as Augment Reality objects to enhance the immersive experience.
- Examine the effect of User Interface design principles on the features. Poor presentation of some features was highlighted throughout the evaluation. The use of different colours, or simpler organizational structure, could result in different ratings from the participants.
- The current research adopted concept map as the knowledge structure to enhance the interaction and support the understanding of the search domain. There are other visual maps that use various theories and techniques to achieve the understanding of concepts (Eppler, 2006). Future work can examine the effectiveness of the different visual maps and structures in supporting exploratory search to identify suitable queries and retrieval.
- The current research found that features with granular interaction are desirable in exploratory search. Granular interaction allowed the users to discern the temporal resource better. With more effective video segmentation techniques (Cheng, Tsai, Hung, Wang, & Yang, 2018; Khoreva, Rohrbach, & Schiele, 2018), the more features can be designed to take advantage of the enriched interaction to discern a video content.
- The current research showed that metadata plays an important role in supporting users in discerning the video quality. Further work is needed to explore what other metadata such as video synopsis, and how the metadata can aid in supporting video search decisions and improve video discovery and selection.

7.6 Concluding Remarks

As video resources become widely available and more people turn to video for learning support, it becomes important that work is done to understand the retrieval behavior and identify challenges so that user-centric interface and features are designed and developed to support the exploratory search process.

The series of studies described in this thesis was done to tackle the prospective issues faced by a group of users, the adolescent learners, in their exploratory video searches. Through the understanding of their video seeking behavior and challenges faced during exploratory searches, important and desirable features that address their needs were developed. Findings proposed in this research provide insights about the importance of enhancing support in query formulation and reducing cognitive load in decision making through a familiar layout or environment.

Designing features that are not desirable by users is meaningless. There is a need to relate features and tools to the actual needs of users where they can act upon within their aptitudes. The current research helped demonstrate the design of video retrieval features that are desirable by the intended users to support exploratory searches.

REFERENCES

- Aciar, S., Zhang, D., Simoff, S., & Debenham, J. (2007). Informed recommender: Basing recommendations on consumer product reviews. *IEEE Intelligent systems*, 22(3), 39-47. doi: 10.1109/mis.2007.55
- Agosto, D. E. (2002). Bounded rationality and satisficing in young people's Web-based decision making. *Journal of the American Society for Information Science and Technology*, 53(1), 16-27. doi:10.1002/asi.10024
- Ahn, J. W., & Brusilovsky, P. (2013). Adaptive visualization for exploratory information retrieval. *Information Processing & Management*, 49(5), 1139-1164. doi:10.1016/j.ipm.2013.01.007
- Al-Hajri, A., Miller, G., Fong, M., & Fels, S. S. (2014). Visualization of personal history for video navigation. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems – CHI'14*, 1187-1196. doi:10.1145/2556288.2557106
- Albertson, D., & Meadows, C. (2011). Situated topic complexity in interactive video retrieval. *Journal of the American Society for Information Science & Technology*, 62(9), 1676-1695. doi:10.1002/asi.21573
- Allan, J., Croft, B., Moffat, A., & Sanderson, M. (2012). Frontiers, challenges, and opportunities for information retrieval. *Report from SWIRL 2012 the second strategic workshop on information retrieval in Lorne at the ACM SIGIR Forum*, 2-32. doi:10.1145/2215676.2215678
- Amadiou, F., & Salmerón, L. (2014). Concept maps for comprehension and navigation of hypertexts. In D. Ifenthaler & R. Hanewald (Eds.), *Digital knowledge maps in education* (pp. 41-59). New York, NY: Springer. doi:10.1007/978-1-4614-3178-7_3
- Amir, A., Srinivasan, S., & Efrat, A. (2003). Search the Audio, Browse the Video - A Generic Paradigm for Video Collections. *Journal on Advances in Signal Processing*, 2003(2), 209-222. doi:10.1155/s111086570321012x
- Annual survey on infocomm usage in households and by individuals for 2018*. (2018). Singapore Retrieved from <https://www2.imda.gov.sg/-/media/Imda/Files/Industry-Development/Fact-and-Figures/Infocomm-usage-HI/Annual-Survey-on-Infocomm-Usage-by-Households-and-Individuals-Report-2018.pdf?la=en>.
- Arguel, A., & Jamet, E. (2009). Using video and static pictures to improve learning of procedural contents. *Computers in Human Behavior*, 25(2), 354-359. doi:10.1016/j.chb.2008.12.014
- Arguello, J., Wu, W. C., Kelly, D., & Edwards, A. (2012). Task complexity, vertical display and user interaction in aggregated search. *Proceedings of the 35th international ACM SIGIR conference on Research and development in information retrieval*, 435-444. doi:10.1145/2348283.2348343
- Athukorala, K., Głowacka, D., Jacucci, G., Oulasvirta, A., & Vreeken, J. (2016). Is exploratory search different? A comparison of information search behavior for exploratory and lookup tasks. *Journal of the Association for Information Science and Technology*, 67(11), 2635-2651. doi:10.1002/asi.23617
- Athukorala, K., Medlar, A., Oulasvirta, A., Jacucci, G., & Glowacka, D. (2016). Beyond relevance: Adapting exploration/exploitation in information retrieval. *Proceedings of the 21st International Conference on Intelligent User Interfaces*, 359-369.
- Auerbach, C., & Silverstein, L. B. (2003). *Qualitative data: An introduction to coding and analysis*. New York, NY: New York University Press.

- Aula, A., Khan, R. M., & Guan, Z. (2010). How does search behavior change as search becomes more difficult? *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems – CHI'10*, 35-44. doi:10.1145/1753326.1753333
- Aye, N., Hattori, F., & Kuwabara, K. (2008). Bridging Semantic Gap in Distant Communication: Ontology-Based Approach. In Nguyen, N. T., Jo, G. S., Howlett, R. J., & Jain, L. C. (Eds.), LNCS: Vol. 4953. *Agent and Multi-Agent Systems: Technologies and Applications* (pp. 252-260). Berlin, Heidelberg: Springer.
- Azzopardi, L., Thomas, P., & Craswell, N. (2018). Measuring the utility of search engine result pages: an information foraging based measure. *Proceedings of the 41st International ACM SIGIR Conference on Research & Development in Information Retrieval*, 605-614.
- Balasubramanian, V., Doraisamy, S. G., & Kanakarajan, N. K. (2016). A multimodal approach for extracting content descriptive metadata from lecture videos. *Journal of Intelligent Information Systems*, 46(1), 121-145. doi:10.1007/s10844-015-0356-5
- Baro, E. E., & Fyneman, B. (2009). Information literacy among undergraduate students in Niger Delta University. *The Electronic Library*, 27(4), 659-675. doi:10.1108/02640470910979606
- Basu, S., Yu, Y., Singh, V. K., & Zimmermann, R. (2016). Videopedia: Lecture video recommendation for educational blogs using topic modeling. *Proceedings of the International Conference on Multimedia Modeling*, 238-250.
- Bates, M. J. (1989). The design of browsing and berrypicking techniques for the online search interface. *Online review*, 13(5), 407-424. doi:10.1108/eb024320
- Bates, M. J. (2002). Toward an integrated model of information seeking and searching. *The New Review of Information Behavior Research*, 3(1), 1-15.
- Bates, M. J. (2005). Berrypicking. In K. Fisher, S. Erdelez, & L. McKechnie (Eds.), *Theories of Information Behavior* (pp. 58-62). Medford, New Jersey: Information Today, Inc.
- Belkin, N. J., Cool, C., Stein, A., & Thiel, U. (1995). Cases, scripts, and information-seeking strategies: On the design of interactive information retrieval systems. *Expert Systems with Applications*, 9(3), 379-395. Doi: 10.1016/0957-4174(95)00011-w
- Belkin, N. J., Oddy, R. N., & Brooks, H. M. (1982). ASK for information retrieval: Part I. Background and theory. *Journal of Documentation*, 38(2), 61-71. doi:10.1108/eb026722
- Bernard, J., Daberkow, D., Fellner, D., Fischer, K., Koepler, O., Kohlhammer, J., . . . Sens, I. (2015). Visinfo: a digital library system for time series research data based on exploratory search - a user-centered design approach. *International Journal on Digital Libraries*, 16(1), 37-59. doi:10.1007/s00799-014-0134-y
- Bernard, J., Ruppert, T., Scherer, M., Kohlhammer, J., & Schreck, T. (2012). Content-based layouts for exploratory metadata search in scientific research data. *Proceedings of the 12th ACM/IEEE-CS joint conference on Digital Libraries*, 139-148. doi:10.1145/2232817.2232844
- Bertini, M., Bimbo, A., Ferracani, A., Landucci, L., & Pezzatini, D. (2013). Interactive multi-user video retrieval systems. *Multimedia Tools & Applications*, 62(1), 111-137. doi:10.1007/s11042-011-0888-9
- Bhaumik, H., Bhattacharyya, S., Nath, M. D., & Chakraborty, S. (2016). Hybrid soft computing approaches to content based video retrieval: A brief review. *Applied Soft Computing*, 46, 1008-1029. doi:10.1016/j.asoc.2016.03.022
- Bilal, D. (2005). Children's information seeking and the design of digital interfaces in the affective paradigm. *Library Trends*, 54(2), 197-208. doi:10.1353/lib.2006.0013
- Blascheck, T., Vermeulen, L. M., Vermeulen, J., Perin, C., Willett, W., Ertl, T., & Carpendale, S. (2018). Exploration Strategies for Discovery of Interactivity in Visualizations. *IEEE Transactions on Visualization and Computer Graphics*, 25(2), 1407-1420.

- Bogner, A., & Menz, W. (2009). The theory-generating expert interview: epistemological interest, forms of knowledge, interaction. In A. Bogner, & W. Menz (Eds.), *Interviewing experts* (pp. 43-80) London, UK:Springer.
- Bonk, C. J. (2010). How technology is changing school. *Educational Leadership*, 67(7), 60-65.
- Bonk, C. J., Kim, M., & Xu, S. (2016). Do You Have a SOLE? Research on Informal and Self-Directed Online Learning Environments. In M. Spector, B. Lockee, & M. Childress (Eds.), *Learning, Design, and Technology: An International Compendium of Theory, Research, Practice, and Policy* (pp. 1-32). Springer.
- Borgman, C. L. (2011). *Fostering learning in the networked world: The cyberlearning opportunity and challenge*: DIANE Publishing.
- Börner, K. (2006). Semantic association networks: Using semantic web technology to improve scholarly knowledge and expertise management. In V. Geroimenko & C. Chen (Eds.), *Visualizing the semantic web* (pp. 183-198) London, UK: Springer.
- Bouchard, P. (2009). Pedagogy without a teacher: What are the limits? *International Journal of Self-Directed Learning*, 6(2), 13-22.
- Boyatzis, R. E. (1998). *Transforming qualitative information: Thematic analysis and code development*. Thousand Oaks, CA: Sage Publications Inc.
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, 3(2), 77-101. doi:10.1191/1478088706qp063oa
- Brindha, N., & Visalakshi, P. (2017). Bridging semantic gap between high-level and low-level features in content-based video retrieval using multi-stage ESN–SVM classifier. *Sādhanā*, 42(1), 1-10. doi:10.1007/s12046-016-0574-8
- Bron, M., Gorp, J. v., Nack, F., Rijke, M. d., Vishneuski, A., & Leeuw, S. d. (2012). A subjunctive exploratory search interface to support media studies researchers. *Proceedings of the 35th international ACM SIGIR*, 425-435.
- Burgoon, J. K., Bonito, J. A., Bengtsson, B., Cederberg, C., Lundeborg, M., & Allspach, L. (2000). Interactivity in human–computer interaction: A study of credibility, understanding, and influence. *Computers in Human Behavior*, 16(6), 553-574. doi:10.1016/S0747-5632(00)00029-7
- Butcher, K. R., & Sumner, T. (2011). Self-directed learning and the sensemaking paradox. *Human-Computer Interaction*, 26(1), 123-159. doi:10.1080/07370024.2011.556552
- Cai, F., Wang, S., & de Rijke, M. (2017). Behavior-based personalization in web search. *Journal of the Association for Information Science and Technology*, 68(4), 855-868.
- Campbell, J. L., Quincy, C., Osserman, J., & Pedersen, O. K. (2013). Coding in-depth semistructured interviews: Problems of unitization and intercoder reliability and agreement. *Sociological Methods & Research*, 42(3), 294-320.
- Cañas, A. J., Carff, R., Hill, G., Carvalho, M., Arguedas, M., Eskridge, T. C., . . . Carvajal, R. (2005). Concept maps: Integrating knowledge and information visualization. In O. Tergan & T. Keller (Eds.), *Knowledge and information visualization* (pp. 205-219) Berlin, Heidelberg: Springer.
- Caplin, A., Dean, M., & Martin, D. (2011). Search and satisficing. *American Economic Review*, 101(7), 2899-2922. doi:10.1257/aer.101.7.2899
- Capra, R., Arguello, J., & Zhang, Y. (2017). The effects of search task determinability on search behavior. *Proceedings of the European Conference on Information Retrieval*, 108-121.
- Case, D. O. & Given, L. M. (Eds.) (2012). *Looking for information: A survey of research on information seeking, needs, and behavior*. UK : Emerald Group Publishing.
- Cazan, A. M., & Schiopca, B. A. (2014). Self-directed learning, personality traits and academic achievement. *Procedia-Social and Behavioral Sciences*, 127, 640-644.

- Chang, Y. K., Xue, Z., Mokhtar, I. A., Foo, S., Majid, S., Luyt, B., & Theng, Y. L. (2012). Assessing students' information literacy skills in two secondary schools in Singapore. *Journal of Information Literacy*, 6(2), 19-34. doi:10.11645/6.2.1694
- Chang, X., Yang, Y., Hauptmann, A., Xing, E. P., & Yu, Y. L. (2015). Semantic concept discovery for large-scale zero-shot event detection. *Proceedings of the 24th International Joint Conference on Artificial Intelligence*, 2234-2240.
- Chen, C. H., Chou, Y. Y., & Huang, C. Y. (2016). An Augmented-Reality-Based Concept Map to Support Mobile Learning for Science. *The Asia-Pacific Education Researcher*, 25(4), 567-578. doi:10.1007/s40299-016-0284-3
- Chen, L., Zhou, Y., & Chiu, D. M. (2013). Video browsing-a study of user behavior in online vod services. *Proceedings of the 22nd International Conference on Computer Communication and Networks - ICCCN'13*. doi:10.1109/ICCN.2013.6614209
- Chen, W. L., & Teng, W. G. (2009). Exploiting browsing history for exploratory search. In M. J. Smith & G. Salvendy (Eds.), LNCS Vol 5617. *Designing Information Environments* (pp. 355-364). doi:10.1007/978-3-642-02556-3_41
- Cheng, J., Tsai, Y. H., Hung, W.C., Wang, S., & Yang, M. H. (2018). Fast and accurate online video object segmentation via tracking parts. *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*, 7415-7424. doi:10.1109/cvpr.2018.00774
- Chi, E. H. (2009). Information seeking can be social. *Computer*, 42(3), 42-46.
- Choak, C. (2013). Asking questions: Interviews and evaluations. In S. Bradford & F. Cullen (Eds.), *Research and Research Methods for Youth Practitioners* (pp. 102-124). London, UK : Routledge.
- Chung, C. T., Hsiung, H. K., Wei, C. K., & Lee, L. S. (2014). Personalized video summarization based on Multi-Layered Probabilistic Latent Semantic Analysis with shared topics. *Proceedings of the 9th International Symposium on Chinese Spoken Language Processing*, 173-177. doi:10.1109/isclsp.2014.6936592
- Cleverley, P. H., & Burnett, S. (2015). Retrieving haystacks: a data driven information needs model for faceted search. *Journal of Information Science*, 41(1), 97-113.
- Cleverley, P. H., Burnett, S., & Muir, L. (2017). Exploratory information searching in the enterprise: A study of user satisfaction and task performance. *Journal of the Association for Information Science and Technology*, 68(1), 77-96.
- Cline, R. J., & Haynes, K. M. (2001). Consumer health information seeking on the Internet: the state of the art. *Health education research*, 16(6), 671-692. doi:10.1093/her/16.6.671
- Coffey, J. W., Hoffman, R. R., Cañas, A. J., & Ford, K. M. (2002). A concept map-based knowledge modeling approach to expert knowledge sharing. *Proceedings of the IASTED International Conference on Information and Knowledge Sharing – IKS'02*, 212-217.
- Costley, J., & Lange, C. H. (2017). Video lectures in e-learning: effects of viewership and media diversity on learning, satisfaction, engagement, interest, and future behavioral intention. *Interactive Technology and Smart Education*, 14(1), 14-30.
- Cotton, D., & Gresty, K. (2006). Reflecting on the think-aloud method for evaluating e-learning. *British Journal of Educational Technology*, 37(1), 45-54. doi:10.1111/j.1467-8535.2005.00521.x
- Covington, P., Adams, J., & Sargin, E. (2016). Deep neural networks for YouTube recommendations. *Proceedings of the 10th ACM conference on recommender systems*, 191-198. doi:10.1145/2959100.2959190
- Creswell, J. W. (2007). *Qualitative inquiry and research design: Choosing among five approaches*. Thousand Oaks, CA: Sage Publications.
- Cromley, J. G., & Wills, T. W. (2016). Flexible strategy use by students who learn much versus little from text: transitions within think-aloud protocols. *Journal of Research in Reading*, 39(1), 50-71. doi:10.1111/1467-9817.12026

- Culpepper, J. S., Diaz, F., & Smucker, M. D. (2018). Research Frontiers in Information Retrieval. *Report from the Third Strategic Workshop on Information Retrieval in Lorne (SWIRL 2018) ACM SIGIR Forum*, 34-90. doi:10.1145/3274784.3274788
- Curtis, A. C. (2015). Defining adolescence. *Journal of Adolescent and Family Health*, 7(2), 2.
- Cutrer, W. B., Castro, D., Roy, K. M., & Turner, T. L. (2011). Use of an expert concept map as an advance organizer to improve understanding of respiratory failure. *Medical teacher*, 33(12), 1018-1026. doi:10.3109/0142159x.2010.531159
- Darabi, K., & Ghinea, G. (2015). Personalized video summarization using sift. *Proceedings of the 30th Annual ACM Symposium on Applied Computing*, 1252-1256.
- DeCuir-Gunby, J. T., Marshall, P. L., & McCulloch, A. W. (2011). Developing and using a codebook for the analysis of interview data: An example from a professional development research project. *Field methods*, 23(2), 136-155. doi:10.1177/1525822x10388468
- Deldjoo, Y., Elahi, M., Cremonesi, P., Garzotto, F., Piazzolla, P., & Quadrana, M. (2016). Content-based video recommendation system based on stylistic visual features. *Journal on Data Semantics*, 5(2), 99-113. doi:10.1007/s13740-016-0060-9
- Delen, E., Liew, J., & Willson, V. (2014). Effects of interactivity and instructional scaffolding on learning: Self-regulation in online video-based environments. *Computers & Education*, 78, 312-320. doi:10.1016/j.compedu.2014.06.018
- Demir, Y., & Uçar, A. (2016). Project based learning using student clubs and short online videos, in-class activities. *Proceedings of the 15th International Conference on Information Technology Based Higher Education and Training – ITHET'16*, 1-5.
- Dennis, J. K. (2003). Problem-based learning in online vs. face-to-face environments. *Education For Health (Abingdon, England)*, 16(2), 198-209. doi:10.1080/1357628031000116907
- Derczynski, L., Bontcheva, K., Liakata, M., Procter, R., Hoi, G. W. S., & Zubiaga, A. (2017). SemEval-2017 Task 8: RumourEval: Determining rumour veracity and support for rumours. *Proceedings of the 11th International Workshop on Semantic Evaluation*.
- DeSantis, L., & Ugarriza, D. N. (2000). The concept of theme as used in qualitative nursing research. *Western Journal of Nursing Research*, 22(3), 351-372. doi:10.1177/019394590002200308
- di Sciascio, C., Brusilovsky, P., & Veas, E. (2018). A study on user-controllable social exploratory search. *Proceedings of the 23rd International conference on intelligent user interfaces*, 353-364. doi:10.1145/3172944.3172986
- Dong, R., O'Mahony, M. P., Schaal, M., McCarthy, K., & Smyth, B. (2016). Combining similarity and sentiment in opinion mining for product recommendation. *Journal of Intelligent Information Systems*, 46(2), 285-312. doi:10.1007/s10844-015-0379-y
- Dörk, M., Riche, N. H., Ramos, G., & Dumais, S. (2012). Pivotpaths: Strolling through faceted information spaces. *IEEE Transactions on Visualization and Computer Graphics*, 18(12), 2709-2718. doi:10.1109/tvcg.2012.252
- Easton, K. L., McComish, J. F., & Greenberg, R. (2000). Avoiding common pitfalls in qualitative data collection and transcription. *Qualitative health research*, 10(5), 703-707. doi:10.1177/104973200129118651
- Eickhoff, C., Collins-Thompson, K., Bennett, P. N., & Dumais, S. (2013). Personalizing atypical web search sessions. *Proceedings of the 6th ACM international conference on Web search and data mining*, 285-294. doi:10.1145/2433396.2433434
- Ellis, D. (1989). A behavioral approach to information retrieval system design. *Journal of Documentation*, 45(3), 171-212. doi:10.1108/eb026843
- Elsaadany, A., & Abbas, K. (2016). Development and implementation of e-learning system in smart educational environment. *Proceedings of the 39th International Convention on*

Information and Communication Technology, Electronics and Microelectronics - MIPRO'16, 1004-1009. doi:10.1109/mipro.2016.7522286

- Eppler, M. J. (2006). A comparison between concept maps, mind maps, conceptual diagrams, and visual metaphors as complementary tools for knowledge construction and sharing. *Information Visualization*, 5(3), 202-210. doi:10.1057/palgrave.ivs.9500131
- Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American journal of theoretical and applied statistics*, 5(1), 1-4.
- Fang, Y. H. (2014). Beyond the credibility of electronic word of mouth: Exploring eWOM adoption on social networking sites from affective and curiosity perspectives. *International Journal of Electronic Commerce*, 18(3), 67-102. doi:10.2753/jec1086-4415180303
- Fazel-Zarandi, M., Devlin, H. J., Huang, Y., & Contractor, N. (2011). Expert recommendation based on social drivers, social network analysis, and semantic data representation. *Proceedings of the 2nd International workshop on information heterogeneity and fusion in recommender systems*, 41-48. doi:10.1145/2039320.2039326
- Fereday, J., & Muir-Cochrane, E. (2006). Demonstrating rigor using thematic analysis: A hybrid approach of inductive and deductive coding and theme development. *International Journal of Qualitative methods*, 5(1), 80-92. doi:10.1177/160940690600500107
- Fernquist, J., & Chi, E. H. (2013). Perception and understanding of social annotations in web search. *Proceedings of the 22nd International conference on World Wide Web*, 403-412.
- Figuerola Salas, Ó., Adzic, V., Shah, A., & Kalva, H. (2013). Assessing internet video quality using crowdsourcing. *Proceedings of the 2nd ACM international workshop on Crowdsourcing for multimedia*, 23-28. doi:10.145/2506364.2506366
- Flanagin, A. J., & Metzger, M. J. (2007). The role of site features, user attributes, and information verification behaviors on the perceived credibility of web-based information. *New Media & Society*, 9(2), 319-342. doi:10.1177/1461444807075015
- Flick, U. (2018). *An introduction to qualitative research* London : Sage Publications Limited.
- Foo, S., Majid, S., Azura Mokhtar, I., Zhang, X., Chang, Y.-K., Luyt, B., & Theng, Y.-L. (2014). Information literacy skills of secondary school students in Singapore. *Aslib journal of information management*, 66(1), 54-76. doi:10.1108/ajim-08-2012-0066
- Forbes, H., Oprescu, F. I., Downer, T., Phillips, N. M., McTier, L., Lord, B., . . . Dayton, J. (2016). Use of videos to support teaching and learning of clinical skills in nursing education: A review. *Nurse education today*, 42, 53-56. doi:10.1016/j.nedt.2016.04.010
- Foster, A. (2003). Serendipity and information seeking: an empirical study. *Journal of Documentation*, 59(3), 321-340. doi:10.1108/00220410310472518
- Gao, Q., Tian, Y., & Tu, M. (2015). Exploring factors influencing Chinese user's perceived credibility of health and safety information on Weibo. *Computers in Human Behavior*, 45, 21-31. doi:10.1016/j.chb.2014.11.071
- Gao, T., Dontcheva, M., Adar, E., Liu, Z., & Karahalios, K. G. (2015). Datatone: Managing ambiguity in natural language interfaces for data visualization. *Proceedings of the 28th Annual ACM Symposium on User Interface Software & Technology*, 489-500.
- Garrison, D. R. (1992). Critical thinking and self-directed learning in adult education: An analysis of responsibility and control issues. *Adult education quarterly*, 42(3), 136-148. doi:10.1177/074171369204200302
- Garrison, D. R. (1997). Self-directed learning: Toward a comprehensive model. *Adult education quarterly*, 48(1), 18-33. doi:10.1177/074171369704800103
- George, C., Bright, A., Hurlbert, T., Linke, E. C., St Clair, G., & Stein, J. (2006). Scholarly use of information: graduate students' information seeking behavior. *Information Research: An International Electronic Journal*, 11(4), n4.

- Given, L. M. (2002). The academic and the everyday: Investigation the overlap in mature undergraduates' information-seeking behaviors. *Library and Information Science Research*, 24(1), 17-29. doi:10.1016/s0740-8188(01)00102-5
- Goel, P., Giangreco, I., Rossetto, L., Tănase, C., & Schuldt, H. (2017). "Hey, vitrivr!" - A Multimodal UI for Video Retrieval. In J. Jose et al. (Eds.), *LNCS Vol: 10193, Advances in Information Retrieval* (pp. 749-752).
- Golovchinsky, G., Diriye, A., & Dunnigan, T. (2012). The future is in the past: designing for exploratory search. *Proceedings of the 4th Information Interaction in Context Symposium – IIIX'12*, 52-61. doi:10.1145/2362724.2362738
- Google launches YouTube Gaming to challenge Amazon-owned Twitch. (2015, 26 August 2015). Retrieved from <https://www.theguardian.com/technology/2015/aug/26/youtube-gaming-live-website-apps>
- Guo, P. J., Kim, J., & Rubin, R. (2014). How video production affects student engagement: An empirical study of mooc videos. *Proceedings of the 1st ACM conference on Learning @ scale conference*, 41-50. doi:10.1145/2556325.2566239
- Halvey, M., Vallet, D., Hannah, D., & Jose, J. M. (2014). Supporting exploratory video retrieval tasks with grouping and recommendation. *Information Processing & Management*, 50(6), 876-898. doi:10.1016/j.ipm.2014.06.004
- Hanjalic, A., Lagendijk, R. L., & Biemond, J. (1999). Automated high-level movie segmentation for advanced video-retrieval systems. *IEEE transactions on circuits and systems for video technology*, 9(4), 580-588. doi:10.1109/76.767124
- Hansch, A., Hillers, L., McConachie, K., Newman, C., Schildhauer, T., & Schmidt, J. P. (2015). Video and online learning: Critical reflections and findings from the field. *HIIG Discussion Paper Series No. 2015-02*. Retrieved from: <https://ssrn.com/abstract=2577882>
- Hargittai, E., & Young, H. (2012). Searching for a "Plan B": young adults' strategies for finding information about emergency contraception online. *Policy & Internet*, 4(2), 1-23.
- Hassan, A., White, R. W., Dumais, S. T., & Wang, Y.-M. (2014). Struggling or exploring?: disambiguating long search sessions. *Proceedings of the 7th ACM international conference on Web search and data mining*, 53-62. doi:10.1145/2556195.2556221
- He, X., Gao, M., Kan, M. Y., Liu, Y., & Sugiyama, K. (2014). Predicting the popularity of web 2.0 items based on user comments. *Proceedings of the 37th International ACM SIGIR conference on Research & development in information retrieval*, 233-242.
- Hearst, M. (2009). *Search user interfaces*. New York, NY: Cambridge University Press.
- Hendahewa, C., & Shah, C. (2017). Evaluating user search trails in exploratory search tasks. *Information Processing & Management*, 53(4), 905-922. doi:10.1016/j.ipm.2017.04.001
- Hinze, A., McKay, D., Vanderschantz, N., Timpany, C., & Cunningham, S. J. (2012). Book selection behavior in the physical library: implications for ebook collections. *Proceedings of the 12th ACM/IEEE-CS joint conference on Digital Libraries*, 305-314.
- Höchstötter, N., & Lewandowski, D. (2009). What users see—Structures in search engine results pages. *Information Sciences*, 179(12), 1796-1812. doi:10.1016/j.ins.2009.01.028
- Houston, J. B., Hansen, G. J., & Nisbett, G. S. (2011). Influence of user comments on perceptions of media bias and third-person effect in online news. *Electronic News*, 5(2), 79-92. doi:10.1177/1931243111407618
- Hudelist, M. A., Schoeffmann, K., & Xu, Q. (2015). Improving interactive known-item search in video with the keyframe navigation tree. In X. He, S. Luo, D. Tao, C. Xu, J. Yang, & M. A. Hasan (Eds.), *LNCS Vol 8935, Multimedia Modeling* (pp. 306-317).
- Hürst, W., Snoek, C. G. M., Spoel, W. J., & Tomin, M. (2011). Size Matters! How Thumbnail Number, Size, and Motion Influence Mobile Video Retrieval. In K. T. Lee, W. H. Tsai, H. Y. M. Liao, T. Chen, J. W. Hsieh, & C. C. Tseng (Eds.), *Advances in Multimedia*

- Modeling: 17th International Multimedia Modeling Conference, MMM 2011, Taipei, Taiwan, January 5-7, 2011, Proceedings, Part II* (pp. 230-240).
- Huurdean, H. C., Wilson, M. L., & Kamps, J. (2016). Active and Passive Utility of Search Interface Features in Different Information Seeking Task Stages. *Proceedings of the ACM on Conference on Human Information Interaction and Retrieval – CHIIR '16*, 3-12.
- Ingwersen, P. (2003). Information-Seeking Research. *International Encyclopedia of Information and Library Science* (pp. 301-303). London, UK: Routledge.
- Islam, M. A., & Tsuji, K. (2010). Assessing information literacy competency of information science and library management graduate students of Dhaka University. *IFLA journal*, 36(4), 300-316. doi:10.1177/0340035210388243
- Jackson, A., Lin, J., Milligan, I., & Ruest, N. (2016). Desiderata for exploratory search interfaces to web archives in support of scholarly activities. *Proceedings of the IEEE/ACM Joint Conference on Digital Libraries – JCDL '16*, 103-106. doi:10.1145/2910896.2910912
- Jain, A., Tayal, D. K., & Yadav, S. (2016). Retrieving web search results using Max–Max soft clustering for Hindi query. *International Journal of System Assurance Engineering and Management*, 7(1), 70-81. doi:10.1007/s13198-014-0307-5
- Jain, S. D., & Grauman, K. (2016). Click carving: Segmenting objects in video with point clicks. *Proceedings of the 4th AAAI Conference on Human Computation and Crowdsourcing*, 89-98. doi:10.1007/s11263-019-01184-2
- Jansen, B. J., Smith, B., & Booth, D. (2007). Learning as a paradigm for understanding exploratory search. *Proceedings of the ACM SIGCHI 2007 Workshop on "Exploratory Search and HCI: Designing and Evaluating Interfaces to Support Exploratory Search Interaction"*, 72-75.
- Jiang, L., Yu, S.-I., Meng, D., Yang, Y., Mitamura, T., & Hauptmann, A. G. (2015). Fast and accurate content-based semantic search in 100m internet videos. *Proceedings of the 23rd ACM International conference on Multimedia*, 49-58. doi:10.1145/2733373.2806237
- Jiang, S., & Wilson, C. (2018). Linguistic signals under misinformation and fact-checking: Evidence from user comments on social media. *Proceedings of the ACM on Human-Computer Interaction*, 2(CSCW), 82. doi:10.1145/3274351
- Jiang, T. (2014). Exploratory search: a critical analysis of the theoretical foundations, system features, and research trends. In C. Chen & R. Larsen (Eds.), *Library and Information Sciences* (pp. 79-103). Berlin, Heidelberg: Springer.
- Jiang, Y. G., Wang, J., Wang, Q., Liu, W., & Ngo, C. W. (2016). Hierarchical visualization of video search results for topic-based browsing. *IEEE Transactions on Multimedia*, 18(11), 2161-2170. doi:10.1109/tmm.2016.2614233
- Joo, S., & Choi, N. (2015). Factors affecting undergraduates' selection of online library resources in academic tasks: usefulness, ease-of-use, resource quality, and individual differences. *Library Hi Tech*, 33(2), 272-291. doi:10.1108/lht-01-2015-0008
- Kakol, M., Nielek, R., & Wierzbicki, A. (2017). Understanding and predicting Web content credibility using the Content Credibility Corpus. *Information Processing & Management*, 53(5), 1043-1061. doi:10.1016/j.ipm.2017.04.003
- Kaldoudi, E., Dovrolis, N., & Dietze, S. (2011). Information organization on the internet based on heterogeneous social networks. *Proceedings of the 29th ACM International conference on Design of communication*, 107-114. doi:10.1145/2038476.2038496
- Kammerer, Y., Brand-Gruwel, S., & Jarodzka, H. (2018). The Future of Learning by Searching the Web: Mobile, Social, and Multimodal. *Frontline Learning Research*, 6(2), 81-91.
- Kammerer, Y., & Gerjets, P. (2014). The role of search result position and source trustworthiness in the selection of web search results when using a list or a grid interface. *International Journal of Human-Computer Interaction*, 30(3), 177-191.

- Kay, R. H. (2012). Exploring the use of video podcasts in education: A comprehensive review of the literature. *Computers in Human Behavior*, 28(3), 820-831. doi:10.1016/j.chb.2012.01.001
- Kelly, D., & Azzopardi, L. (2015). How many results per page?: A Study of SERP Size, Search Behavior and User Experience. *Proceedings of the 38th International ACM SIGIR Conference on Research and Development in Information Retrieval*, 183-192.
- Khoo, K., Bolt, P., Babl, F. E., Jury, S., & Goldman, R. D. (2008). Health information seeking by parents in the Internet age. *Journal of paediatrics and child health*, 44(7-8), 419-423. doi:10.1111/j.1440-1754.2008.01322.x
- Khoreva, A., Rohrbach, A., & Schiele, B. (2018). Video object segmentation with language referring expressions. In C. Jawahar, H. Li, G. Mori, & K. Schindler (Eds.), *LNCS Vol: 11364, Computer Vision – ACCV 2018* (pp. 123-141).
- Kim, J. (2009). Describing and predicting information-seeking behavior on the Web. *Journal of the Association for Information Science and Technology*, 60(4), 679-693. doi:10.1002/asi.21035
- Kim, J., Lee, D., & Chung, K. Y. (2014). Item recommendation based on context-aware model for personalized u-healthcare service. *Multimedia tools and applications*, 71(2), 855-872. doi:10.1007/s11042-011-0920-0
- Kim, K. S., & Allen, B. (2002). Cognitive and task influences on Web searching behavior. *Journal of the American Society for Information Science and Technology*, 53(2), 109-119. doi:10.1002/asi.10014
- Kim, R., Olfman, L., Ryan, T., & Eryilmaz, E. (2014). Leveraging a personalized system to improve self-directed learning in online educational environments. *Computers & Education*, 70, 150-160. doi:10.1016/j.compedu.2013.08.006
- Kind, T., & Evans, Y. (2015). Social media for lifelong learning. *International Review of Psychiatry*, 27(2), 124-132. doi:10.3109/09540261.2014.990421
- Kleftodimos, A., & Evangelidis, G. (2016). An interactive video-based learning environment supporting learning analytics: Insights obtained from analyzing learner activity data. In Y. Li et al. (Eds.), *State-of-the-Art and Future Directions of Smart Learning* (pp. 471-481) Singapore : Springer.
- Klouche, K., Ruotsalo, T., Cabral, D., Andolina, S., Bellucci, A., & Jacucci, G. (2015). Designing for exploratory search on touch devices. *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems – CHI'15*, 4189-4198.
- Kodama, C., Jean, B. S., Subramaniam, M., & Taylor, N. G. (2017). There's a creepy guy on the other end at Google!: engaging middle school students in a drawing activity to elicit their mental models of Google. *Information Retrieval Journal*, 20(5), 403-432.
- Kolikant, Y. B. D. (2010). Digital natives, better learners? Students' beliefs about how the Internet influenced their ability to learn. *Computers in Human Behavior*, 26(6), 1384-1391. doi:10.1016/j.chb.2010.04.012
- Kop, R., & Fournier, H. (2011). New dimensions to self-directed learning in an open networked learning environment. *International Journal of Self-Directed Learning*, 7(2), 1-18.
- Koper, R. (2003). Combining reusable learning resources and services with pedagogical purposeful units of learning. In A. Littlejohn (ed.), *Reusing online resources* (pp. 64-77). London, UK: Routledge.
- Krishnan, K., Krishnan, R., & Muthumari, A. (2017). A semantic-based ontology mapping–information retrieval for mobile learning resources. *International Journal of Computers and Applications*, 39(3), 169-178. doi:10.1080/1206212x.2017.1309223
- Krippendorff, K. (2004). Content analysis: An introduction to its methodology (4th ed.). London, UK: Sage Publications.

- Krovetz, R., & Croft, W. B. (1992). Lexical ambiguity and information retrieval. *ACM Transactions on Information Systems (TOIS)*, 10(2), 115-141.
- Kuehne, H., Gall, J., & Serre, T. (2016). An end-to-end generative framework for video segmentation and recognition. *Proceeding of the IEEE Winter Conference on Applications of Computer Vision - WACV'16*, 1-8.
- Kuhlthau, C. C. (1991). Inside the search process: Information seeking from the user's perspective. *Journal of the American Society for Information Science*, 42(5), 361-371. doi:10.1002/(sici)1097-4571(199106)42:5%3C361::aid-asi6%3E3.0.co;2-#
- Kules, B., & Capra, R. (2008). Creating exploratory tasks for a faceted search interface. *Proceedings of the 2nd workshop on HCIR'08*, 18-21.
- Kules, B., Capra, R., Banta, M., & Sierra, T. (2009). What do exploratory searchers look at in a faceted search interface? *Proceedings of the 9th ACM/IEEE-CS joint conference on Digital libraries*, 313-322. doi:10.1145/1555400.1555452
- Kumar, A., Srivastava, K., Yadav, K., & Deshmukh, O. (2017). Multi-faceted Index driven Navigation for Educational Videos in Mobile Phones. *Proceedings of the 22nd International Conference on Intelligent User Interfaces*, 357-361.
- Lee, H., & Smeaton, A. F. (2006). Designing the user interface for the Físchlár Digital Video Library. *Journal of Digital information*, 2(4).
- Lee, M. K., Cheung, C. M., & Chen, Z. (2005). Acceptance of Internet-based learning medium: the role of extrinsic and intrinsic motivation. *Information & management*, 42(8), 1095-1104. doi:10.1016/j.im.2003.10.007
- Lee, S. W. Y., & Tsai, C. C. (2011). Students' perceptions of collaboration, self-regulated learning, and information seeking in the context of Internet-based learning and traditional learning. *Computers in Human Behavior*, 27(2), 905-914. doi:10.1016/j.chb.2010.11.016
- Lin, L., Ravitz, G., Shyu, M. L., & Chen, S. C. (2007). Video semantic concept discovery using multimodal-based association classification. *Proceedings of the IEEE International Conference on Multimedia and Expo – ICME'07*, 859-862. doi:10.1109/ICME.2007.4284786
- Lin, W.-Y., Zhang, X., Song, H., & Omori, K. (2016). Health information seeking in the Web 2.0 age: Trust in social media, uncertainty reduction, and self-disclosure. *Computers in Human Behavior*, 56, 289-294. doi:10.1016/j.chb.2015.11.055
- List, A., Grossnickle, E. M., & Alexander, P. A. (2016). Undergraduate students' justifications for source selection in a digital academic context. *Journal of Educational Computing Research*, 54(1), 22-61. doi:10.1177/0735633115606659
- Little, J. J., & Gu, Z. (2001). Video retrieval by spatial and temporal structure of trajectories. *Proceedings of the SPIE 4315, Storage and Retrieval for Media Databases*.
- Liu, C. C., Fan Chiang, S. H., Chou, C. Y., & Chen, S. Y. (2010). Knowledge exploration with concept association techniques. *Online Information Review*, 34(5), 786-805.
- Liu, M., Wang, X., Nie, L., He, X., Chen, B., & Chua, T.-S. (2018). Attentive moment retrieval in videos. *Proceedings of the 41st International ACM SIGIR Conference on Research & Development in Information Retrieval*, 15-24. doi:10.1145/3209978.3210003
- Long, T., Logan, J., & Waugh, M. (2016). Students' perceptions of the value of using videos as a pre-class learning experience in the flipped classroom. *TechTrends*, 60(3), 245-252.
- Lucrédio, D., Fortes, R. P. d. M., & Whittle, J. (2008). MOOGLE: A model search engine. In K. Czarniecki, I. Ober, J. M. Bruel, A. Uhl, & M. Völter (Eds.), *LNCS Vol: 5301, Model Driven Engineering Languages and Systems* (pp. 296-310).
- Luo, L. (2010). Web 2.0 integration in information literacy instruction: an overview. *The Journal of Academic Librarianship*, 36(1), 32-40. doi:10.1016/j.acalib.2009.11.004

- MacQueen, K. M., McLellan, E., Kay, K., & Milstein, B. (1998). Codebook development for team-based qualitative analysis. *Field methods*, 10(2), 31-36. doi:10.1177/1525822x980100020301
- Madden, A., Ruthven, I., & McMenemy, D. (2013). A classification scheme for content analyses of YouTube video comments. *Journal of Documentation*, 69(5), 693-714.
- Marchionini, G. (1995). *Information seeking in electronic environments*. Cambridge, UK: Cambridge University Press.
- Marchionini, G. (2006). Exploratory search: From finding to understanding. *Communications of the ACM*, 49(4), 41-46. doi:10.1145/1121949.1121979
- Marie, N., Gandon, F., Giboin, A., & Palagi, É. (2014). Exploratory search on topics through different perspectives with DBpedia. *Proceedings of the 10th International Conference on Semantic Systems*, 45-52. doi:10.1145/2660517.2660518
- Matthijs, N., & Radlinski, F. (2011). Personalizing web search using long term browsing history. *Proceedings of the 4th ACM international conference on Web search and data mining – WSDM'11*, 25-34. doi:10.1145/1935826.1935840
- Maxwell, J. A. (2013). *Qualitative research design: An interactive approach* (Vol. 41). Thousand Oaks, California: Sage publications.
- McLellan, E., MacQueen, K. M., & Neidig, J. L. (2003). Beyond the qualitative interview: Data preparation and transcription. *Field methods*, 15(1), 63-84. doi:10.1177/1525822x02239573
- Mergenthaler, E., & Stinson, C. (1992). Psychotherapy transcription standards. *Psychotherapy Research*, 2(2), 125-142. doi:10.1080/10503309212331332904
- Merkt, M., Weigand, S., Heier, A., & Schwan, S. (2011). Learning with videos vs. learning with print: The role of interactive features. *Learning and Instruction*, 21(6), 687-704. doi:10.1016/j.learninstruc.2011.03.004
- Messing, S., & Westwood, S. J. (2014). Selective exposure in the age of social media: Endorsements trump partisan source affiliation when selecting news online. *Communication research*, 41(8), 1042-1063. doi:10.1177/0093650212466406
- Millard, D., Howard, Y., Bailey, C., Davis, H., Gilbert, L., Jeyes, S., . . . Tulloch, I. (2005). Mapping the e-learning assessment domain: concept maps for orientation and navigation. *Proceedings of the E-Learn: World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education*, 2770-2775.
- Miner, K. I. (2019). Sentiment Analysis. Retrieved from <https://www.knime.com/blog/sentiment-analysis>
- Ministry of Education, Singapore. (2019). *Post-Secondary Education*. Retrieved from <https://www.moe.gov.sg/education/post-secondary>
- Mitra, A., Biswas, S., & Bhattacharyya, C. (2016). Bayesian modeling of temporal coherence in videos for entity discovery and summarization. *IEEE Transactions on pattern analysis and machine intelligence*, 39(3), 430-443. doi:10.1109/tpami.2016.2557785
- Monchaux, S., Amadieu, F., Chevalier, A., & Mariné, C. (2015). Query strategies during information searching: Effects of prior domain knowledge and complexity of the information problems to be solved. *Information Processing & Management*, 51(5), 557-569. doi:10.1016/j.ipm.2015.05.004
- Mor, N., Riva, O., Nath, S., & Kubiawicz, J. (2015). Bloom Cookies: Web Search Personalization without User Tracking. *Proceedings of the Network and Distributed System Security Symposium*. doi:10.14722/ndss.2015.23108
- Morris, D., Ringel Morris, M., & Venolia, G. (2008). SearchBar: a search-centric web history for task resumption and information re-finding. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 1207-1216. doi:10.1145/1357054.1357242

- Mu, X., & Marchionini, G. (2003). Enriched video semantic metadata: Authorization, integration, and presentation. *Proceedings of the American Society for Information Science and Technology*, 40(1), 316-322. doi:10.1002/meet.1450400139
- Nanni, L. P., & Feltrim, V. D. (2015). Desire: A dynamic approach for exploratory search results recommendation. *Proceeding of the Brazilian Conference on Intelligent Systems - BRACIS'15*, 288-293. doi:10.1109/BRACIS.2015.57
- Napoletano, P. (2018). Visual descriptors for content-based retrieval of remote-sensing images. *International journal of remote sensing*, 39(5), 1343-1376. doi:10.1080/01431161.2017.1399472
- Ngoon, T. J., Walker, C. M., & Klemmer, S. (2019). The Dark Side of Satisficing: Setting the Temperature of Creative Thinking. *Proceedings of the 2019 on Creativity and Cognition*, 591-596. doi:10.1145/3325480.3326581
- Nguyen, P. Q., Do, T., Nguyen-Thi, A. T., Ngo, T. D., Le, D. D., & Nguyen, T. A. H. (2016). Clustering web video search results with convolutional neural networks. *Proceedings of the 3rd National Foundation for Science and Technology Development Conference on Information and Computer Science - NICS'16*, 135-140. doi:10.1109/nics.2016.7725638
- Nguyen, T., & Zhang, J. (2006). A novel visualization model for web search results. *IEEE Transactions on Visualization and Computer Graphics*, 12(5), 981-988.
- Novak, J. D., & Cañas, A. J. (2008). *The theory underlying concept maps and how to construct and use them* (IHMC 2006-01). Retrieved from Florida Institute for Human and Machine Cognition website:
<http://cmap.ihmc.us/Publications/ResearchPapers/TheoryUnderlyingConceptMaps.pdf>
- Oomen-Early, J., Bold, M., Wiginton, K. L., Gallien, T. L., & Anderson, N. (2008). Using asynchronous audio communication (AAC) in the online classroom: A comparative study. *Journal of Online Learning and Teaching*, 4(3), 267-276.
- Palagi, E., Gandon, F., Giboin, A., & Troncy, R. (2017). A survey of definitions and models of exploratory search. *Proceedings of the 2017 ACM Workshop on Exploratory Search and Interactive Data Analytics*, 3-8. doi:10.1145/3038462.3038465
- Pavel, A., Hartmann, B., & Agrawala, M. (2014). Video digests: a browsable, skimmable format for informational lecture videos. *Proceedings of the 27th annual ACM symposium on User interface software and technology*, 573-582. doi:10.1145/2642918.2647400
- Peltonen, J., Belorustceva, K., & Ruotsalo, T. (2017). Topic-relevance map: Visualization for improving search result comprehension. *Proceedings of the 22nd International Conference on Intelligent User Interfaces*, 611-622. doi:10.1145/3025171.3025223
- Pinho, E., Godinho, T., Valente, F., & Costa, C. (2017). A multimodal search engine for medical imaging studies. *Journal of Digital Imaging*, 30(1), 39-48. doi:10.1007/s10278-016-9903-z
- Pirolli, P., & Card, S. (1995). Information foraging in information access environments. *Proceedings of the SIGCHI conference on Human Factors in Computing Systems*.
- Plummer, B. A., Brown, M., & Lazebnik, S. (2017). Enhancing video summarization via vision-language embedding. *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*, 5781-5789. doi:10.1109/cvpr.2017.118
- Puntambekar, S., Stylianou, A., & Hübscher, R. (2003). Improving navigation and learning in hypertext environments with navigable concept maps. *Human-Computer Interaction*, 18(4), 395-428. doi:10.1207/s15327051hci1804_3
- Qu, Y., & Furnas, G. W. (2008). Model-driven formative evaluation of exploratory search: A study under a sensemaking framework. *Information Processing & Management*, 44(2), 534-555. doi:10.1016/j.ipm.2007.09.006

- Rath, M., Ghosh, S., & Shah, C. (2018). Exploring online and offline search behavior based on the varying task complexity. *Proceedings of the 2018 Conference on Human Information Interaction & Retrieval*, 285-288. doi:10.1145/3176349.3176890
- Ren, F., & Bracewell, D. B. (2009). Advanced information retrieval. *Electronic Notes in Theoretical Computer Science*, 225, 303-317.
- Rieh, S. Y., Collins-Thompson, K., Hansen, P., & Lee, H. J. (2016). Towards searching as a learning process: A review of current perspectives and future directions. *Journal of Information Science*, 42(1), 19-34. doi:10.1177/0165551515615841
- Robertson, S., Zaragoza, H., & Taylor, M. (2004). Simple BM25 extension to multiple weighted fields. *Proceedings of the 13th ACM international conference on Information and knowledge management*, 42-49. doi:10.1145/1031171.1031181
- Rodicio, H. G. (2015). Students' evaluation strategies in a Web research task: Are they sensitive to relevance and reliability? *Journal of Computing in Higher Education*, 27(2), 134-157.
- Rupp, M. A., Odette, K. L., Kozachuk, J., Michaelis, J. R., Smither, J. A., & McConnell, D. S. (2019). Investigating learning outcomes and subjective experiences in 360-degree videos. *Computers & Education*, 128, 256-268. doi:10.1016/j.compedu.2018.09.015
- Saldaña, J. (2009). *The coding manual for qualitative researchers*. London, UK: Sage Publications.
- Salim, F. A., Haider, F., Conlan, O., & Luz, S. (2017). An Alternative Approach to Exploring a Video. In A. Karpov, R. Potapova, & I. Mporas (Eds.), *LNCS Vol: 10458, Speech and Computer* (pp. 109-118).
- Sapa, R., Krakowska, M., & Janiak, M. (2014). Information seeking behavior of mathematicians: scientists and students. *Information Research: An International Electronic Journal*, 19(4), n4.
- Savolainen, R. (2007). Filtering and withdrawing: strategies for coping with information overload in everyday contexts. *Journal of Information Science*, 33(5), 611-621. doi:10.1177/0165551506077418
- Savolainen, R. (2018). Berrypicking and information foraging: Comparison of two theoretical frameworks for studying exploratory search. *Journal of Information Science*, 44(5), 580-593. doi:10.1177/0165551517713168
- Schymik, G., Corral, K., Schuff, D., & St Louis, R. (2015). The benefits and costs of using metadata to improve enterprise document search. *Decision Sciences*, 46(6), 1049-1075. doi:10.1111/dec.12154
- Sen, D., & Raman, B. (2019). Video skimming: taxonomy and comprehensive survey. *ACM Computing Surveys (CSUR)*, 52(5), 106. doi:10.1145/3347712
- Shah, C., Hendaheba, C., & González-Ibáñez, R. (2015). Two's company, but three's no crowd: Evaluating exploratory web search for individuals and teams. *Aslib journal of information management*, 67(6), 636-662. doi:10.1108/ajim-05-2015-0082
- Sharghi, A., Laurel, J. S., & Gong, B. (2017). Query-focused video summarization: Dataset, evaluation, and a memory network based approach. *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition CVPR '17*, 4788-4797.
- Sharp, H., Rogers, Y., & Preece, J. (2019). *Interaction design : beyond human-computer interaction*. New York, US: John Wiley and Sons.
- Siatri, R. (1999). The evolution of user studies. *Libri*, 49(3), 132-141. doi:10.1515/libr.1999.49.3.132
- Siddiq, F., & Scherer, R. (2017). Revealing the processes of students' interaction with a novel collaborative problem solving task: An in-depth analysis of think-aloud protocols. *Computers in Human Behavior*, 76, 509-525. doi:10.1016/j.chb.2017.08.007

- Sikos, L. F. (2018). Ontology-based structured video annotation for content-based video retrieval via spatiotemporal reasoning. In H. Kwasnicka & L. Jain (Eds.), *ISRL Vol: 145, Bridging the Semantic Gap in Image and Video Analysis* (pp. 97-122). Springer.
- Singh, R., Hsu, Y.-W., & Moon, N. (2013). Multiple perspective interactive search: a paradigm for exploratory search and information retrieval on the web. *Multimedia tools and applications*, 62(2), 507-543. doi:10.1007/s1042-011-0910-2
- Sivic, J., & Zisserman, A. (2003). Video Google: A text retrieval approach to object matching in videos. *Proceedings of the 9th IEEE International conference on Computer Vision*.
- Snoek, C. G., Huurnink, B., Hollink, L., De Rijke, M., Schreiber, G., & Worring, M. (2007). Adding semantics to detectors for video retrieval. *IEEE Transactions on Multimedia*, 9(5), 975-986. doi:10.1109/tmm.2007.900156
- Snoek, C. G., Worring, M., Koelma, D. C., & Smeulders, A. W. (2007). A learned lexicon-driven paradigm for interactive video retrieval. *IEEE Transactions on Multimedia*, 9(2), 280-292. doi:10.1109/tmm.2006.886275
- Song, D., & Bonk, C. J. (2016). Motivational factors in self-directed informal learning from online learning resources. *Cogent Education*, 3(1), 1205838.
- Song, L., & Hill, J. R. (2007). A conceptual model for understanding self-directed learning in online environments. *Journal of Interactive Online Learning*, 6(1), 27-42.
- Soper, D. (2019). *Sentiment Analyzer*. Retrieved from <https://www.danielsoper.com/sentimentanalysis/default.aspx>
- Starling, S., & Cheshire, C. (2016). Information seeking and evaluation of inline sexual health resources among late adolescents. *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems*, 3204-3210.
- Steinberg, L. (2010). A dual systems model of adolescent risk-taking. *Developmental Psychobiology*, 52(3), 216-224. doi:10.1002/dev.20445
- Steinberg, L. (2014). *Age of opportunity: Lessons from the new science of adolescence* New York, NY: Houghton Mifflin Harcourt.
- Stöhr, C., Stathakarou, N., Mueller, F., Nifakos, S., & McGrath, C. (2019). Videos as learning objects in MOOCs: A study of specialist and non-specialist participants' video activity in MOOCs. *British Journal of Educational Technology*, 50(1), 166-176.
- Stvilia, B., & Gasser, L. (2008). Value-based metadata quality assessment. *Library & Information Science Research*, 30(1), 67-74. doi:10.1016/j.lisr.2007.06.006
- Sugiyama, K., Hatano, K., & Yoshikawa, M. (2004). Adaptive web search based on user profile constructed without any effort from users. *Proceedings of the 13th International conference on World Wide Web*, 675-684. doi:10.1145/988672.988764
- Swar, B., Hameed, T., & Reyhav, I. (2017). Information overload, psychological ill-being, and behavioral intention to continue online healthcare information search. *Computers in Human Behavior*, 70, 416-425. doi:10.1016/j.chb.2016.12.068
- Tan, B., Shen, X., & Zhai, C. (2006). Mining long-term search history to improve search accuracy. *Proceedings of the 12th ACM SIGKDD international conference on Knowledge discovery and data mining*, 718-723. doi:10.1145/1150402.1150493
- Teevan, J., Alvarado, C., Ackerman, M. S., & Karger, D. R. (2004). The perfect search engine is not enough: a study of orienteering behavior in directed search. *Proceedings of the SIGCHI conference on Human factors in computing systems – CHI'04*, 415-422.
- Thomas, S. S., Gupta, S., & Venkatesh, K. (2017). Perceptual synoptic view-based video retrieval using metadata. *Signal, Image and Video Processing*, 11(3), 549-555.
- Traphagan, T., Kucsera, J. V., & Kishi, K. (2010). Impact of class lecture webcasting on attendance and learning. *Educational Technology Research and Development*, 58(1), 19-37. doi:10.1007/s11423-009-9128-7

- Tsai, C. H., & Brusilovsky, P. (2018). Beyond the ranked list: User-driven exploration and diversification of social recommendation. *Proceedings of the 23rd International Conference on Intelligent User Interfaces*, 239-250. doi:10.1145/3172944.3172959
- Tsironis, A., Katsanos, C., & Xenos, M. (2016). Comparative usability evaluation of three popular MOOC platforms. *Proceedings of the IEEE Global Engineering Education Conference – EDUCON'16*, 068-612. doi:10.1109/EDUCON.2016.7474613
- Turcu, G., Mihaescu, M. C., Heras, S., Palanca, J., & Julián, V. (2019). Video Transcript Indexing and Retrieval Procedure. *Proceedings of the International Conference on Software, Telecommunications and Computer Networks – SoftCOM'19*.
- Van Genuchten, E., Scheiter, K., & Schüler, A. (2012). Examining learning from text and pictures for different task types: Does the multimedia effect differ for conceptual, causal, and procedural tasks? *Computers in Human Behavior*, 28(6), 2209-2218. doi:10.1016/j.chb.2012.06.028
- van Wyk, M. M. (2017). Exploring student teachers' views on eportfolios as an empowering tool to enhance self-directed learning in an online teacher education course. *Australian Journal of Teacher Education*, 42(6), 1-21. doi:10.14221/ajte.2017v42n6.1
- Vandeveld, S., Van Keer, H., Schellings, G., & Van Hout-Wolters, B. (2015). Using think-aloud protocol analysis to gain in-depth insights into upper primary school children's self-regulated learning. *Learning and Individual Differences*, 43, 11-30.
- Virzi, R. A., Sorce, J. F., & Herbert, L. B. (1993). A comparison of three usability evaluation methods: Heuristic, think-aloud, and performance testing. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 37(4), 309-313.
- Viviani, M., & Pasi, G. (2017). Quantifier guided aggregation for the veracity assessment of online reviews. *International Journal of Intelligent Systems*, 32(5), 481-501.
- Waddell, T. F. (2018). What does the crowd think? How online comments and popularity metrics affect news credibility and issue importance. *New Media & Society*, 20(8), 3068-3083. doi:10.1177/1461444817742905
- Wang, Y., Luo, Z., & Jodoin, P. M. (2017). Interactive deep learning method for segmenting moving objects. *Pattern Recognition Letters*, 96, 66-75. doi:10.1016/j.patrec.2016.09.014
- Weiland, L., Hanser, F., & Scherp, A. (2014). Requirements to a Search Engine for Semantic Multimedia Content. *International Journal of Multimedia Data Engineering and Management*, 5(4), 53-65. doi:10.4018/ijmdem.2014100104
- White, R. W., & Morris, D. (2007). Investigating the querying and browsing behavior of advanced search engine users. *Proceedings of the 30th annual international ACM SIGIR conference on Research and development in information retrieval*, 255-262. doi:10.1145/1277741.1277787
- White, R. W., & Roth, R. A. (2009). Exploratory search: Beyond the query-response paradigm. *Synthesis Lectures on Information Concepts, Retrieval, and Services*, 1(1), 1-98. doi:10.2200/s0017ed1v01y200901icr003
- Wildemuth, B. M., & Freund, L. (2012). Assigning search tasks designed to elicit exploratory search behaviors. *Proceedings of the Symposium on Human-Computer Interaction and Information Retrieval – HCIR'12*, a4. doi:10.1145/2391224.2391228
- Williamson, K., & Johanson, G. (2013). *Research methods: information, systems and contexts*. Victoria, Australia: Tilde University Press.
- Willson, R., & Given, L. M. (2010). The effect of spelling and retrieval system familiarity on search behavior in online public access catalogs: a mixed methods study. *Journal of the American Society for Information Science and Technology*, 61(12), 2461-2476. doi:10.1002/asi.21433

- Wilson, M. L., & White, R. W. (2009). Evaluating advanced search interfaces using established information-seeking models. *Journal of the American Society for Information Science and Technology*, 60(7), 1407-1422. doi:10.1002/asi.21080
- Wilson, T. D. (2000). Human information behavior. *Informing science*, 3(2), 49-56.
- Winter, S., Brückner, C., & Krämer, N. C. (2015). They came, they liked, they commented: Social influence on Facebook news channels. *Cyberpsychology, Behavior, and Social Networking*, 18(8), 431-436. doi:10.1089/cyber.2015.0005
- Wood, W., & Hayes, T. (2012). Social Influence on consumer decisions: Motives, modes, and consequences. *Journal of Consumer Psychology*, 22(3), 324-328. doi:10.1016/j.jcps.2012.05.003
- Worring, M., Snoek, C. G., de Rooij, O., Nguyen, G. P., & Smeulders, A. W. (2007). The mediamill semantic video search engine. *Proceedings of the IEEE International Conference on Acoustics, Speech and Signal Processing – ICASSP '07*, 1213-1216.
- Wu, D., & Cai, W. (2016). An empirical study on Chinese adolescents' web search behavior. *Journal of Documentation*, 72(3), 435-453. doi:10.1108/jd-04-2015-0047
- Wu, J., Zhong, S.-h., Jiang, J., & Yang, Y. (2017). A novel clustering method for static video summarization. *Multimedia tools and applications*, 76(7), 9625-9641. doi:10.1007/s11042-016-3569-x
- Xia, Z., Xiong, N. N., Vasilakos, A. V., & Sun, X. (2017). EPCBIR: An efficient and privacy-preserving content-based image retrieval scheme in cloud computing. *Information Sciences*, 387, 195-204. doi:10.1016/j.ins.2016.12.030
- Xu, S., Li, H., Chang, X., Yu, S.-I., Du, X., Li, X., . . . Burger, S. (2015). Incremental multimodal query construction for video search. *Proceedings of the 5th ACM on International Conference on Multimedia Retrieval*, 675-678. doi:10.1145/2671188.2749413
- Xu, S., Sharples, S., & Makri, S. (2011). A user-centred mobile diary study approach to understanding serendipity in information research. *Information Research*, 16(3).
- Yadav, K., Gandhi, A., Biswas, A., Shrivastava, K., Srivastava, S., & Deshmukh, O. (2016). Vizig: Anchor points based non-linear navigation and summarization in educational videos. *Proceedings of the 21st International Conference on Intelligent User Interfaces*, 407-418. doi:10.1145/2856767.2856788
- Young, L. M., & Gavade, S. R. (2018). Translating emotional insights from hospitality employees' comments: Using sentiment analysis to understand job satisfaction. *International Hospitality Review*, 32(1), 75-92. doi:10.1108/ihr-08-2018-0007
- Yu, S., Yang, X., Cheng, G., & Wang, M. (2015). From learning object to learning cell: A resource organization model for ubiquitous learning. *Journal of Educational Technology & Society*, 18(2), 206-224.
- Yue, Z., Han, S., & He, D. (2014). Modeling search processes using hidden states in collaborative exploratory web search. *Proceedings of the 17th ACM conference on Computer supported cooperative work & social computing*, 820-830. doi:10.1145/2531602.2531658
- Zhang, D., Zhou, L., Briggs, R. O., & Nunamaker Jr, J. F. (2006). Instructional video in e-learning: Assessing the impact of interactive video on learning effectiveness. *Information & management*, 43(1), 15-27. doi:10.1016/j.im.2005.01.004
- Zhang, J., & Fei, W. (2010). Search engines' responses to several search feature selections. *The International Information & Library Review*, 42(3), 212-225. doi:10.1080/10572317.2010.10762866
- Zhang, Q., Wang, Y., Gong, Y., & Huang, X. (2016). Keyphrase extraction using deep recurrent neural networks on twitter. *Proceedings of the 2016 conference on empirical methods in natural language processing*, 836-845. doi:10.18653/v1/D16-1080

- Zhang, Y., Gao, K., Zhang, B., & Li, P. (2016). TimeTree: a novel way to visualize and manage exploratory search process. In C. Stephanidis (ed.), *Communications in Computer and Information Science* (pp. 313-319).
- Zhao, B., Xu, S., Lin, S., Wang, R., & Luo, X. (2019). A New Visual Interface for Searching and Navigating Slide-Based Lecture Videos. *Proceedings of the IEEE International Conference on Multimedia and Expo – ICME '19*, 928-933. doi:10.1109/ICME.2019.00164
- Zhu, H., Chen, E., Xiong, H., Yu, K., Cao, H., & Tian, J. (2015). Mining mobile user preferences for personalized context-aware recommendation. *ACM Transactions on Intelligent Systems and Technology (TIST)*, 5(4), 1-27. doi:10.1145/2532515
- Zimmerman, B. J. (1990). Self-regulated learning and academic achievement: An overview. *Educational Psychologist*, 25(1), 3-17. doi:10.1207/s15326985ep2501_2

APPENDICES

Appendix 3-1: IRB approval for Study 1



Research Support Office

Reg. No. 200604393R

IRB-2016-10-042

08 December 2016

Professor Foo Shou Boon, Schubert
Wee Kim Wee School of Communication and Information

NTU INSTITUTIONAL REVIEW BOARD APPROVAL

Project Title: Design and evaluation of video retrieval interfaces for post-secondary students

I refer to your application for ethics approval with respect to the above project.

The Board has considered your application and noted from your application that your research involves collecting behavioral data from participants through the use of video clips.

You have also confirmed that informed consent will be obtained from the participants and you have guaranteed the confidentiality of your participants' biodata obtained from them.

The documents reviewed are:

- a) NTU IRB application form dated **29 November 2016**
- b) Participant information sheet and consent form: version 1 dated **29 November 2016**
- c) Data collection form: version 1 dated **29 November 2016**

The Board is therefore satisfied with the bioethical consideration for the project and approves the ethics application under **Expedited** review. The approval period is from **08 December 2016** to **07 December 2017**. The NTU IRB reference number for this study is **IRB-2016-10-042**. Please use this reference number for all future correspondence.

The following protocol and compliances are to be observed upon NTU IRB approval

1. All research involving procedures greater than minimal risk on minors (individuals who are less than the legal age of 21 years old) requires IRB approved written Parental Consent and assent from the participant to be obtained before any research protocols can be administered. Minimal risk refers to an anticipated level of harm and discomfort that is no greater than that ordinarily encountered in daily life, or during the performance of routine educational, physical, or psychological examination.
2. Only the approved Participants Information Sheet and Consent Form should be used. It must be signed by each subject prior to initiation of any protocol procedures. In addition, each subject should be given a copy of the signed consent form.

Blk N2.1, B4-01, 76 Nanyang Drive, Singapore 637331 Nanyang Avenue, Singapore 639798
Tel : +65 6791 9857, Fax: 6793 2019
www.ntu.edu.sg



Research Support Office

3. Consent forms are important documents therefore they should be stored in the strictest arrangement. Loss of consent form would result in disciplinary action.
4. No deviation from, or changes of, the protocol should be initiated without prior written NTU IRB approval of an appropriate amendment.
5. The Principal Investigator should report promptly to NTU IRB regarding:
 - a. Deviation from, or changes to the protocol.
 - b. Changes increasing the risk to the subjects and/or affecting significantly the conduct of the trial
 - c. All serious adverse events (SAEs) which are both serious and unexpected.
 - d. New information that may affect adversely the safety of the subjects of the conduct of the trial.
 - e. Completion of the study.
6. Continuing Review Request/ Notice of Study completion form should be submitted to NTU IRB for the following:
 - a. Annual review: Status of the study should be reported to the NTU IRB at least annually using the Continuing Review Request/ Notice of Study completion form.
 - b. Study completion or termination: Continuing Review Request/ Notice of Study completion form is to be submitted within 4 to 6 weeks of study completion or termination.
7. All Principal Investigators should comply with existing legislation that would have an impact on the domain of their research.

A handwritten signature in black ink, appearing to read "Lionel", is positioned above the name of the signatory.

Professor Lionel Lee
Chair, NTU Institutional Review Board
encl.

cc Members, NTU Institutional Review Board

Appendix 3-2: Exploratory search tasks for participants (Study 1)

Exploratory Task 1

<XXXX>* is a class that will be taught in this semester. You want to find out more about this class so that you can prepare a presentation/demonstration related to a topic in this class. You have yet to decide on a specific topic. Find video(s) that can help you in this assignment.

Exploratory Task 2

Recall some topics that have been taught and select a topic that interests you and can be developed into a final year project, capstone project or project to be submitted for competition. Find video(s) that you feel can help you to scope your project.

Appendix 3-3: Advertisement for recruitment of participants (Study 1)

Research Participants Needed

Objectives:

This study aims to understand the video seeking behavior of Polytechnic/ITE students for self-directed learning. It also aims to recognise the desirable interactive features of the video retrieval system which is used to identify useful and relevant videos for learning.

Requirements:

1. Post-secondary students (ages 16-22)
2. At least 1 year of experience in searching for videos in the Internet
3. Participate in think-aloud video search session with short interviews within the session
4. Participate in post search interview

Expected time of Experiment:

- Approximately 1 hour

Incentives:

- Cash Incentive (\$10)

Study Details:

We are recruiting participants as part of a PhD research, “Design of Interactive features for Video Retrieval System”, under the supervision of Professors Schubert Foo and Shaheen Majid. We hope that you will be able to be a part of this study by participating in a think-aloud search session and interviews. A short video demonstration of think-aloud protocol will be introduced before the start of the search session. In the search session, you will be requested to complete 2 video search tasks using the think-aloud protocol followed by an interview at the completion of the tasks. The whole session will take about 1 hour.

Participation is strictly voluntary and you can choose to withdraw your participation at any time without needing to furnish reasons for withdrawal.

For more information, or to express your interest to participate in the study, please contact **Cliff Loke** at telephone: **6790 4460** or email: **cloke002@e.ntu.edu.sg**.

Appendix 3-4: Interview questions (Study 1)

Segment 1 - Input

1. What are the features that you think is useful in helping you find the videos in this platform?
2. What are other features that you think can help you find the videos better by allowing you to express what you need better?

Segment 2 - Refinement

1. With the initial search completed. You may find a need to improve and update the existing search result. Can you discuss on features that you think can help you refine the result list?
2. The results from the initial search might be overwhelming, what features will you use to manage the results?

Segment 3 - Selection

1. Based on the list of videos retrieved by you, can you discuss the features in this platform that can help you decide the most appropriate or helpful video(s)?
2. Are there any other features not found in this platform that you think would help you select the video?

Exit Interview

1. What other platforms/websites/applications have you used previously to search for videos?
2. How often do you manage to find videos that satisfy your needs and what are the difficulties encountered?
3. Are there any other features that you think a video search system should have?

Appendix 3-5: Part of the Inter-coder-Reliability computation

	Node	Kappa-Row
	Able to select from hierarchical cate	1
	Able to select from hierarchical cate	1
	Able to select from hierarchical cate	0.3829
	Assessment of video through skimmi	0.483
	Assessment of video through skimmi	1
	Assessment of video through skimmi	1
	Broad to narrow search	0.4827
	Broad to narrow search	1
	Broad to narrow search	1
	Broadening the search	0.5
	Broadening the search	1
	Broadening the search	1
	Decisions based on running time of v	0.4928
	Decisions based on running time of v	1
	Decisions based on running time of v	1
		
	Uses the subtitles when available	0.4863
	Uses the subtitles when available	1
	Using comments	1
	Using comments	0.4567
	Using comments	1
	View counts of video	1
	View counts of video	0.4848
	View counts of video	1
	Wary about click baits and commerc	0.4976
	Wary about click baits and commerc	1
	Wary about click baits and commerc	1
	Inter-coder Reliability	0.822946667

Appendix 4-1: IRB approval for Study 2



IRB-2017-11-016

03 January 2018

Professor Foo Shou Boon, Schubert
Wee Kim Wee School of Communication and Information

NTU INSTITUTIONAL REVIEW BOARD APPROVAL

Project Title: Design of video retrieval interface for exploratory video searches

I refer to your application for ethics approval with respect to the above project.

The Board has considered your application and noted from your application that your research involves collecting behavioral data from participants through interviews.

You have also confirmed that informed consent will be obtained from the participants and you have guaranteed the confidentiality of your participants' biodata obtained from them.

The documents reviewed are:

- a) NTU IRB application form dated **10 December 2017**
- b) Participant information sheet and consent form: version 1 dated **10 December 2017**
- c) Data collection form: version 1 dated **10 December 2017**

The Board is therefore satisfied with the bioethical consideration for the project and approves the ethics application under **Expedited** review. The approval period is from **03 January 2018** to **02 January 2019**. The NTU IRB reference number for this study is **IRB-2017-11-016**. Please use this reference number for all future correspondence.

The following protocol and compliances are to be observed upon NTU IRB approval

1. All research involving procedures greater than minimal risk on minors (individuals who are less than the legal age of 21 years old) requires IRB approved written Parental Consent and assent from the participant to be obtained before any research protocols can be administered. Minimal risk refers to an anticipated level of harm and discomfort that is no greater than that ordinarily encountered in daily life, or during the performance of routine educational, physical, or psychological examination.
2. Only the approved Participants Information Sheet and Consent Form should be used. It must be signed by each subject prior to initiation of any protocol procedures. In addition, each subject should be given a copy of the signed consent form.

Research Integrity and Ethics Office, NTU Institutional Review Board

50 Nanyang Avenue, NS4-05-92A, Singapore 639798, T: (65) 6592-2495, www.ntu.edu.sg

3. Consent forms are important documents therefore they should be stored in the strictest arrangement. Loss of consent form would result in disciplinary action.
4. No deviation from, or changes of, the protocol should be initiated without prior written NTU IRB approval of an appropriate amendment.
5. The Principal Investigator should report promptly to NTU IRB regarding:
 - a. Deviation from, or changes to the protocol.
 - b. Changes increasing the risk to the subjects and/or affecting significantly the conduct of the trial
 - c. All serious adverse events (SAEs) which are both serious and unexpected.
 - d. New information that may affect adversely the safety of the subjects of the conduct of the trial.
 - e. Completion of the study.
6. Continuing Review Request/ Notice of Study completion form should be submitted to NTU IRB for the following:
 - a. Annual review: Status of the study should be reported to the NTU IRB at least annually using the Continuing Review Request/ Notice of Study completion form.
 - b. Study completion or termination: Continuing Review Request/ Notice of Study completion form is to be submitted within 4 to 6 weeks of study completion or termination.
7. All Principal Investigators should comply with existing legislation that would have an impact on the domain of their research.



Professor Lionel Lee
Chair, NTU Institutional Review Board
encl.

Appendix 4-2: Email template to engage the experts

Email title: **Design ideas for Video retrieval systems interface and features**

Dear <addressee>,

I am a PhD student from Wee Kim Wee School of Communications and Information, Nanyang Technological University. I am currently exploring on the design of video retrieval interface features that can make exploratory video searches more efficient and effective.

As part of the data collection process, a series of expert interviews will be conducted to elicit design ideas and concepts for video retrieval systems' interfaces that can enhance exploratory searches. The project is supervised by Prof Schubert Foo (sfoo@ntu.edu.sg) and A/Prof Shaheen Majid (ASMAJID@ntu.edu.sg) from the same School. The IRB (Institution Review Board) has approved the data collection methodology for the project (Reference: IRB-2017-11-016).

As a <researcher/systems developer/designer> who has substantial experience and interaction with multimedia and videos, I cordially invite you to participate in a semi-structured interview to provide valuable insights and suggestions from your perspective of video retrieval interfaces. The face-to-face or phone interview is estimated to take no more than one hour. Your participation will be most invaluable to the research and could lead to development of novel interfaces that could make searching much more effective. You can find some of the interview questions at the end of this message.

If you are able to participate and assist with this research, please let me know so that I can follow up to determine a suitable date and time for the interview. I can be contacted at cloke002@e.ntu.edu.sg and 96266588. Please do not hesitate to contact me or my supervisors if you have any further questions or queries on the request and research.

Thank you very much for considering the request. I hope to have a favourable reply from you soon.

Best Regards,
Cliff Loke

Interview Questions (partial)

1. How is your experience with video retrieval, in particularly, when performing exploratory video searches?
2. Videos are multi-dimensional, consisting of audio channel and moving images channel as well as temporal. Do you think the multi-dimensional makeup of video can have richer interface features to be developed?
3. Very often, videos can be quite long and there can be so many videos presented in the results list. How can video seekers, be acquainted to the content of the video more efficiently and sufficiently so that they can decide whether the video is relevant?
4. What futuristic interface features can you envisage from the next generation of video retrieval systems?

Appendix 4-3: Interview Guide

Design of video retrieval interface features for exploratory searches

Objective: To develop effective video retrieval systems interface features and the interface features design concepts when performing exploratory video searches.

Research Questions:

1. What video interface features design concepts for a video retrieval system can enhance exploratory video searches?
 2. What video interface features can be suggested for a video retrieval system to support input/refinement for search of videos?
 3. What video interface features can be suggested for a video retrieval system to acquaint video content more efficiently?
-

Name of Interviewee: _____

Domain expertise: _____

Highest qualifications attained: _____

Date/Time of Interview: _____

Location of interview: _____

Thank you for agreeing to be interviewed for this study. People often turn to videos to support self-directed learning. My goal is to develop novel interface features and concepts for a video retrieval system that can support effective exploratory video searches for learners.

Before I begin, may I have your permission to have the interview audio recorded? As the interview would be about an hour, audio recording of the interview would allow me to have a more thorough and repeated examination of the interview as well as to ensure that I will not miss out details that you have said.

1. Opening Questions

1.1 Can you tell me what video or multimedia related work you are currently engaged with now?

1.2 How is your experience with video retrieval, in particularly, when performing exploratory* video searches?

**Exploratory search: Search in unfamiliar or new domain, unsure about goals and no clear-cut "correct" answers.*

[If nothing is said about challenges encountered:] What has been not-so-helpful or a challenge to you when performing such exploratory video searches?

2. Design concepts Questions

2.1 Videos are multi-dimensional, consisting of audio channel and moving images channel as well as is temporal. Do you think the multi-dimensional makeup of video can have richer interface features to be developed to support exploratory video searches for learning?

2.1.1 Can you describe possible instances of these features?

2.2 With more complex information needs, expressing exploratory searches can be challenging. For example, a user may be looking for a video but cannot properly define the problem, and/or there is no single correct video. For instance, the user might want to look for video(s) that shows the design factors for a car to have a balance between stability and speed. What new video interface features can allow input and refinement of such **exploratory** information needs for learning better?

2.2.1 Are you able to describe the design concept(s) behind this feature?

2.3 Very often, videos can be quite long and there can be so many videos presented in the results list. How can video seekers, be acquainted to the content of the video more efficiently and sufficiently so that they can decide whether the video is relevant for their **learning**?

2.4 What futuristic interface features can you envisage from the next generation of video retrieval systems?

2.4.1 Can you explain why do you think these features are important?

2.5 Are there other interface features that you think can make exploratory video searches more efficient and effective?

2.6 [Repeat Q2.5 until no new information is provided by the interviewee]

Thank you for your time.

May I also ask if you have other recommendations of others whom I can approach to be part of this panel of experts?

Appendix 5-1: IRB Approval for Study 3



Reg. No. 200604393R

IRB-2019-03-030

27 March 2019

Professor Foo Shou Boon, Schubert
Wee Kim Wee School of Communication and Information

NTU INSTITUTIONAL REVIEW BOARD APPROVAL

Project Title: Evaluation of video retrieval interface and features for post-secondary student learners

I refer to your application for ethics approval with respect to the above project.

The Board has considered your application and noted from your application that your research involves collecting behavioral data from participants through questionnaires and decision making tasks.

You have also confirmed that informed consent will be obtained from the participants and you have guaranteed the confidentiality of your participants' biodata obtained from them.

The documents reviewed are:

- a) NTU IRB application form dated **18 March 2019**
- b) Participant information sheet and consent form: version 1 dated **18 March 2019**
- c) Data collection form: version 1 dated **18 March 2019**

The Board is therefore satisfied with the bioethical consideration for the project and approves the ethics application under **Expedited** review. The approval period is from **27 March 2019 to 26 March 2020**. The NTU IRB reference number for this study is **IRB-2019-03-030**. Please use this reference number for all future correspondence.

The following protocol and compliances are to be observed upon NTU IRB approval

1. Any research involving subjects less than 21 years old would require IRB approved written Parental Consent and consent from the participant before any research protocols can be administered unless waiver of consent is given by IRB. Minimal risk refers to an anticipated level of harm and discomfort that is no greater than that ordinarily encountered in daily life, or during the performance of routine educational, physical, or psychological examination.
2. Only the approved Participants Information Sheet and Consent Form should be used. It must be signed by each subject prior to initiation of any protocol procedures. In addition, each subject should be given a copy of the signed consent form.
3. Consent forms are important documents therefore they should be stored in the strictest arrangement. Loss of consent form would result in disciplinary action.
4. No deviation from, or changes of, the protocol should be initiated without prior written NTU IRB approval of an appropriate amendment.

Research Integrity and Ethics Office, NTU Institutional Review Board

62 Nanyang Drive, Block N1.2-B1-02A, Singapore 637459, T: (65) 6592-2495, www.ntu.edu.sg

5. The Principal Investigator should report promptly to NTU IRB regarding:
 - a. Deviation from, or changes to the protocol.
 - b. Changes increasing the risk to the subjects and/or affecting significantly the conduct of the trial
 - c. All serious adverse events (SAEs) which are both serious and unexpected.
 - d. New information that may affect adversely the safety of the subjects of the conduct of the trial.
 - e. Completion of the study.
6. Continuing Review Request/ Notice of Study completion form should be submitted to NTU IRB for the following:
 - a. Annual review: Status of the study should be reported to the NTU IRB at least annually using the Continuing Review Request/ Notice of Study completion form.
 - b. Study completion or termination: Continuing Review Request/ Notice of Study completion form is to be submitted within 4 to 6 weeks of study completion or termination.
7. All Principal Investigators should comply with existing legislation that would have an impact on the domain of their research.
8. Advertisements/ Notices for recruitment of subjects must meet the following requirements:
 - a. Advertisements must clearly state that volunteers are being recruited to participate in an NTU research project with proper research title and NTU logo.
 - b. Name and contact details of Principal Investigator (usually a faculty member), and NTU-IRB contact details (Tel: 6592 2495; Email: IRB@ntu.edu.sg) should be provided.
 - c. The NTU-IRB project reference number should be stated.
 - d. Advertisements should include eligibility criteria.
 - e. Advertisements recruiting Minors must explicitly state that parental consent is required for participation (unless NTU-IRB has granted approval for a waiver of parental consent).

Advertisements/ Notices should NOT contain the following:

 - a. State or imply a certainty of favourable outcome or other benefits beyond what is outlined in the informed consent form and the application/protocol.
 - b. Make claims, either explicitly or implicitly, that a procedure or intervention is safe or effective or superior to other standard procedures or interventions.
 - c. Use catchy words like "free" or "exciting."
 - d. Advertisements may state that participants will be paid, but should not emphasize the payment or the amount to be paid (e.g. by such means of larger or bold type)



Professor Lionel Lee
Chair, NTU Institutional Review Board
encl.

Appendix 5-2: Recruitment Advertisement for Study 3

Participants Needed in a Paid Study

We are recruiting Polytechnic/ITE students for a study to understand their perceptions on video retrieval interfaces and features.

WHO:

Post-secondary students (ages 16-22)
Currently enrolled in a post-secondary course

WHAT:

Participate in a search task walk-through session and complete a questionnaire. This will take approximately 1.5 hour.

RISK:

There is no known risks for participating in this study.

INCENTIVE:

Cash Incentive (SGD 20) upon completion of the participation

CONTACT:

Mr Cliff Loke
HP: 96266588
cloke002@e.ntu.edu.sg

NOTE: This study is approved by NTU-Institutional Review Board (**IRB-2019-03-30**). If you have any questions, feel free to contact a representative of the IRB (irb@ntu.edu.sg).

Scan to schedule an appointment:



cloke002@e.ntu.edu.sg 96266588	cloke002@e.ntu.edu.sg 96266588	cloke002@e.ntu.edu.sg 96266588	cloke002@e.ntu.edu.sg 96266588	cloke002@e.ntu.edu.sg 96266588	cloke002@e.ntu.edu.sg 96266588	cloke002@e.ntu.edu.sg 96266588	cloke002@e.ntu.edu.sg 96266588	cloke002@e.ntu.edu.sg 96266588	cloke002@e.ntu.edu.sg 96266588	cloke002@e.ntu.edu.sg 96266588	cloke002@e.ntu.edu.sg 96266588
--	--	--	--	--	--	--	--	--	--	--	--

Appendix 5-3: Task Description and Task Steps

Evaluation of Video retrieval interface features for exploratory searches Task description and Walk-through Steps

Search task (Scenario)

- RAID – Redundant Array of Independent Disks

Imagine that you are going to learn about computer system storage technology and you are interested in learning more about various Redundancy Array of Independent Disks (RAID) technologies. It seems that there are myriad of RAID configurations meant for different purposes. You need to prepare a short write up to justify the implementation of RAID for various enterprise requirements.

Specifically, how can computer storage be implemented using RAID technology to give a balance between reliability, performance and capacity and why?

You decided to find 3 videos to help you prepare the short write up.

Feature introduction:

- 1) Concept map display
- 2) Concept Snippet
- 3) Concept map navigation
- 4) Session history
- 5) Video segments – Concepts
 - a. Results list
 - b. Dynamic thumbnails
 - c. Jump-in segments
 - d. Video view
- 6) Video segments – View counts
 - a. Results list
 - b. Dynamic thumbnails
 - c. Jump-in segments
 - d. Video view
- 7) Comments
 - a. Word cloud
 - b. Phrase cloud
 - c. Sentiment meter
- 8) Video information
 - a. Results list
 - b. Video view
- 9) Segment container

1. Beginning search using search query

Concept map display	
Step	Action/Display
1	At the landing page, click on the query text box to begin video search.
2	Click on the text box again to simulate the input of query.
3	Click on the “magnifying glass” to search.
4	A concept map related to the query is displayed with videos that correspond to the concept of “RAID”.
5	Click on the “Concept Map On/Off” button to toggle concept map display.
6	Hover the mouse over “help?”.

2. Exploring search concepts

Concept snippets	
Step	Action/Display
1	Ensure that the Concept Map is displayed. Hover your mouse over some of the following concepts: a. Virtualization b. Centralised storage c. Mirroring d. Hamming Code e. Storage RAID f. Physical disk drives g. RAID 0 h. Parity
2	Concept definition is displayed in the snippet.

3. Concept Map Navigation

Concept map navigation	
Step	Action/Display
1	Click on the concept “ Parity ”.
2	A concept map related to “Parity” is displayed with videos that correspond to the concept of “Parity”.
3	Click on the “ RAID ” concept. This brings you back to the previous session.
4	Click on the concept “ Centralised storage ”.
5	A concept map related to “Storage Area Network” is displayed with videos that correspond to the concept of “Storage Area Network”.

4. Session history

Session history	
Step	Action/Display
1	Click on session number [2] on the top right corner of the screen.
2	The concept map related to “Parity” from the 2 nd search iteration is displayed with videos that correspond to the concept of “Parity”.
3	Scroll down to view the videos from the 2 nd iteration.
4	Click on any session [1] link found in the video list.
5	The concept map related to “RAID” from the 1 st search iteration is displayed with videos that correspond to the concept of “RAID”.

6	Hover the mouse over “help?”.
---	-------------------------------

5. Examining the result list

Segment timeline – Concept	
Step	Action/Display
1	Read the legend for video segments.
2	From the session numbers, the video RAID and Storage Solutions by ITfreetraining, appeared in all the search sessions. Compare the Blue segment timeline of the same video (RAID and Storage Solutions by <u>ITfreetraining</u>) between the 1 st session (concept-RAID) and 3 rd session (concept-SAN). Done by toggling between session numbers.
3	Go to the 3 rd session (SAN).
4	Hover the mouse over the blue segments.
5	Click on the last blue segment for the video - RAID and Storage Solutions by ITfreetraining.
6	Video starts to play from the selected segment.
7	Click on session [3] to return to video list for 3 rd iteration (SAN).

Segment timeline – View counts	
Step	Action/Display
1	Compare the Yellow segment timeline of the same video (RAID and Storage Solutions by <u>ITfreetraining</u>) between the 1 st session (concept-RAID) and 3 rd session (concept-SAN).
2	Go to the 3 rd session (SAN).
3	Hover the mouse over the yellow segments for the video RAID and Storage Solutions .

Video comments	
Step	Action/Display
1	Hover the mouse over “help?” for Comments.
2	Place the mouse over the comment cloud for the video “RAID and Storage Solutions” by ITfreetraining.
3	Click on the radio button “Phrase”.
4	Place the mouse over the comment cloud for the video “RAID and Storage Solutions” by ITfreetraining.
5	Click on the radio button “Sentiment”.
6	Place the mouse over the sentiment meter for the video “RAID and Storage Solutions” by ITfreetraining.
7	Click on the radio button “Word”.

Video recommendations	
Step	Action/Display
1	Hover the mouse over “help?” for Recommendations.
2	Examine the recommendation list from fellow viewers.
3	Click on the radio button “Authoritative”.
4	Examine the recommendation list from authoritative sources.
5	Click on the radio button “Viewers”.

Video information	
Step	Action/Display
1	Notice the Green Box up.
2	Examine the types of metadata for videos in the results list.

6. Video Viewing

Video information	
Step	Action/Display
1	From the video list, click on the video “RAID and Storage Solutions” by ITfreetraining.
2	Examine the metadata for video.
3	Hover the mouse over coloured segments for dynamic thumbnails.

7. Customising video segments

Segment Containers creation	
Step	Action/Display
1	From the video view, click on the “Create Segment Container” button.
2	Click on the Container name text field to input container name. - “RAID segments” has been simulated as the container name.
3	Click on the “Create” button to create the segment container.
4	Drag and drop desired segments into the container created. - The drag and drop is simulated.
5	Click on session [3] history to return to the latest results list.
6	Click on the video “Introduction to RAID” by Eli the Computer guy.
7	Drag and drop desired segments into the container created. - The drag and drop is simulated.

Customising Segments sequence	
Step	Action/Display
1	Click on the “Segment Container” shortcut to access to the Segment Container page.
2	Click on the segment container “Edit” button to begin customisation.
3	Drag and drop the segments according to desired sequence. - Segment 4 and 5 is simulated to swap with segment 1 and 2 respectively. - Click on video to perform simulation.
4	Click on the “Done!” button to exit edit mode.
5	Click on the “Container” side menu to go back to the container page.
6	Click on the “Share” button.

Note: Participants will complete the accompanying questionnaire at the end of each task and at the end of the study.

Appendix 5-4: Participant Questionnaire

Participant Information

A. Age: _____

B. Gender: ☐ Male ☐ Female

C. Course/Program enrolled in: _____

D. Familiarity in using video retrieval platforms:

1	2	3	4	5	6	7
Not						Very
familiar						familiar

E. Proficiency in using video retrieval platforms:

1	2	3	4	5	6	7
Not						Very
proficient						proficient

F. How comfortable are you in using video retrieval platforms?

1	2	3	4	5	6	7
Not at						Very at
ease						ease

G. What is your frequency of use of the following video platforms?

	Frequency of access					
	Daily	Several times a week	Several times a month	Once a month	Never	
YouTube	☐	☐	☐	☐	☐	
Vimeo	☐	☐	☐	☐	☐	
Dailymotion	☐	☐	☐	☐	☐	
Metacafe	☐	☐	☐	☐	☐	
Veoh	☐	☐	☐	☐	☐	
Others: _____	☐	☐	☐	☐	☐	

Search Task (Scenario)

- RAID – Redundant Array of Independent Disks

Imagine that you are going to learn about computer system storage technology and you are interested in learning more about various Redundancy Array of Independent Disks (RAID) technologies. It seems that there are myriad of RAID configurations meant for different purposes. You need to prepare a short write up to justify the implementation of RAID for various enterprise requirements.

Specifically, how can computer storage be implemented using RAID technology to give a balance between reliability, performance and capacity and why?

You decided to find 3 videos to help you prepare the short write up.

Demonstration of the list of features/interface

1. Concept map display
2. Concept snippets
3. Concept map navigation
4. Session history
5. Concept video segments timeline (results list & video view)
6. Interaction video segments timeline (results list & video view)
7. Dynamic thumbnails for segments (results list & video view)
8. Segment jump-in
9. Comments cloud (3 options)
10. Recommendations (2 options)
11. Video information (list)
12. Video information (video view)
13. Segment container

Please refer to the walk-through steps before starting the questionnaire.

Design feature: **Concept map**

A concept map of the core concept in the query is displayed together with a resulting list of videos. The concept map depicts the relationships between sub-concepts within the topic of interest. Rate your perception of the concept map feature.

	Strongly Disagree	Somewhat Disagree	Neither agree nor disagree	Somewhat Agree	Strongly Agree
	1	2	3	4	5
It is easy to use this feature.					
This feature enables me to explore the domain of interest.					
This feature allows new information to be discovered.					
This feature is useful for my learning.					
This feature can help me to formulate new search queries.					
This feature is important in the success of the search task.					
I intend to use this feature to search for videos for my learning.					

What do you like about the concept map feature?

What do you **NOT** like about the concept map feature?

Design feature: **Concept snippets**

A concept snippet shows the definition of the concept appears with a mouse-over. Rate your perception of the concept snippet feature.

	Strongly Disagree	Somewhat Disagree	Neither agree nor disagree	Somewhat Agree	Strongly Agree
	1	2	3	4	5
This feature enables me to understand concepts in the domain of interest.					
This feature allows new information to be discovered.					
This feature is useful for my learning.					
This feature can help me to formulate new search queries.					
This feature is important for the success of the search task.					
I intend to use this feature to search for videos for my learning.					

What do you like about the concept snippet feature?

What do you **NOT** like about the concept snippet feature?

Design feature: **Concept map navigation**

Clicking on a concept in the concept map will display a new concept map that is anchored upon the selected concept and retrieve a list of videos that correspond to the selected concept. Rate your perception of the concept map navigation feature.

	Strongly Disagree	Somewhat Disagree	Neither agree nor disagree	Somewhat Agree	Strongly Agree
	1	2	3	4	5
This feature enables me to explore the domain of interest effectively.					
This feature allows new information to be discovered.					
This feature is useful for discovering new videos for learning.					
This feature is important for the success of the search task.					
I intend to use this feature to search for videos for my learning.					

What do you like about the concept map navigation feature?

What do you **NOT** like about the concept map navigation feature?

Design feature: **Session history**

Every search iteration (search list) is recorded until the search session is cleared. The previous search list and concept map can be recalled by clicking on the search iteration number. Rate your perception of the session history feature.

	Strongly Disagree	Somewhat Disagree	Neither agree nor disagree	Somewhat Agree	Strongly Agree
	1	2	3	4	5
It was easy to use this feature.					
This feature enables me to recall my previous searches effectively.					
This feature is important for the success of the search task.					
I intend to use this feature to search for videos for my learning.					

What do you like about the session history feature?

What do you **NOT** like about the session history feature?

Design feature: **Video timeline - Segments of concept of interest + Dynamic segment thumbnails + segment navigation**

This video timeline reveals the video segments containing the concept of interest depending on the **core concept** in the search query. For the same video, there can be different “concept” video segments being displayed. Dynamic thumbnails for each segment appears during mouse-over. Clicking on the segment will play the video from the start of the segment. Rate your perception of the video timeline (segments of concept of interest) feature.

	Strongly Disagree	Somewhat Disagree	Neither agree nor disagree	Somewhat Agree	Strongly Agree
	1	2	3	4	5
It was easy to use this feature.					
This feature enables me to locate segments of interest easily.					
This feature helps me to identify important video segments more easily.					
This feature allows me to make an assessment of the video content more easily.					
This feature helps me to select videos for the search task.					
This feature is important for the success of the search task.					
I intend to use this feature to search for videos for my learning.					

What do you like about the video timeline (segments of concept of interest) feature?

What do you **NOT** like about the video timeline (segments of concept of interest) feature?

Design feature: **Video timeline - Segments of view counts + Dynamic segment thumbnails + segment navigation**

This video timeline reveals the video segments that has high viewer interactions, such as view counts. For the same video, the interaction segment remains the **same**. Dynamic thumbnails for each segment appears during mouse-over. Clicking on the segment will play the video from the start of the segment. Rate your perception of the video timeline (Segments of view counts) feature.

	Strongly Disagree	Somewhat Disagree	Neither agree nor disagree	Somewhat Agree	Strongly Agree
	1	2	3	4	5
It was easy to use this feature.					
This feature enables me to locate segments of interest easily.					
This feature helps me to identify popular video segments more easily.					
This feature allows me to make an assessment of the video content more easily.					
This feature helps me to select videos for the search task.					
This feature is important for the success of the search task.					
I intend to use this feature to search for videos for my learning.					

What do you like about the video timeline (Segments of view counts) feature?

What do you **NOT** like about the video timeline (Segments of view counts) feature?

Design feature: **Visualization of video comments – 3 options**

Very often, video in the public domain are open to viewer comments. When there are sufficient video comments, the comments can be summarized in the form of 1) word cloud, 2) phrase cloud, and 3) sentiment meter. Rate your perception of the visualization of video comments feature.

Word Cloud	Strongly Disagree 1	Somewhat Disagree 2	Neither agree nor disagree 3	Somewhat Agree 4	Strongly Agree 5
This feature enables me to know what others feel about the video.					
This feature helps me to know the quality of the video content easily.					
This feature helps me to select videos for the search task.					
This feature is important for the success of the search task.					
I intend to use this feature to search for videos for my learning.					
Phrase Cloud	Strongly Disagree 1	Somewhat Disagree 2	Neither agree nor disagree 3	Somewhat Agree 4	Strongly Agree 5
This feature enables me to know what others feel about the video.					
This feature helps me to know the quality of the video content easily.					
This feature helps me to select videos for the search task.					
This feature is important for the success of the search task.					
I intend to use this feature to search for videos for my learning.					
Sentiment Meter	Strongly Disagree 1	Somewhat Disagree 2	Neither agree nor disagree 3	Somewhat Agree 4	Strongly Agree 5
This feature enables me to know what others feel about the video.					
This feature helps me to know the quality of the video content easily.					
This feature helps me to select videos for the search task.					
This feature is important for the success of the search task.					

I intend to use this feature to search for videos for my learning.					
--	--	--	--	--	--

What do you like about the visualization of comments feature?

What do you **NOT** like about the visualization of comments feature?

Please rank (1,2,3) the design options in terms of helpfulness, ease of use and satisfaction.

	Word Cloud	Phrase Cloud	Sentiment Meter
Helpfulness			
Ease of use			
Satisfaction			

Please specify your reasons for your ranking (if any).

Design feature: **Recommendations – 2 options**

Recommended videos related to the core concept from 1) fellow viewers, and 2) authoritative sources. Rate your perception of the recommendations feature.

Viewers	Strongly Disagree 1	Somewhat Disagree 2	Neither agree nor disagree 3	Somewhat Agree 4	Strongly Agree 5
This feature helps me to know the quality of the video content easily.					
I can find useful videos in viewers recommended list.					
This feature helps me to select videos for the search task.					
This feature is important for the success of the search task.					
I intend to use this feature to search for videos for my learning.					
Authoritative	Strongly Disagree 1	Somewhat Disagree 2	Neither agree nor disagree 3	Somewhat Agree 4	Strongly Agree 5
This feature helps me to know the quality of the video content easily.					
I can find useful videos in recommended list from authoritative sources, such as education institutions.					
This feature helps me to select videos for the search task.					
This feature is important for the success of the search task.					
I intend to use this feature to search for videos for my learning.					

What do you like about the recommendations feature?

What do you **NOT** like about the recommendations feature?

Please rank (1,2) the design options in terms of helpfulness, ease of use and satisfaction.

	Viewers	Authoritative
Helpfulness		
Ease of use		
Satisfaction		

Please specify your reasons for your ranking (if any).

Design feature: **Video Information – Results list**

More information related to the video, included socially generated data is displayed within the results list. Socially generated data (Number of “Likes” and “Dislikes”) is highlighted when the ratio between the “Likes” and “Dislikes” is above a threshold. Rate your perception of the video information presented in the results list.

	Strongly Disagree 1	Somewhat Disagree 2	Neither agree nor disagree 3	Somewhat Agree 4	Strongly Agree 5
This feature enables me to know what others feel about the video.					
This feature allows me to make an assessment on the suitability of the video before viewing the video.					
This feature helps me to know the quality of the video content more easily before viewing the video.					
This feature helps me to select videos for the search task.					
This feature is important for the success of the search task.					
I intend to use this feature to search for videos for my learning.					

What do you like about the video information presented in the results list?

What do you **NOT** like about the video information presented in the results list?

Design feature: **Video Information – Video View**

More information related to the video, included socially generated data is displayed in the video view. Rate your perception of the video information presented in the video view.

	Strongly Disagree 1	Somewhat Disagree 2	Neither agree nor disagree 3	Somewhat Agree 4	Strongly Agree 5
These interface enables me to recall to why the video is selected.					
This interface allows me to make an assessment on the suitability of the video before viewing the video.					
This interface helps me to know the quality of the video content more easily.					
This interface is important for the success of the search task.					
I intend to use this interface to search for videos for my learning.					

What do you like about the video information presented in the video view?

What do you **NOT** like about the video information presented in the video view?

Design feature: **Video segment container**

Video segments (from different videos) of interest can be put together in a video segment container and segments in the container can be re-arranged to form a “new” video that can be shared. Rate your perception of the video segment container feature.

	Strongly Disagree	Somewhat Disagree	Neither agree nor disagree	Somewhat Agree	Strongly Agree
	1	2	3	4	5
This feature enables me to remember useful video segments.					
This feature allows me to create suitable videos for my learning.					
I intend to use this interface to search for videos for my learning.					

What do you like about the video segment container feature?

What do you **NOT** like about the video segment container feature?

End of Questionnaire

Appendix 5-5: Study Information Sheet and Consent Form



Study Information sheet

Prof Scubert Foo

Nanyang Technological University, Wee Kim Wee School of Communications and Information

31 Nanyang Link, Singapore 637718

IRB reference number: IRB-2019-03-030

Title of Study: Evaluation of video retrieval interface and features for post-secondary student learners

Objective: The purpose of this study is to investigate student learners' perceptions on the design concepts of a video retrieval platform. 100 participants will be recruited.

Procedures: In this study, you will be introduced to the video retrieval environment. Thereafter, you will be required to perform a walk-through of a video search task on the video retrieval environment and answer a questionnaire. The whole procedure will take about 60-90 minutes to complete.

Right to Refuse or Withdraw: Your participation in this study is completely voluntary, and you may withdraw from the study at any time without penalty. However, it is important to us that you answer all questions honestly. You may withdraw by informing the researcher that you no longer wish to participate. You will not be questioned in case you decide to withdraw. Your decision to participate, decline, or withdraw participation will have no effect on your status or relationship with the Nanyang Technological University.

Risks and Discomforts: There are no anticipated risks associated with participating in this study.

Benefits: There are no direct benefits. Your participation is highly appreciated and we hope that you will gain insights into how research is conducted.

Compensation: You will receive SGD 20 as a token of appreciation for your completion in participation in this study.

Anonymous and Confidential Data Collection: Your participation in this study will remain anonymous. Your responses will be assigned a code number that is not linked with any other identifying information.



Confidentiality of records: Your identity will not be stored with your data. Your responses will be assigned a code number that is not linked with any other identifying information.

Personal Data:

By signing the Consent Form attached, you (*or your legally acceptable representative, if relevant*) are authorizing (i) collection, access to, use and storage of your "Personal Data", and (ii) disclosure to, and use and storage by, authorised service providers and relevant third parties, whether located in Singapore or overseas, for the purposes of the study, and other similar research studies conducted by Nanyang Technological University.

"**Personal Data**" means data about you which makes you identifiable: (i) from such data; or (ii) from that data and other information which an organisation has or likely to have access.

Research arising in the future, based on this "Personal Data", will be subject to review by the relevant institutional review board.

Data collected are the property of Nanyang Technological University. In the event of any publication regarding this study, your identity will remain confidential.

Who to contact with questions: If you have questions about the study, please contact Mr. Cliff Loke (Email: cloke002@e.ntu.edu.sg) or Prof Schubert Foo (Email: sfoo@ntu.edu.sg). This study is approved by the Institutional Review Board (IRB). IRB Ref no. (IRB-2019-03-030).

Should you have questions on participants' rights in the study, please contact:

NTU-Institutional Review Board
Research Integrity and Ethics Office
50 Nanyang Avenue, North Spine
NS4-05-92A
Singapore 639798
Email: irb@ntu.edu.sg

Consent Form

I have read, discussed and understand the information and procedures in the study information sheet attached to this consent form. My questions concerning the study have been answered to my satisfaction, and I acknowledge that I am participating in this study of my own free will. I understand that I may refuse to participate or stop participating at any time.



Consent to participate in the research

- ☐ Yes I agree to participate in this research.
- ☐ No, I do not agree to participate in this research.

Name of Participant Signature Date

For study involving minors (unmarried subjects who are less than 21 years of age), consent from a parent or guardian is necessary

I give consent for my child as named above to participate in the study and agree to the consent as noted above.

Name of Parent Signature Date

Appendix 6-1: Participants' Profile Summary

Participant Code	Gender	Course	Course type	Institute
P1	M	Network Systems & Security	S	P
P2	F	Supply Chain Management	N	P
P3	M	Business Informatics	S	P
P4	F	Biomedical Engineering	S	P
P5	M	Energy System & Management	S	P
P6	M	Infocomm & Security	S	P
P7	F	Networking & System Administration	S	P
P8	M	Accounting & Finance	N	P
P9	F	Early Childhood Education	N	I
P10	F	Optometry	S	P
P11	F	Computer Engineering	S	P
P12	M	Information Technology	S	P
P13	M	Information Technology	S	P
P14	F	Mass Communication	N	P
P15	F	Mass Communication	N	P
P16	F	Mass Communication	N	P
P17	M	Mass Communication	N	P
P18	M	Infocomm Technology	S	I
P19	M	Multimedia & Infocomm technology	S	P
P20	M	Information Technology	S	P
P21	F	Computer Engineering	S	P
P22	F	Early Childhood Education	N	I
P23	F	Early Childhood Education	N	I
P24	F	Early Childhood Education	N	I
P25	M	Electronics Engineering	S	I
P26	M	Audio Visual, Electronics Engineering	S	I
P27	M	Cybersecurity	S	I
P28	M	Cyber & Network Security	S	I
P29	M	Information Technology	S	P
P30	M	Information Technology	S	I
P31	F	Early Childhood Education	N	I
P32	M	Early Childhood Education	N	I
P33	M	Electronics Engineering	S	I
P34	M	Electronics Engineering	S	I
P35	F	Biomedical Engineering	S	P
P36	M	Biomedical Engineering	S	P
P37	F	Customer Experience Management with Business	N	P
P38	M	System & Network	S	I
P39	M	Cyber & Network Security	S	I
P40	M	Computer Engineering	S	P

P41	F	Interaction Design	N	P
P42	M	Cyber & Network Security	S	I
P43	F	Cybersecurity	S	I
P44	M	Cyber & Network Security	S	I
P45	F	Finance Services	N	I
P46	M	Finance Services	N	I
P47	F	Digital Game, Art & Design	S	P
P48	M	Electronics, Computer & Communications Engineering	S	P
P49	F	Engineering (Control & Automation)	S	P
P50	F	Business Studies	N	P
P51	F	Business Studies	N	P
P52	M	Accountancy	N	P
P53	M	Accountancy	N	P
P54	F	Business Studies	N	P
P55	F	Business Studies	N	P
P56	F	Common Engineering	S	P
P57	M	Digital Video, Audio & Photography	S	I
P58	F	Accountancy	N	P
P59	F	Tourism & Resort Management	N	P
P60	F	Business Studies	N	P
P61	M	Tourism & Resort Management	N	P
P62	M	Business Studies	N	P
P63	M	Energy System & Management	S	P
P64	F	Energy System & Management	S	P
P65	M	Hospitality Operations	N	I
P66	M	Hospitality Operations	N	I
P67	M	IT Application Development	S	I
P68	M	IT Application Development.	S	I
P69	M	Games Programming & Development	S	I
P70	F	Tourism & Resort Management	N	P
P71	F	International Business	N	P
P72	M	Business Studies	N	P
P73	F	Business Studies	N	P
P74	F	Accountancy	N	P
P75	F	Veterinary Technology	S	P
P76	F	Veterinary Technology	S	P
P77	F	Veterinary Technology	S	P
P78	F	Veterinary Technology	S	P
P79	M	IT Systems & Networks	S	I
P80	M	Financial Informatics	S	P
P81	M	Financial Informatics	S	P
P82	F	Financial Informatics	S	P

P83	F	Financial Informatics	S	P
P84	F	Business Studies	N	P
P85	F	business Studies	N	P

M = Male

F = Female

S = STEM course

N = Non-STEM course

P = Polytechnic

I = ITE

Appendix 6-2: Summary of themes and comments for Concept Map

Summary of themes for what participants liked about the Concept map feature

What participants liked about the concept map feature?			
Theme	Sub-theme	No. of instances (%)*	Selected examples of instances
Support for query formulation	Understand domain	25 (19.8%)	• It shows information that is related to the thing that I am searching which allows me to better understand the concepts and how they are related. (P60) • I like about how you can choose to see what are related to the thing that I am searching and it might help me get a better understanding about what I don't know. (P57) • It will help me understand what I am looking for easier. (P70)
	Extend domain	19 (15.1%)	• You are not limited to the topic that you have typed in but to explore other related topics that might help. (P49) • It helps to widen my search radius. (P5)
	Informative	10 (7.9%)	• The concept map is pretty detailed with its information which enables people with zero knowledge to understand the basics. (P83)
	Ideas creation	9 (7.1%)	• The concept map allows for a branch of ideas to be feature hence while I am asking the big question, smaller questions will also come into play. (P36)
Domain exploration	Visualised summary of the domain	25 (19.8%)	• As a visual learner, having a concept map that shows me all the summarised points allows me to understand and digest. (P47) • It shows different points of the things that we search up on and creates a sense of summary. (P58) • I am able to visualise the whole idea from the map at one glance. (P3)
	Related concepts	11 (8.7%)	• Gives you all the related sub-topics that could help me understand more about the vague topic. (P78) • It branches out to related aspects and it may be easier to search. (P73)
	Simplified exploration	6 (4.8%)	• It simplifies the work needed to find out more about something I do not know as a big mind map allows for me to research on more. (P39)

	Starting point	4 (3.2%)	It helps me to branch out to more subjects of my research and actually find out more about the things I'm searching that I did not even know about. It also helps to stay within the boundaries of my search so that I will stay relevant during my research. (P74)
	Realises the boundary	2 (1.6%)	It helps me to branch out to more subjects and yet stay within the boundaries of my search. (P74)
Ease in usage	Easy to use	12 (9.5%)	- The simplicity and ease of use make its good for new users. (P44) - It is easy to use as when you search for one thing, many related topics and concepts appears. (P15)
	Useful in tasks	3 (2.4%)	It is useful for me to do some research of topic, I could complete my work and project easily. (P46)
Total positive comments on the feature		126	

* Percentage of comments over the total comments for this theme

Summary of themes for what the participants dislike about the Concept map feature

What participants not like about the concept map feature?			
Theme	Sub-theme	No. of instances (%)	Selected examples of instances
Poor Presentation	Messy	20 (23.0%)	- Concept maps might be too bulky. For example, one particular bubble has many arrows out. (P67) - The lines are a bit too messy and may be hard to trace each points. (P73)
	Confusing	16 (18.4%)	- Can be confusing as it has too many lines. (P25) - It can be confusing for people with no knowledge of the topic. (P15)
	Complex	13 (14.9%)	- Might be a bit unfriendly if you are new to the subject and with such a big map display, it may not be able to find the information easily and they might be at the wrong concept. (P48) - At a glance, it is visually intimidating. (P62)
	Cluttered	5 (5.7%)	It is much cluttered for a whole lot for information to be absorbed at once for something which I have little idea of. (P12)
Weak Map structure	Starting Point	5 (5.7%)	It can make me overwhelm by the amount of foreign details I can possibly find and not know where to start. (P64)

	Irrelevant paths or words	2 (2.3%)	• I might be exposed to keywords that are irrelevant to the information that I would not like. (P12)
	Lack of Customizability	2 (2.3)	• The possibility of the concept map being either too large or too minute in its scale of answers. (P79)
Low level of informativeness	Too simplified	8 (9.2%)	• I don't like concept maps that don't give me the full information. (P16) • Certain terms need extra searches online to figure its meaning. (P26)
	Handling unknown terms	4 (4.6%)	• When you do not know the term of the topic that you want to search, it is tough to find the relevant topics. (P42)
	Lack of pictures	2 (2.3%)	• It is too plain as it has only one colour and there is no pictures and it doesn't help me as I am a visual learner. (P43)
	Wordiness	2 (2.3%)	• Too many words and it's too messy (P83)
User Characteristics consideration	Initial knowledge	5 (5.7%)	• Can be a bit hard to view and if I have zero knowledge on the item that I searched on, all the extra branches are just merely words to me without much explanation. (P85)
	Distraction	3 (3.4%)	• It can be a distraction as it piques my interest about other things. (P14)
Total negative comments on the feature		87	

Summary of themes for what participants liked about the Concept snippet feature

What participants liked about the concept snippet feature?			
Theme	Sub-theme	No. of instances (%)	Selected examples of instances
Improved understanding	Aids understanding	34 (32.1%)	• This helps users understand things that they are not familiar with. (P5) • Seeing the keywords such as “Virtualisation”, I may not know the meaning of, based on the context of my search. Being able to have a short read up can tell me if it is something relevant to what I need to know. (P12) • Will help me formulate some sort of understanding about the term and the whole topic itself. (P17) • Good for understanding initial concepts without being overwhelmed with technicality. (P29)

	Brief explanation	15 (14.2%)	• It is very helpful in giving a rough idea of what certain terms means and it isn't too wordy. (P41) • It shows the definition of each term so that I do not have to Google for them. (P4)
	Topic overview	6 (5.7%)	• It gives a clearer view of the topic while not jumbling up the page with random bits of text. (P79)
	Essential information	4 (3.8%)	• It gives me quick and essential information that I need to know in the process of my search. (P14)
Ease in usage	Saves time	17 (16.0%)	• Saves time, I need not go through many different tabs and pages to understand something. (P43) • It reduces the time for the user to Google any terms that they are curious about. (P6)
	Convenient	12 (11.3%)	• It is very convenient and easy to use, users can look for the definition without opening a new tab or window. (P10) • It is very convenient for me to find out about the area. (P32)
	Easy to digest	7 (6.6%)	• It immediately gives me the definition of the concept in bite-size pieces that is relatively easy to digest. (P16)
Helps extends search	Extends query	2 (1.9%)	• With this information given, it might entice users to want to find out more. (P36)
	Discover concepts	2 (1.9%)	• Got a lot of different words that can be discovered. (P25)
	Extends ideas	4 (3.8%)	• Gives people the idea of what those terms meant and helps people to generate ideas. (P78)
	Helps judge	3 (2.8%)	• I liked how the information is summarised for me to quickly determine if the subject that I am hovering is relevant to my research. (P13)
Total positive comments in the feature		106	

Summary of themes for what participants disliked about the Concept snippet feature

What participants not like about the concept snippet feature?			
Theme	Sub-theme	No. of instances (%)	Selected examples of instances
Low level of informativeness	Lacks details	16 (41.0%)	• If it is a brief description, the user may need a more detailed description and the user may relate to other sites instead. (P67) • The explanation is too short and a link to more detailed explanation can be added. (P70)

	No context	2 (5.1%)	Not sure about the scope of information in the snippet. (P79)
Needs improvement in interaction	More control on display	2 (5.1%)	May find it hard to use as they have to keep the mouse over. (P50)
	Standout boundary	2 (5.1%)	Have a boundary to make it more obvious after it pops up. (P13)
	Include resources	4 (10.3%)	Could include small visual learning aids like photos or short videos. (P24)
Lack of consideration of user knowledge	Wordy	5 (12.8%)	The snippet may be too long and very dry to read. (P53)
	Difficult to understand	3 (7.7%)	As this is potentially for a topic that I am trying to learn, after reading it, it may be still difficult to understand. (P64)
	Confusing	3 (7.7%)	If the description is too short, it might further confuse me. (P18)
	Needs help in usage	2 (5.1%)	It will be good to have some instructions on the website to let people know that they can use this feature. (P6)
Total negative comments in the feature		39	

Summary of themes for what participants liked about the Concept Map Navigation feature

What participants liked about the concept map navigation?			
Theme	Sub-theme	No. of instances (%)	Selected examples of instances
Extends exploration	Support exploration	14 (13.7%)	- Helps to venture to even more related topics to the initial topic. (P15) - It allows me to deep dive into the relevant topics and their branches. (P29)
	Relates information	7 (6.9%)	In a new topic, this feature tells me what to expect when searching for sub-concepts. (P12)
	Aids understanding	4 (3.9%)	It creates a form of linkage between different ideas which makes learning and understanding easier. (P58)
Contextualise search	Provides a context for search	28 (27.5%)	- It omits unnecessary things of the same words and allowed me to focus on my topic of interest. (P77) - It helps with my search on the area of topic more effectively as it circles into only the area that I need to search on. (P41)

			This helps keep unnecessary information out and I would not be confused with what I am searching for. (P45)
	Handles synonyms	5 (4.9%)	The user can search for the specific meaning and not the wrong meaning of the same word. (P67)
	Focuses search	17 (16.7%)	- Very specific to the topic that I want to know. (P78) - This feature narrows down the information for me, making it more convenient. (P83)
Information structure	Provides overview	3 (2.9%)	Having all the information in an easy to navigate space helps summarize information for the learner. (P47)
	Organize information	2 (2.0%)	This helps to organize brand new information. (P17)
Ease in usage	Easy to use	10 (9.8%)	- I can freely tap into that topic to understand more about it, compared to searching up on it. (P1) - One click and you are immediately there on almost all the things. (P39)
	Saves time	7 (6.9%)	Fast and efficient as the concept navigation is linked back to the main concept, based off what was searched at the beginning. (P8)
	Convenient	5 (4.9%)	It allows users to experience convenience in the search and not having to hassle with other related words. (P66)
Total positive comments in the feature		102	

Summary of themes for what participants disliked about the Concept Map Navigation feature

What participants not like about the concept map navigation?			
Theme	Sub-theme	No. of instances (%)	Selected examples of instances
Confusing navigation	Lost in navigation	5 (45.5%)	It can get confusing with a complex map and may add to information overload. (P12)
	No navigation path	3 (27.3%)	An indication of a navigation path would be good for tracing the steps taken and thought process. (P29)
	Messy	2 (18.2%)	Can be a little messy for some people (P31)
	Lack of heading	1 (9.1%)	It does not have a heading for the concept map and I might get confused or lost from where I have started from. (P12)
Total negative comments in the feature		11	

Appendix 6-3: Summary of themes and comments for Granular Interaction

Summary of themes for what participants liked about the Video timeline – Segments for concept of interest feature

What participants liked about the Video timeline – Segments for concept of interest feature?			
Theme	Sub-theme	No. of instances (%)	Selected examples of instances
Video coverage identification	Identify important segments	17 (14.7%)	- It helps user to better locate the segments which they are more interested in as compared to other segments. (P69) - It saves me time from watching the other video segments which are not of particular interest. (P77)
	Pinpoints focal information	10 (8.6%)	- It gives me an understanding on how much it is covering on a particular topic. And the blue bar allows me to see a preview of what's to come in the video. This helps me save time where I can just jump to a certain point of focus in the video instead of watching the whole video. (P19) - With this segments feature, it will allow to be more efficient with my searches and pinpoints down to the sections of the video where I need to focus on to gain more useful information. (P22)
	Finding relevant content	10 (8.6%)	- It will be useful to use this feature to find the important information in the video and you do not have to take time to browse through the video to find the relevant information that you need. (P21) - It helps me save time so that I do not need to skip the video and waste my time trying to find a more relevant content for my research. (P61)
	Relevant segments	8 (6.9%)	It helps me to break down the video into smaller sections and helps me to save time during my research by helping me to find which are the information relevant to my research. (P74)
	Content coverage	8 (6.9%)	- It gives me an understanding on how much it is covering on a particular topic. And the blue bar allows me to see a preview of what's to come in the video. (P19) - This feature allow me to see a preview of what is in the video and I find it is related to the concept that I am looking for. This is especially useful when the concept that I am trying to search for is very content heavy and can be related to many other things. (P84)
Usage	Saves time	39 (33.6%)	- I can efficiently get to the point and it will be good for videos with long screen time. (P1) - Allows fast search and get into the main points of the video, which saves time during the search. (P8) - This helps me save time where I can just jump to a certain point of focus in the video instead of watching the whole video. (P19) - Ultimately it would save a lot of time for the user as they are able to preview the important parts they don't need to waste time watching the whole video and they might end up wasting their time if the video doesn't have the information that they need. I like this feature as it summaries the key points for me so it is easier for me to judge whether I want to watch the whole video or not. (P47)

	Easy to use	3 (2.6%)	It's easy to use and also makes it a lot easier for the students to have access to information that's they are looking for. (P35)
	Reduces miss information	2 (1.7%)	I find it pretty amusing because it has always been a hassle for me to skip the videos on YouTube which often results in me missing out certain important information. This features enables me to directly bring me to the concept that I want to learn which is hassle-free and convenient to use. (P83)
In-video navigation	Pinpoint navigation	15 (12.9%)	- I am able to jump straight into a specific part of a video without the need of watching the whole video. Hence it saves time and very user friendly. (P3) - To be able to show snippets based on the specific video timeline. Able to see the different topic of the video directly without the need to enter into the video. (P20)
	Topical navigation	4 (3.4%)	With the segmentation, it gives users an option of skipping the unrelated and unimportant part of the videos so as to reach their topic of interest swiftly. (P36)
Total positive comments in the feature		116	

Summary of themes for what participants disliked about the Video timeline – Segments for concept of interest feature

What participants dislike about the Video timeline – Segments for concept of interest feature?			
Theme	Sub-theme	No. of instances (%)	Selected examples of instances
Inadequacies in Segment identification	Worried about missed information	14 (42.4%)	- It might missed out information of the key word that I am searching for before the blue bar for example, and this might reduce my understanding of the concept I'm searching for. (P60) - It helps save time but there is still the fear that information may be missed out. (P76)
	Sceptical over identified concepts	6 (18.2%)	Focused content might get repetitive since each video focuses on the same topic of interest. (P75)
Presentation and usage	Confusing to use	9 (27.3%)	It might be confused for first time user at the first place but I believe if can be used to it if keep using this feature. (P6)
	Poor presentation	4 (12.1%)	Users may not remember what both the different coloured icons stands for and may need to keep scrolling up to see what each of them mean (P58)
Total negative comments in the feature		33	

Summary of themes for what participants liked about the Video timeline – Segments for high interactivity feature

What participants liked about the Video timeline – Segments for concept of interest feature?			
Theme	Sub-theme	No. of instances (%)	Selected examples of instances
Reveals various segments	Useful segments	21 (31.3%)	• Tells me which parts of the video views found valuable. Which parts to stop watching as the video might digress to unimportant information. (P12) • It shows users the parts of a video that is either popular or important based on how many views the parts got, hence simplifying the search. (P26) • It shows which part of the video provides more of the useful information that is searched by the other users, hence there is more time efficiency. (P59)
	Popular segments	9 (13.4%)	• The features allows the users to view what is popular in the video which shortens the time frame of searching. (P66)
	Interesting segments	2 (3%)	• It highlights where and what other people have looked at, which is interesting and potentially useful to know when looking/learning something. (P79)
Exploring from other viewers perspectives	Leads interest to explore	12 (17.9%)	• It will perk my interest as to why there are so many view counts on that particular part of the video. Hence, I will also watch that particular part of the video as well. (P3) • It shows me which parts of the video people are more interested in, which may highlight the more important parts of a video. I will be able to pay closer attention to those parts with the knowledge that it has a high viewer interaction rate. (P82)
	Takes viewer's views as perspective	11 (16.4%)	• It could give viewers the chance of viewing things from the perspective of others and see what is so important or interesting about a certain part of the video. (P36) • By knowing where viewers interacted the most, I may be able to identify concepts where people usually have problems in. This helps me to learn better by knowing potential problem areas. (P51)
	Leads to queries	5 (7.5%)	• Helps to notify me on which parts of the videos has more viewer counts and can bring my attention and focus on those areas instead. (P58)
Supports video selection	Aid judgement in video content	4 (6.0%)	• That it helps select the most viewed segments of the video by people. As those who searched the similar content may and would have viewed similar videos. (P68)
	Filters popular videos	3 (4.5%)	• It easy filters out the more popular videos as it shows the view count of the videos. (P50)
Total positive comments in the feature		67	

Summary of themes for what participants disliked about the Video timeline – Segments for high interactivity feature

What participants disliked about the Video timeline – Segments for concept of interest feature?			
Theme	Sub-theme	No. of instances (%)	Selected examples of instances
Inadequacies in segment identification	Worried over missed information	7 (20%)	Might miss out needed information if only using those with high interaction. (P17)
	Scripted interactions	3 (8.6%)	This feature can be a potential drawback as people can simply write scripts or make playlists and leave devices replaying to make the whole video have high user interaction. This defeats the purpose of such a feature. (P12)
Doubtful over the utility of segments	Different seasons for high interaction	9 (25.7%)	This may not be the best representation of what is useful to people. Some segments gets higher view counts because of other factors like how interesting it is and so on. People may be misled and miss out the actual important stuff in the video which may not be popular. However, it is up to people to make their own discretion. (P15)
	Popular segments does not equate usefulness	6 (17.1%)	I personally do not think I will use this feature as I am not very interested in which segments of the video others are watching so I don't think it's particularly useful to me. (P82)
	Popular segments need not equate relevance	3 (8.6%)	I feel that it might not be as relevant as what I am looking for might not necessarily be the same as what others are looking for even though we are searching for the same concept. (P60)
Presentation	Confusing	5 (14.3%)	The feature can be rather confusing and misleading if the high views do not help with the concept I am searching for. (P84)
	Distracting	2 (5.7%)	Might be distracting me from my search as I would focus more on looking for how the audience reacted more so than researching. (P75)
Total negative comments in the feature		35	

Summary of themes for what participants liked about the Video Segment Container feature

What participants liked about the Video timeline – Segments for concept of interest feature?			
Theme	Sub-theme	No. of instances (%)	Selected examples of instances
Autonomy in selection of learning video segments	Collection of good segments	18 (21.2%)	- The video segment container allows me to choose parts of videos that I feel important to the concept that I am searching about and it is definitely very convenient if I want to refer back to it again later on to refresh my memory of the concept. The ability for me to rearrange the parts also helps me to understand the parts in whole if all the information are related perfectly with no problem in understanding it if I watch the video that I have put together. It will be a good way to summarises and teach someone else about it. (P84) - Instead of having to open up multiple videos at once just to switch around and view them, this gives a good summary of all the videos that has great segments and combine them to make a new video that has all the main and important things for the task. (P8)
	Customize selection to needs	17 (20.0%)	- We are able to customise videos based on our needs and learning, by choosing the segments we want and creating containers. This is not available anywhere else as when we view videos on YouTube, if we want to pick up certain parts of a long video, we have to download the entire video and edit it ourselves. This is an excellent feature to have as it is both convenient and useful. (P15) - It allows the user to heavily customise useful sections of the video. (P62)
	Autonomy in video creation	12 (14.1%)	- It helps me to decide which information is useful for my research. (P4) - It allows users to create their own videos that contains favoured information they have seen in other videos that are useful. (P26)
	Supports learning	10 (11.8%)	- The ability to get what is needed in my learning. So that I can maximise my learning efficiency without going into irrelevant topics. After putting into container, I have the ability to share it out for others to learn on the container I've created. (P20) - It helps collect information in an easy to access place. When you are done with the video and want to go back to remember the key points. This feature helps in making a summary of the important points that you need and would make learning convenient. (P47)
Management of video segments	Sharing function	16 (18.8%)	- It can create a container if the video that I am searching for is relevant or somehow is related to the topic that I am finding and what's more is that it can arrange the sequence that I am think is the ways that does and can share the video to my project group mates if they have questions or guiding them for the project. (P6) - Can easily be shared to friends by simply sharing whatever the user has compiled. Can easily be referenced back in case of a last minute exam check. (P67)

	Recall resources	5 (5.9%)	Being able to segment out information Easily like that lets me be able to recap what I've done if I have forgotten and being able to share it online with my friends is another good thing as it can help spread useful information faster. (P39)
	Organizes resources	4 (4.7%)	Saving segments that are useful, important and relevant helps to save a lot of time and I don't have to always go back and redo my whole search and trace back my steps. I can revisit my saved segments anytime I like. Rearranging the saved segments helps to reinforce my learning as I know myself best and can organise the information in a way that is best for me to understand and learn. (P14)
	Act as a summary	3 (3.5%)	It will help me to create a video summary and understand what I have learn from all the video I have watched and summarises everything. (P43)
Total positive comments in the feature		85	

Summary of themes for what participants disliked about the Video Segment Container feature

What participants disliked about the Video Segment Container feature?			
Theme	Sub-theme	No. of instances (%)	Selected examples of instances
Poor usability	Complicated to use	13 (44.8%)	- It looks a bit complicated to use, if I accidentally drag the wrong part to the container, I will have to look through and delete accordingly. (P10) - That there would be a slight confusion when there are too many segments. There should be a priority segment. (P68)
	Learning curve	4 (13.8%)	It might be a little difficult to use at first, but it can be easily overcome with frequent usage of the feature. (P59)
Need to richer feature	Lack of utility	10 (34.5%)	- Maybe let me be able to rename the parts so we can understand our own edits better. (P33) - The fact that we cannot cut the segments ourselves because I might like a part of segment 2 and another's part of segment 3 but find the 2nd part of segment 3 useless so I don't want to include it. (P73)
	Transitions between segments	2 (6.9%)	Between different segments that is a continuously played (eg. Segments from different videos), might be good to have a very short pause to know that the video is changing. (P49)
Total negative comments in the feature		29	

Appendix 6-4: Summary of themes and comments for Metadata

Summary of themes for what participants liked about the Video Metadata in results list

What participants liked about the Video metadata in results list?			
Theme	Sub-theme	No. of instances (%)	Selected examples of instances
Positive metadata	Presence of social cues	33 (34.0%)	• It shows an indication of the video because of the likes and dislikes displayed. This is rare, because on other video platforms like YouTube, not all of these video information would be presented in the results list, especially the likes and dislikes portion. (P15) • The social cues provides a clear representative on the viewers' views of the video. (P62) • The highlighting feature (Likes/Dislike) is interesting, I will know what videos to avoid and what videos to watch. (P70) • The extra box that highlights large ratio does help me identify which video to watch and not to watch. For example those wot red boxes I would avoid the video since it has more negative rating than a positive one. (P85)
	Closed Caption indication	20 (20.6%)	• That they will. Let you know about the whether the videos has subtitles or what not. The presented information can also maybe include having extra links in the video which may or may not help with the product or subject viewing. (P18) • I like that the video information presented have subtitles, as I am a visual learner and looking at the words while listening to the audio helps me personally to grasp more information quickly. I also like that the likes and dislikes helps me to know whether the video is beneficial or not for my search. (P55)
	Video rating	3 (3.1%)	• It gives a rating how the video has been useful for the other viewers and that if it contains relevant information. (P22)
	Sentiment indication	2 (2.1%)	• Feels like YouTube as it's easy to understand the video synopsis and general sentiments felt towards it. (P29)
	Concept segments	2 (2.1%)	• The blue segments, because I feel that it helps me find out which video i should probably watch. The box for the ratio around the number of likes and dislikes as it allows me to make a faster decision as to which videos I should prioritise. (P60)
Influencing perception on video	Supports video selection	12 (12.4%)	• Let me select the videos I watch easily and find one that accommodates my needs. Eg closed captions. (P55) • It is able to gauge whether the video is liked by others and rates whether it is helpful, guiding me to make a decision on whether to watch it. (P9)

	Helps in video assessment	11 (11.3%)	- User will know which video is better based on the likes and dislikes, and also knowing which video provides subtitle is extremely helpful because sometimes, Lecturers prefer using videos to teach the class but it is hard to understand if the person is talking too fast so subtitle will help. (P10) - A good variety of information is available to help me make a more informed choice as to which videos would be more suitable or helpful for my learning and this helps to save a lot of time when it comes to doing efficient research. (P76)
	Learn about the video	6 (6.2%)	Allows me to have quick assess of the video quality and if other viewers found the video helpful. (P75)
Utility	Useful	5 (5.2%)	The information is useful and helps in my decision to watch the video or not. It helps me know what other viewers opinions are and this would help me decide if I should watch the video or not. (P47)
	Saves time	3 (3.1%)	Gives a really good idea on whether the video is good and relevant enough to watch it, thus saving time and effort. (P78)
Total positive comments in the feature		97	

Summary of themes for what participants disliked about the Video Metadata in results list

What participants disliked about the Video metadata in results list?			
Theme	Sub-theme	No. of instances (%)	Selected examples of instances
Doubtful over veracity of social metadata	Social cues may not reflect usefulness	8 (20.5%)	- This concept isn't new and that it might not really be helpful as views and likes can't really determine how useful the video is. (P16) - Might not be a fair representation of videos in a sense that not all viewers might rate videos so even if some videos has great contents, viewers might not rate it and this leaves the videos at the bottom ranking. (P58)
	Concern over the accuracy of information	3 (7.7%)	I do not like that at times the ratings may be inaccurate, causing the video information to be perceived as not relevant. (P55)
	Concern over effect of spams	2 (5.1%)	Fake dislikes/likes might affect the outcome. (P5)
	Decision not influenced by social cues	2 (5.1%)	I don't consult metadata when searching for things I'm unfamiliar with. (P45)

Desired metadata	Indicate language availability	3 (7.7%)	• It did not show what languages are the subtitles available in, which would definitely help in search efficiency. (P59)
	Grouping by social cues	2 (5.1%)	• I think that the highlighted parts could be grouped up together compared to being randomly put out there. Being grouped together will be able to help save more time for research too. (P39)
	Presentation of social cue	2 (5.1%)	• The highlighting of the likes/dislikes ratio has a good concept but can however be executed differently (by ranking it higher). (P62)
	Video description	2 (5.1%)	• Maybe add a slightly lengthier description on the video. (P19)
	User annotation	1 (2.6%)	• Should allow annotation to be presented for note taking purposes. (P30)
Poor Usability	Highlight of social cue	6 (15.4%)	• I think the highlighted green box of the like and dislike feature can be a little overwhelming. (P41)
	Overwhelming for new users	5 (12.8%)	• It looks scary to new users of the website, maybe allow users to customise the info they see on the page. (P56)
	Messy placement	3 (7.7%)	• Might need to touch up and the placement as it's kind of messy. (P66)
Total negative comments in the feature		39	

Summary of themes for what participants liked about the Video Metadata in video view

What participants liked about the Video metadata in video view?			
Theme	Sub-theme	No. of instances (%)	Selected examples of instances
Supports video assessment	Recall reasons for selection	18 (26.9%)	• It is good to help users recall the reason why they chose this videos. Especially for students like us, when we are doing research, we tend to open many tabs at one go, but only can review it one by one. Most of the times, we tend to forget what we chose a certain video to watch, and most of the time, we end up closing the tabs anyways. This feature will come in handy during situations like this. (P15) • It would remind me why did I even started to watch the video in case I forgot the reason why I came to watch the video. (P43)
	Perception of video quality	4 (6.0%)	• It allows me to me to know the quality of the video and effective of it after I watched it and it will help me in my studies after I watch the video and I know that I am on the right track and not looking at video that are not useful. (P54)

	Reliability of metadata	1 (1.5%)	It would help in checking the reliability of the ratings and comments that were highlighted from the video. (P22)
Provides video information	Summary of video information	15 (22.4%)	- Provides a good summary of the video and is easy to read. (P1) - It is able to give a brief summary of what we have search whether it is the correct thing. (P28)
	Informative	9 (13.4%)	It's informative, and everything you would need is presented there. (P13)
	Overview of video	4 (6.0%)	A summed up overview of what lead to the user arriving at the video based on the searched concepts. (P29)
	Video description	2 (3.0%)	I like the description bar on the right as I can refer to it with much ease while watching the video without any distractions. Unlike when reading the description of videos in other platforms like YouTube where I have to scroll down and miss a few seconds of the video or pause the video just to take a look at the description. (P61)
Exploring within the video	In-Video navigation	7 (10.4%)	It saves time and provides convenience to swiftly find my targeted information. (P32)
	Video segment highlights	2 (3.0%)	It helps to highlight which segment of the video is used for the specified keyword searches. (P30)
Familiar look	Familiar interface	5 (7.5%)	The video information are all familiar in other major video streaming platforms like YouTube and are good for allowing viewers to better understand the what the video entails. (P62)
	Layout of video view	2 (3.0%)	The information are presented beside the videos as compared to when you watch YouTube where you have to scroll down and expand the box to actually read the information. I find it pretty convenient as well because the information is just side by side so as and when the viewer is able to take a glance at the information while also watching the video. (P83)
Total positive comments in the feature		67	

Summary of themes for what participants disliked about the Video Metadata in video view

What participants disliked about the Video metadata in video view?			
Theme	Sub-theme	No. of instances (%)	Selected examples of instances
Overwhelming information	Placement of metadata	15 (44.2%)	The information can be put below the time bar, instead of the side which makes a video small and may have difficulties in viewing. (P8)

			• It makes the interface looks a little messy as everything is squeezed into one page. Maybe could spread the information further apart in the page. (P19)
	Too much metadata	9 (26.5%)	• Can be a little overwhelming for some people as there are too many information. (P31)
	Too many time bars	2 (5.9%)	• As said, the concept bar and interaction bar would be more convenient if its place at the video playing bar. (P64)
	Confusing	2 (5.9%)	• Too much things on it, a bit confusing. (P27)
Features to improve	Include full comments	3 (8.8%)	• Viewing all comments should be included. Discussions about the video topic could be more valuable than the video itself. People might point me in the right direction if I find the video unhelpful. The layout of the metadata is not visually appealing. (P12)
	Remove comments visualization	3 (8.8%)	• The word cloud is a little pointless in my opinion as it does not serve much purpose to me as I have already decided to watch the video. (P61)
Total negative comments in the feature		34	

Appendix 6-5: Summary of themes and comments for Value-Adding

Summary of themes for what participants liked about the Session history

What participants liked about the Session history feature?			
Theme	Sub-theme	No. of instances (%)	Selected examples of instances
Tracking searches	Recall previous searches	27 (30.7%)	- It is easily accessible and can help me remember things that I've searched about. (P9) - Allows for easier recall, thus less time wasted on thinking about what I previously searched. I also like how the relevant videos are also denoted. Allows me to find the most helpful video for my enquiry. (P51) - It is similar to cookies but I feel that this is more direct in giving the user a way of recalling back in a slightly different manner from cookies as the video tools for session history is quite beneficial. (P65)
	Track back search sessions	21 (23.9%)	- Allows fast recap of what was search instead of having the user to backtrack all the way to the beginning and search for the concept again. (P8) - It allows me to track down my navigation history and video relevance to each session, helping me identify videos with more common content shared by the sessions. (P29) - Able to track back my search history in an orderly manner and able to know the frequency of the term search, related to relevant videos. (P78)
	Help navigating searches	5 (5.7%)	Easily navigated me back to my previous searches so I do not need to search for them again. The session history at the videos is also very useful as it helps me identify which video is the most relevant to my search and which videos contain all the info I am looking for. (P85)
	Organizes searches	3 (3.4%)	It provides viewers with the ability to return to their previous searches effortlessly and on top of that also labels the videos that had appeared in previous searches making it more organised. (P26)
Video selection	Helps in video judgement	10 (11.4%)	- Enable to see which video actually covers the relevant topic in the navigations so that it produce the best result. (P20) - It is useful and effective so that i will be able to know that the video is related to what I am doing for and will help me in my learning. (P54)
	Shows common results	7 (8.0%)	That it shows links to what was searched previously, as well as the common result of all the searches. (P59)
	Relate video to concept	6 (6.8%)	This makes reviewing of topics easy as it gives us the liberty to navigate through already reviewed topics easily without us having to try and recall what we were searching before. This will make things easier for users as well as they do not have to be wary to not forget their previously reviewed topics. (P36)

Usage	Easy to use	9 (10.3%)	It allows easy navigation back to the previous searches and shows relevant videos. It is convenient. (P2)
Total positive comments in the feature		88	

Summary of themes for what participants disliked about the Session history

What participants disliked about the Session history feature?			
Theme	Sub-theme	No. of instances (%)	Selected examples of instances
Inadequate presentation	Session numbers lacks information	21 (40.4%)	- I do not know which session belongs to what topic. Probably text instead of numbers would be better. (P1) - It does not have words. It's numbered based on the session history. That in itself is not a problem. I might however, forget what concept is bounded to which number. Having a tooltip that indicates what concept the session number is would be valuable. (P12) - By writing only the session number I won't know what that session is and therefore still have to keep clicking until I get the right one. (P53)
	Messy for long history	10 (19.2%)	- The numbers is a bit chunky, and if there is too much history the numbers might take up too much space making it a bit of a sore eye. (P8) - If my sessions were to add up to more than 10 sessions for example, then the whole page would look very messy. (P58)
More utility	Session management	8 (15.4%)	In addition to the session numbers showing up on the screen, the user should also be allowed to sort through videos based on how many sessions a certain video has shown up. This would allow the user to make multiple searches and then choose a video that contains most if not all the information required. (P13)
	More interaction	3 (5.8%)	Maybe give us a snippet when we hover on one history link. (P33)
Poor Usability	Confusing	7 (13.5%)	The numbers might be confusing if I forget the order of topics that I clicked on previously. Might cause myself to keep finding for the right session. (P17)
	Tedious to use with increased sessions	3 (5.8%)	The session history feature is convenient and easy to navigate when there are a few sessions however once the learner gets deep into their session they might not remember what exactly each session was. When there are too many sessions going on I feel like this feature will not be as useful anymore. (P47)
Total negative comments in the feature		52	

Summary of themes for what participants liked about the Comments visualization

What participants liked about the Comments visualization feature?			
Theme	Sub-theme	No. of instances (%)	Selected examples of instances
Gathers opinions	Overview of opinions	26 (33.8%)	- I like that it gives me an overview of how people feel about the video and that it gives a rough measure of whether the video was helpful or not. (P16) - It is a nice and brief summary to know what other people think about the video, ability to find the video best needs based on the user saying. (P20) - It summarises other people viewpoint of the same video that you are watching so it's easy to identify whether this video is useful to most or not. (P52)
	Allows quick assessment of comments	8 (10.4%)	It is able to give a brief feel to the user whether people found the video useful and maybe a quick judge on whether they may find this video useful. (P36)
Supports video assessment	Supports judgement on video	16 (20.8%)	- Allows me to know how viewers felt about the video, and the quality of the video. (P51) - It allows the user to get a brief summary of comment behavior towards to video at a glance, allowing them to self-interpret the video's quality and usefulness freely and easily. (P62)
	Identify suitable video	6 (7.8%)	Useful to the user to see if the videos are relevant to what they are searching for. With the sentiment cloud, we can use that to back up the relevance and importance of that video to our needs. (P65)
	Find keywords to represent video	6 (7.8%)	It helps to qualify/gauge the rough keywords/phrases used to represent the video. (P29)
	Identify interesting content	2 (2.6%)	You are able to tell the key topic of the video and points of interest. (P1)
Usage	Saves time	5 (6.5%)	It is an interesting feature that saves time from reading comments. (P70)
	Easy to read	5 (6.5%)	I like that it highlights people's comments about videos, hence it is easy for users to know what reviews there are of a certain video. (P50)
	Visually pleasing	3 (3.9%)	It is visually pleasing to look at, and it helps me to see the overview of how people feel about the video. (P10)
Total positive comments in the feature		77	

Summary of themes for what participants disliked about the Comments visualization

What participants disliked about the Comments visualization feature?			
Theme	Sub-theme	No. of instances (%)	Selected examples of instances
Doubtful over veracity of comments	Off-topic comments	8 (13.1%)	- I don't think it would be quite practical as I don't usually look at the comment to determine whether a video is helpful and some comments may just be trolls. (P10) - In the world of online comments, there is many possibility of off topic comments that may cause a throw in the grading. It could do harm instead of help based on the current features. (P20)
	Misleading comments	6 (9.8%)	It can be misleading at times as the words picked up might not be beneficial for related to the content of the video. (P22)
	Scripted comments	5 (8.2%)	I find that the sentiment is not relevant as there might be bots spamming causing the result to be inaccurate. (P43)
Weak relationship between Comments and search	Comments not useful in search	14 (23.0%)	- That the comments may not even be helpful at all in the search itself. (P18) - It might not show words that are directly related to the context of the video and the concept that I am searching for, so it might become unnecessary information that I will spend time going through the research process. (P84)
	Not to be influenced by comments	8 (13.1%)	It would not particularly impact my decision on which videos to select. (P76)
	Missing information	3 (4.9%)	Useful comments may go undetected. (P56)
Presentation	Messy	10 (16.4%)	- It looks a bit messy and the words may not be much related to the video. The colours used are also a bit bright and could make the user not want to view it. (P9) - I feel it might affect how I feel about the videos even when I feel that it's not true and it look messy. (P58)
	Too wordy	5 (8.2%)	It looks wordy to start reading as it has been clustered together. However, the sentiment meter is easy to read and understand at first glance. (P64)
	Confusing	2 (3.3%)	Although the word cloud does help but due to the vagueness of the words the user might be confused and unclear of the true meaning. (P68)
Total negative comments in the feature		61	

Summary of themes for what participants liked about the Expert and viewer recommendations

What participants liked about the Expert and viewer recommendations feature?			
Theme	Sub-theme	No. of instances (%)	Selected examples of instances
Dual perspectives	Lists with alternative views	17 (20.5%)	- It gives two different perspectives as the videos recommended from the viewers point can differ from the authoritative sources. (P22) - I like there being officially sourced videos from established sites while still having viewership popularity in the recommended list. (P79)
	Options for different purposes	13 (15.7%)	- Authoritative: for studies purposes. Viewers: for entertainment. (P2) - I like that there are two variations, one for a more casual search and one for more informative purpose. (P72)
	Leverages on other references	6 (7.2%)	I like that it is spilt into two kind of recommendations as you get a better perspective from others as well as the authorities. (P41)
Trusted quality	Related videos	13 (15.7%)	- Let's me view related videos, especially ones that are recommended by other viewers, so they would be more relevant to me. It is good to have both viewers and authoritative sources point of view. (P14) - The recommendations feature is able to direct to me to related videos publicly perceived as positive and useful. (P62)
	Trustworthy	11 (13.3%)	- It shows reliable and trustworthy sources that would help in my exploratory tasks. (P32) - I believe that the feature is useful because it shows users what videos are good to watch to help them in their learning process and I feel that it is great that it classifies the recommended videos based on viewers and authoritative. (P37)
	Known quality	6 (7.2%)	It shows which video is the best among the rest and which is helpful for my learning so that I will not waste time to look at other video and just focus on the one based on recommendations. (P54)
Supports video search	Guides the search	4 (4.8%)	It easily guides us to videos that will be useful for our exploratory search. It also helps us to save time. (P17)
	Directs a search	4 (4.8%)	A general sense of direction on where to proceed next. (P63)
	Helps decide on video	3 (3.6%)	It helps me to decide which video I should watch. (P4)
Usage	Saves time	4 (4.8%)	Helps me to save time in terms of searching up useful video and contents for my search. (P58)

	Convenient	2 (2.4%)	It is easy to find videos that are related to the concept I am searching with the recommendations and know which video I should continue watching next. With videos that falls within both, I will definitely look out for them and ensure I watch it. (P84)
Total positive comments in the feature		83	

Summary of themes for what participants disliked about the Expert and viewer recommendations

What participants disliked about the Expert and viewer recommendations feature?			
Theme	Sub-theme	No. of instances (%)	Selected examples of instances
Concerns over recommendation neutrality	Inaccurate feedback	5 (17.9%)	There might be other users that gives inaccurate recommendations and results in a bad recommendation, it would be better if both recommendations cross check with one another. (P8)
	Fake feedback	5 (17.9%)	There can be potential spams (fake recommendations) and I do not know how popular the recommendation is. (P64)
	Bias recommendations	5 (17.9%)	I do not like that sometimes it is inaccurate or bias as opinions from viewers and authoritative sources may vary to each individual's choice and preference. (P55)
Not useful	Not catered to needs	5 (17.9%)	It might not cater to what the user needs as it uses common searched word to filter out what is being recommended. (P59)
	Missed recommendations	2 (7.1%)	They may recommend videos that I'm not interested in. (P45)
Distracting	Cognitive load in comparing	4 (14.3%)	Might be a little confusing as there are two types. (P31)
	Placement of feature	2 (7.1%)	It's a bit messy to be place at the side of the website. Easily would be treated like advertisement and get ignored. (P49)
Total negative comments in the feature		28	