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ATILIM UNIVERSITY 2024

THE IMPACT OF SEARCH ENGINE PRESENCE ON INDIVIDUALS' METACOGNITIVE EVOLUTIONS AND REMEMBERING

THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
ATILIM UNIVERSITY

RUMAN ABDIRASHID SHEIKH

A MASTER OF SCIENCE THESIS
IN
THE DEPARTMENT OF SOFTWARE ENGINEERING

JANUARY 2024

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A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
ATILIM UNIVERSITY

BY

RUMAN ABDIRASHID SHEIKH

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SOFTWARE ENGINEERING
IN
THE DEPARTMENT OF SOFTWARE ENGINEERING

JANUARY 2024

Approval of the Graduate School of Natural and Applied Sciences, Atilim University.

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I certify that this thesis satisfies all the requirements as a thesis for the degree of **Master of Software Engineering, Atılım University**.

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ABSTRACT

THE IMPACT OF SEARCH ENGINE PRESENCE ON INDIVIDUALS' METACOGNITIVE EVOLUTIONS AND REMEMBERING.

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January 2024, 94 pages

This thesis investigates the intricate relationship between search engine accessibility and its impact on various cognitive processes, specifically focusing on cognitive self-esteem, feeling-of-knowing (FOK), feeling-of-findability (FOF), willingness to answer questions, recognition, and information retention. The study was structured around general knowledge questions of varying difficulty levels, presented under conditions of both access and no access to search engines, providing a unique lens to examine the influence of digital tools on cognitive functions.

Utilizing a one-way repeated measures ANOVA, the study demonstrated significant effects of search engine access on participants' cognitive self-esteem and metacognitive perceptions. Findings revealed that participants exhibited a higher willingness to engage with challenging queries and showed enhanced recognition and findability feelings when they had access to search engines. This underlines the pivotal role of external digital tools in boosting cognitive confidence and perceived competence, especially in complex tasks.

This suggests a potential re-evaluation of assessment strategies in educational settings, considering the benefits of multiple-choice formats for both initial learning and long-term retention.

While the study provides significant insights, it acknowledges the limitations posed by the binary nature of search engine access conditions and the influence of individual differences, which may affect the generalizability of the findings. These aspects underscore the need for future research to explore these dynamics in more nuanced and varied real-life scenarios.

This thesis contributes to the understanding of how digital tools, particularly search engines, intersect with human cognitive processes, offering practical implications for educational strategies and knowledge-based work environments in our increasingly digital world.

Keywords: Cognitive offloading, distributed cognitive system, Transactional memory system, feeling of knowing and findability, multiple-choice questions, short-answer questions.

ÖZ

ARAMA MOTORUNDA BULUNDUĞUNUN BİREYLERİN METABİLİŞSEL GELİŞİMLERİ VE HATIRLAMA ÜZERİNDEKİ ETKİSİ.

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yüksek lisans, yazılım mühendisliği bölümü
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Ocak 2024, 94 Sayfa

Bu tez, arama motoru erişilebilirliği ile bunun çeşitli bilişsel süreçler üzerindeki etkisi arasındaki karmaşık ilişkiyi araştırıyor; özellikle bilişsel özsaygı, bilme hissi (FOK), bulunabilirlik hissi (FOF), soruları yanıtlama isteği, tanınma ve bilgi saklama. Çalışma, arama motorlarına hem erişimin olduğu hem de erişimin olmadığı koşullar altında sunulan ve dijital araçların bilişsel işlevler üzerindeki etkisini incelemek için benzersiz bir mercek sağlayan, değişen zorluk seviyelerindeki genel bilgi soruları etrafında yapılandırılmıştır.

Tek yönlü tekrarlanan ölçüm ANOVA'sını kullanan çalışma, arama motoru erişiminin katılımcıların bilişsel özgüvenleri ve üstbilişsel algıları üzerinde önemli etkilerini gösterdi. Bulgular, katılımcıların zorlu sorgularla ilgilenme konusunda daha yüksek bir isteklilik sergilediklerini ve arama motorlarına erişimleri olduğunda daha iyi tanınma ve bulunabilirlik duyguları sergilediklerini ortaya çıkardı. Bu, özellikle karmaşık görevlerde bilişsel güveni ve algılanan yeterliliği artırmada harici dijital araçların önemli rolünün altını çiziyor.

Üstelik araştırma, soru formatlarına bağlı olarak performans ve akılda tutma açısından kayda değer farklılıkların altını çizdi; çoktan seçmeli sorular, özellikle zor

içeriklerde, kısa cevaplı formatlara kıyasla daha yüksek akılda tutma oranları gösteriyor. Bu, hem ilk öğrenme hem de uzun süreli kalıcılık açısından çoktan seçmeli formatların yararları dikkate alınarak, eğitim ortamlarındaki değerlendirme stratejilerinin potansiyel olarak yeniden değerlendirilmesini önermektedir.

Çalışma önemli bilgiler sağlarken, arama motoru erişim koşullarının ikili yapısının getirdiği sınırlamaları ve bulguların genellenebilirliğini etkileyebilecek bireysel farklılıkların etkisini de kabul ediyor. Bu yönler, bu dinamikleri daha incelikli ve çeşitli gerçek hayat senaryolarında keşfetmek için gelecekteki araştırmalara duyulan ihtiyacın altını çiziyor.

Anahtar Kelimeler: Bilişsel boşaltma, dağıtılmış bilişsel sistem, Transaktif bellek sistemi, bilme ve bulunabilirlik hissi, çoktan seçmeli sorular, kısa cevaplı sorular.

ACKNOWLEDGMENTS

I would like to express my deepest gratitude to my supervisor Dr Sacip Toker, for his invaluable guidance and unwavering support during this challenging period of dissertation writing. He not only served as a mentor but also as a source of inspiration, motivating me to push the boundaries of my academic pursuits. I am truly fortunate to have had such a dedicated and knowledgeable supervisor by my side throughout this journey.

contributing significantly to my journey through this dissertation. My lovely mother, Salima, has been my steadfast backbone, offering unwavering support and fostering a positive mindset. Her belief in my capabilities from the beginning has been a source of strength. My father and my uncles, whose wisdom and guidance have been invaluable, played a pivotal role in shaping my academic pursuits. Their unwavering belief in my abilities and constant encouragement fuelled my determination. My brother, a source of inspiration provided valuable insights and support during challenging moments. Muna, consistently cared for my well-being, with her daily inquiries about my progress serving as a display of her considerate nature. Anab, emotionally available whenever I needed support, served as my motivator during moments of doubt. I am truly blessed to have such a supportive and loving family, and I owe the successful completion of this dissertation to their collective belief in my potential. I love them all dearly.

In addition, I extend my gratitude to the Departments of Software Engineering and the Graduate School of Natural Science, as well as the esteemed Board of Directors.

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CHAPTER 1

INTRODUCTION

The way we access, and store information has completely changed with the spread of the internet and the popularity of search engines, particularly Google. With the development of the digital age, people's reliance on search engines to find information and find solutions to their queries affects various cognitive and self-perception processes.

The development of computer-based systems that enable outsourcing or brain-based processing has benefited from a better understanding of how humans incorporate their environments into their cognitive loops[1]. This has led to an increase in computer capabilities. Numerous real-world instances in today's digital environment highlight our growing reliance on technology for information management and storage. The universal GPS makes navigation simple by guiding us along unfamiliar routes. Our smartphones have evolved into encyclopedias. Thanks to search engines, which have become the go-to resource for storing, retrieving, and analyzing vaa st array of information. Google Calendar is a helpful digital tool that keeps our schedules meticulously organized by reminding us of upcoming appointments. Todo lists, which are frequently digital these days, offer a structured method of task management, making sure that no significant detail is overlooked[1]. Together, these instances show how our reliance on technology has simplified our daily lives while also redefining how we access, manage, and interact with information.

Search engine differs significantly from other external memory formats, mainly due to its incredibly invisible nature. It is constantly available and can be accessed through wearable computers like Google Glass and the Sony Smartwatch, access points scattered throughout homes and offices, smartphones carried in pockets, and pocketbooks. Perhaps most importantly, it almost always provides the desired information. Before, finding certain pieces of information might have taken hours, days, or even minutes. Now, all it takes is a quick finger swipe. It is possible that

searching the internet is even quicker than searching one's memory[2]. While trying to retrieve information from memory can take a long time and possibly never be successful, Google returns search results in a matter of seconds, sometimes even less[3].

People may use search engines more frequently than any other information source, internal (such as their memory) or external (such as friends), due to its speed advantage over both other external sources and people's minds[4]. Because conducting an online search saves more time and requires less cognitive energy than searching through one's memories. people may be inclined to search for information that they believe they already know but cannot currently recall. This "feeling of knowing" e.g., Nelson [2]&Narens[3], or belief that one knows something that might not be immediately accessible, is not always a reliable predictor of actual knowledge (or of the ability to recall this knowledge). Once the correct information is retrieved, however, people may experience recognition memory, leading to the "knew it all along" effect.

The significance of this study lies in the relatively unexplored domain of how search engines influence our cognitive functions, particularly memory. In previous research Wegner[4] has delved into the general effects of the internet on memory[5]. However, limited information exists regarding the specific cognitive impacts of depending on search engines. This study aims to bridge this knowledge gap by illuminating how our memories and perceptions of our cognitive selves may change information retrieval.

This study aims to advance knowledge of how the digital age is affecting our cognitive processes and sense of self by addressing the cognitive effects of search engines on memory and self-perception. It is a step toward understanding the complexities of human cognition in the information age and may provide insightful information for academics, psychologists, and people trying to make the most of the internet without sacrificing their cognitive ability.

1.1 BACKGROUND OF THE STUDY

In the modern digital landscape, the transformative impact of technology on cognitive processes has become a subject of intense examination. A seminal study by Sparrow [6] introduced the term "digital amnesia," demonstrating a change in how people remember things. People tend to remember where to find information online rather than the content itself. This phenomenon highlights a fundamental shift in cognitive processes: the move from reliance on internal memory to external accessibility made possible by search engines.

Adding depth to the discussions Matei 7] in his book "The Shallows: What the Internet Is Doing to Our Brain" advances the hypothesis that the Internet, including search engines, might be impairing our ability to process information deeply. According to Matei, the constant overload of distractions and the pull of rapid satisfaction create a shallow cognitive style that blocks in-depth reflection and critical thought.

Extending beyond memory and cognitive processing, the widespread availability of online information retrieval has transformed people's methods for approaching cognitive tasks. Reliance on search engines regularly may cause one to believe that their knowledge and problem-solving abilities are less independent [8]. According to Sparrow[5] the "Google effect" on our cognitive self-esteem and self-perception may be impacted by how much we trust search engines to store and retrieve information.

Jansen [9] explored how search engines affect knowledge retrieval processes, highlighting the significant impact search engines have on people's information search and development practices. The importance of search engines in influencing the way people acquire information is highlighted by this study, which also raises questions regarding the accuracy of information retrieval and possible cognitive effects.

Ackerman's [10] exploration into the internet's impact on memory capacity introduces the concept of "cognitive offloading." Examining how using the internet influences memory capacity. According to their research, frequent internet users may tend to rely on the internet to remember facts, which may affect their offline memory retention. The study investigated the idea of "cognitive offloading," whereby people

delegate the burden of remembering information to online resources or search engines. In the digital age, where the reliance on individual memory is supplemented by the external storage capabilities of the internet, this research highlights the potential transformation of memory processes.

Hidi [11] and Hancock [12] clarified the complex relationship between conceptual comprehension and online information-seeking. The study revealed that although search engines are useful tools for retrieving information, they might not always improve comprehension or learning. In certain circumstances, people might rely on the availability of information online without exerting the cognitive effort required for true comprehension. This study casts doubt on the effectiveness of cognitive processing when looking for information online and makes the case that using search engines for convenience may not always result in a conceptual understanding that is more in-depth.

In the study of Risko [13] users who engage in cognitive offloading utilize search engines and the internet as external memory resources. It examines how people contract out their memory and problem-solving to online tools by using search engines to enhance their cognitive abilities. According to the study, people rely on search engines' external memory and purposefully use the internet to assign cognitive tasks. This shift in cognitive strategies affects problem-solving, memory, and information organization in the digital age. It emphasizes how crucial it is to understand how search engines affect memory and other cognitive processes as well as how they are integrated into human cognition.

Regarding the field of educational evaluation, the choice of question format plays a crucial role in shaping students' performance and study habits. Laboratory studies, such as those conducted by Voss [6]and Thiede [7], have consistently shown intriguing patterns in student behaviors and outcomes when faced with different question types. Notably, Vyas[8] observed that students tend to perform better on multiple-choice questions than on short-answer items. Petter [9] further delved into the dynamics of student preparation, revealing that students tend to invest more time studying for short-answer exams compared to multiple-choice exams.

Interestingly, Thiede's [10]findings also unveiled a cognitive paradox – students expected to recall information for short-answer questions, even though their performance was higher when recalling information than relying on recognition. McDaniel, Blischak, and Challis [11] added another layer to this by discovering that students did not alter their reading strategies for different test formats in laboratory settings.

Building upon this intriguing backdrop, this dissertation seeks to delve into the interplay between question formats, cognitive processes, and the influence of search engines in the digital learning landscape. Specifically, the research aims to explore how the performance and retention of short-answer and multiple-choice questions are differentially affected by varying levels of question difficulty and the presence or absence of a search engine.

The driving force behind this investigation lies in the contemporary educational landscape, where digital tools and technologies have become integral components of learning environments. The widespread availability of search engines has fundamentally transformed how students access and retrieve information. Thus, understanding the specifics of how search engines impact memory, cognitive self-esteem, and self-perception becomes imperative in crafting effective educational practices and assessments in the digital age.

Through a comprehensive exploration of these aspects, this dissertation aspires to offer insightful information that can contribute to the improvement of educational practices and assessments in the evolving digital landscape. By shedding light on the intricate dynamics between question formats, cognitive processes, and the role of search engines, this research aims to inform educators, policymakers, and instructional designers, fostering an environment conducive to enhanced learning outcomes in the digital era.

Although these studies have provided valuable insights into the wider effects of the internet and search engines on cognition and self-perception, there is still a void in the literature regarding the specific cognitive consequences of using search engines for clarification. By carefully planned experiments, this study aims to close this gap by clarifying the complex ways that search engines affect memory, self-perception,

and cognitive self-esteem. By doing this, it hopes to clarify the complex dynamics of digital-age information retrieval.

1.2 DEFINITION OF TERMS

1.2.1 Cognitive offloading

Cognitive offloading, the externalization of information from one's working memory to reduce cognitive load, involves deliberate decision-making influenced by metacognitive judgment[14]. Metacognitive judgments refer to individuals' assessments of their memory abilities, influencing their choice to engage in cognitive offloading. For instance, individuals are more likely to offload information when they lack confidence in their ability to remember.

The importance of metacognitive judgments decision-making process was emphasized by Dunn[12]who presents a metacognitive perspective on cognitive offloading. According to them, cognitive offloading is a deliberate strategy used by people to weigh the advantages of externalizing information against the costs of doing so, as well as the cognitive demands of a task. Understanding why and how people use cognitive offloading strategies in various domains is made possible by this metacognitive approach. The metacognitive nature of cognitive offloading is not limited to domains; it encompasses a wide range of tasks, such as taking notes, solving problems, and making decisions. For instance, during lectures, students frequently take notes to offload information from their working memory and concentrate on understanding and organization. While using external tools like spreadsheets or lists to support their decisions in decision-making contexts, people may externalize intermediate steps or calculations in problem-solving scenarios to reduce cognitive load.

1.2.2 Transactive memory system

The expansion of the mind through the process of offloading memories to external storage devices is captured by the theory of “transactive memory” [16]. Transactive

memory's fundamental premise is one of effectiveness. People are unable to know everything. However, by delegating the responsibility for types of information to others, they gain the ability to both increase the depth of their knowledge in a small number of personal areas of expertise and access the information held by many different people, each of whom has comparable advanced knowledge in their respective fields of expertise. People who are involved in a transactive memory structure typically do not need to know very much about a subject; rather, they just need to know who knows it.

These transactive memory structures consist of links among group members, where a link signifies an individual's regional knowledge about a particular subject understanding held by another member. The distribution of content knowledge among group members usually occurs based on three principles: concerning expertise, shared responsibilities, and knowledge of other group members' access to information [17].

In an ideal transactive memory structure, every member is responsible for a specific portion of the data and is informed of the knowledge held by the others. These structures, and the division of knowledge within them, seem to form and function automatically, especially in long-term relationships. As people get to know one another, they naturally assign roles to one another, often without having to express it aloud. This transactive memory structure serves as a system that is both socially connected and cognitively efficient. Because of their cognitive interdependence, members are bonded together, and the loss of a member makes them less united.

A transactive memory structure exists in its most basic form at the dynamic level. Long-term interactions between two people form this kind of structure, a cognitive link between each person's mind and the knowledge within it and the other's mind[18] Each person gains access to knowledge that is both internally (in their minds) and externally (in their partner's minds) through this connection, enabling them to learn more than they could have separately[19].

1.2.3 Distributed Cognitive Systems.

The idea of distributed cognition, which depends on the dynamic interaction between internal and external cognitive resources, challenges the traditional view that holds that our minds are contained within our bodies [20]. The concept of 'distributed cognition' includes the idea that cognitive functions are not limited to personal minds alone, but rather are distributed and closely linked to external resources and surroundings. Distributed cognition broadens our understanding of how people engage with and use outside sources in their cognitive processes about cognitive offloading and transactive memory.

The results of information offloading show the effect of using various external storage devices. For instance, utilizing search engines on the internet can affect a person's willingness to respond to inquiries, which can affect their perception of their value, confidence, discoverability, and self-worth. The difference in results emphasizes how people and their preferred storage devices have a complex relationship[21]. Nonetheless, there is still a clear distinction between internal and external despite the widespread influence of outside sources. Getting information from friends, browsing books in libraries, or using the internet all require different procedures that each represent the complex interaction between the mind's internal workings and the outside world. Gaining knowledge about distributed cognition can help us better understand how our minds flow outside of our bodies and interconnect with the various resources in our immediate surroundings.

1.2.4 Feeling of Findability

Within the framework of a human internet transactive memory system, the 'feeling of findability' refers to the intuitive perception of how easy or difficult it might be to locate specific information using online search tools [22] This psychological phenomenon affects how people make decisions when they need relevant information that is accessible online.

Imagine yourself in a position where you must look up specific information online. Your "feeling of findability" may play a role in whether you decide to use pre-existing knowledge or conduct an external search. This feeling of intuition captures

how simple you think the information is to find using internet search engines. If you think it is easily accessible, you might be more likely to look it up elsewhere. On the other hand, you might decide to rely on what you already know if you think the information is difficult to locate or not easily accessible.

In the field of information retrieval and search, an interesting discovery has been made people usually struggle to distinguish between the knowledge they obtain online and the knowledge they possess internally [20]. Because online sources are so easily accessible and convenient, this phenomenon raises concerns about how people might mistakenly attribute external information to their cognitive resources. As demonstrated by Ward's study, this tendency has real-world impacts on how people understand and apply information from both digital and personal sources.

1.2.5 Feeling of knowing

The idea of the "feeling of knowing" is closely related to metacognition, which is the process by which people consider how their cognitive processes—including their internal states of knowing—are reflected. The phenomenon known as the "feeling of knowing," like the "feeling of findability," has been extensively studied in academic literature [23]. When people answer "I don't know" to a question and are then asked to rate how well they feel they can recall the answer later, this rating is a good representation of how well they can retrieve the information [24].

Individuals have a good understanding of the relative accessibility of information stored in their internal or biological memory, as shown by the interaction between subjective assessments of one's knowledge and subsequent retrieval performance [22]. It emphasizes the idea that our metacognitive abilities encompass a complex understanding of the accessibility and retrieval of information, even within our internal cognitive reservoirs, and go beyond simple awareness of our cognitive process.

Imagine a situation where someone answers a question with uncertainty by saying, "I don't know." There afterward "feeling of knowing" regarding their potential to remember the information later thus serves as an important substitution for their true

retrieval abilities. This metacognitive understanding of one's cognitive processes is useful for problem-solving, decision-making, and learning strategies.

1.3 RESEARCH OBJECTIVES.

1. Does the cognitive self-esteem of participants change significantly when transitioning from difficult general knowledge questions to easier ones, depending on their access to the search engine?
2. When transitioning from difficult general knowledge questions to easier ones, do participants' cognitive responses undergo significant changes in the presence or absence of access to the search engine? Specifically:
    a. To what extent does the accessibility of a search engine impact participants' willingness to respond to questions?
    b. How does the accessibility of search engines significantly influence the nature of the feeling of knowing?
    c. How does the availability of a search engine affect the feeling of findability of information among participants?
    d. Do significant differences exist in recognition abilities when individuals have access to a search engine compared to when they do not have access?
3. What is the level of retention among participants for both short-answer and multiple-choice questions after two weeks? Additionally, how does the performance of short-answer and multiple-choice questions vary when participants have access to a search engine compared to when they do not? Furthermore, which question type, short-answer or multiple-choice, demonstrates a higher level of retention among participants, and is this difference statistically significant?
    a. How does the performance of participants in both short-answer and multiple-choice grades, as well as their retention of these grades, differ for difficult questions when participants have no access versus access to a search engine?

b. How does the performance of participants in both short-answer and multiple-choice grades, as well as their retention of these grades, vary for medium questions when participants have no access versus access to a search engine?

c. How does the performance of participants in both short-answer and multiple-choice grades, as well as their retention of these grades, differ for easy questions when participants have no access versus access to a search engine?

1.4 CONCEPTUAL FRAMEWORK.

The conceptual framework of this study examines the complex relationships among search engine use, different cognitive variables, and participants' retention ability. The study adopts a comprehensive approach to the independent variable "Search Engine," This multidimensional viewpoint attempts to represent the various ways that people interact with search engines when looking for information. The dependent variables, representing cognitive factors and retention capacity, encompass a range of dimensions. These include participants' willingness to respond to questions, the subjective feeling of knowing, and findability of information, cognitive self-esteem, recognition ability, and retention capacity.

1.4.1 Conceptual Framework for Metacognition.

Metacognition refers to the awareness and understanding of one's thought processes. In the context of this study, involves examining how individuals perceive and regulate their cognitive processes while using search engines and retaining information. Here's an explanation of each component:

Willingness to Answer Questions: This aspect explores participants' readiness to respond to questions related to the information they have found. It reflects their confidence in their ability to retrieve and articulate relevant information.

Findability: This pertains to the ease with which individuals can locate information using search engines. It involves assessing the efficiency and effectiveness of search strategies employed by participants.

The feeling of Knowing: This aspect involves individuals' subjective sense of confidence or certainty about their knowledge or understanding of a particular topic or concept. It reflects their metacognitive awareness of their level of understanding.

Recognition: Recognition refers to the ability of individuals to identify previously encountered information among a set of alternatives. It involves assessing participants' capacity to recognize information they have previously encountered during the search process.

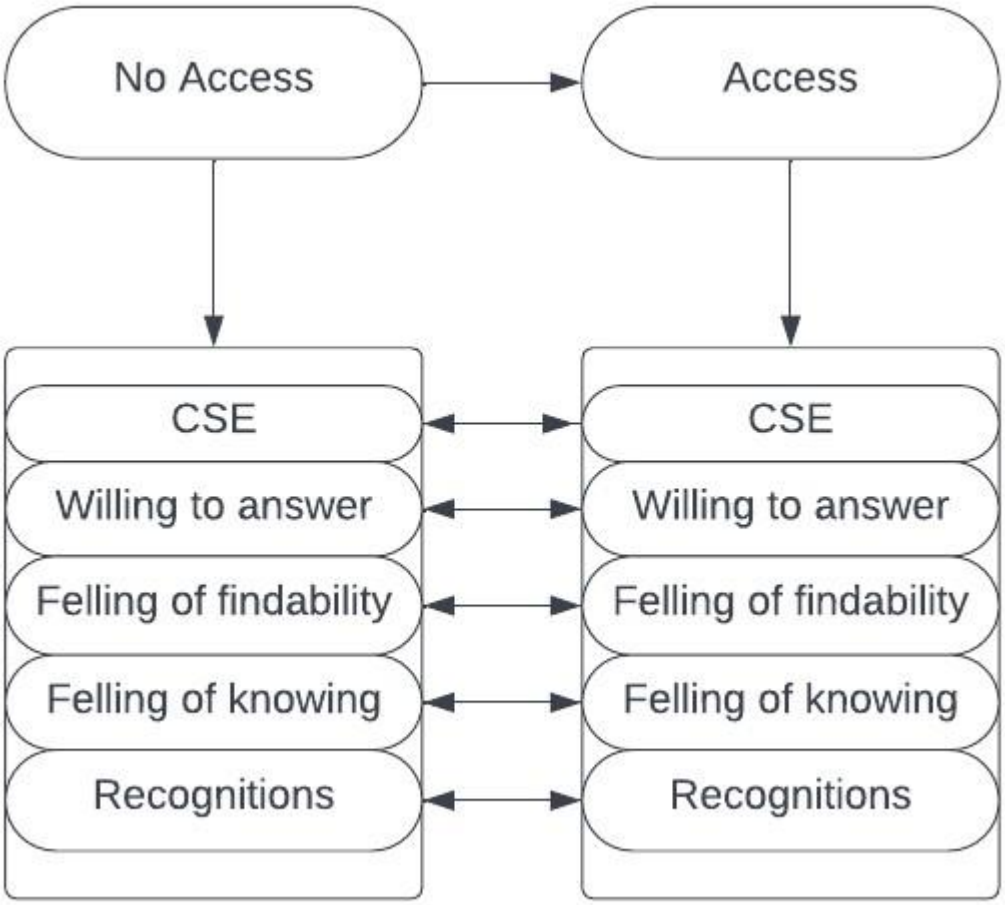

Figure1.1 Conceptual Framework for Metacognition

1.4.2 Conceptual Framework for Achievement.

This framework focuses on the performance outcomes and retention capacity of participants following their interaction with search engines and the information retrieval process. It examines how individuals' search behaviors and cognitive processes influence their ability to retain information over time. Here's an explanation of each component:

Performance in Short Answer and Multiple-Choice Formats: This aspect evaluates participants' performance in retrieving and conveying information using different formats. It includes assessing their ability to provide concise answers to questions (short answer format) and to select correct responses among multiple options (multiple-choice format).

Access vs. No Access: This dimension compares participants' performance and retention when they have access to the retrieved information versus when they do not have access. It explores how access to information affects performance and retention outcomes.

Retention After 2 Weeks: This aspect assesses the durability of participants' retention of information over time. It involves measuring their ability to recall and retain information two weeks after the initial interaction with the search engine and information retrieval process.

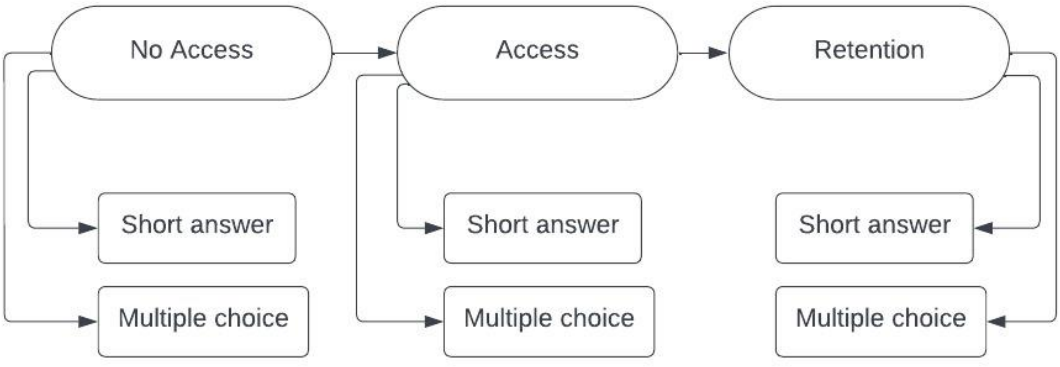

Figure1.2 Conceptual Framework for Achievement

CHAPTER 2

LITERATURE REVIEW

The introduction of the internet has caused a paradigm shift in how people view themselves, especially when it comes to cognitive self-esteem. According to research by Galinsky [25], people tend to incorrectly credit their abilities for outcomes connected to the internet. This phenomenon calls into question how cognitive processes are integrated with the online environment and how that might affect how people perceive themselves.

2.1 Integration of Cognitive Processes with the Internet.

Recent studies have examined the complex relationship that exists between people and the characteristics of the internet, with a focus on cognitive self-esteem. One area of investigation has been the possibility that people may incorrectly attribute their abilities to outcomes associated with the Internet [26]. This complex investigation raises the possibility that people may integrate the online environment with their cognitive processes, leading to a change in how they view themselves. Therefore, traits related to the internet, such as those relating to information-gathering abilities or transactive memory aids like Google, might be seen as essential components of their identity [27]

2.2 Measuring participant's Self-Perception.

Researchers use a wide range of constructs and specialized measurement scales to fully evaluate the effects of cognitive integration with the internet on self-perception, as explained by [24] This comprehensive evaluation approach seeks to capture the complex dynamics that emerge when people integrate the digital world with their cognitive processes. Global measures, like the Rosenberg Self-Esteem Scale [28] are fundamental instruments that give people a broad picture of their self-esteem and insights into their overall self-perceptions. A rich tapestry of targeted scales, in

addition to global assessments, helps to provide a more in-depth and sophisticated understanding of self-perception. These scales, each designed to evaluate different aspects, paint a complete picture of the person's cognitive integration with the virtual world.

Beliefs in Physical ability[29] investigate how people view their physical abilities in their digital interactions. It also investigates whether the combination of cognitive processes and the online environment affects people's perceptions of their physical skills, reflecting a holistic understanding of the interconnected self. This scale, Academic Ability Impact Assessment[30], examines how people's perceptions of their intelligence are impacted by their cognitive integration with the online environment and whether the digital world contributes to or diminishes their sense of academic value. The analysis of Social Skills[29] in the framework of cognitive integration investigates the complex ways people understand their interpersonal skills and whether the digital environment affects how people interact with others and how they see themselves in the social domain.

This multidimensional assessment strategy, which combines targeted and global scales, guarantees a thorough investigation of the complex relationship between self-perception and cognitive integration with the online environment. Through the examination of distinct aspects such as physical attributes, cognitive abilities, interpersonal abilities, and body image, scholars can clarify the complex framework of how people create and modify their self-concepts in the dynamic Worlds of digital media. This advanced insight adds to the larger conversation about the psychological effects of our increasing interconnection with digital lives.

When we explore cognitive integration with the internet world and its significant impact on one's self-concept, the investigation flows naturally into the understanding of the internet as a dynamic transactive memory partner rather than just a storage medium. This change in emphasis is like the historical function of normal inorganic storage devices, such as computers, file cabinets, and books, which have all been acknowledged as essential parts of transactive memory's complex structure[31].

2.3 Evolution of Inorganic Storage Devices:

Books, filing cabinets, and computers are examples of inorganic storage devices that have historically been thought of as temporary parts of transactive memory structures. Their roles have been carefully examined, with information access, concerning knowledge, and agreed-upon responsibilities serving as guiding principles [32]. Several academic debates have explored the crucial role these tools play in collective memory frameworks. However, when we examine their fundamental shortcomings, namely the inability to record actively and share information unconsciously, the story takes a turn for the worse. Even though these devices have been extremely important, the literature that has already been written about them—such as works by [33]indicates the complex issues that limit their capacity to be fully functional components of a transactive memory structure.

2.4 Transition to the Internet as a Transactive Memory Partner.

In today's digital world, the internet appears as a disruptive force that calls into question traditional assumptions regarding inorganic storage. In contrast to its previous generations, the internet exceeds the restrictions of simple storage because of its vast information network. The idea that the internet takes on a more active and collaborative role within transactive memory frameworks is at the center of recent discussions. This change forces us to reconsider the fundamentals of self-perception and cognitive integration in the framework of a changing transactive memory environment.

2.5 The Impact of Internet Accessibility on Memory Processes.

The internet's significant effect on memory processes has been the subject of extensive research due to its evolving landscape. [34] research explores the effects of continuous internet access and points out a worrying trend in which people become less likely to participate critically as they get lost in the vast amount of online content. Instead, when navigating online information, there is a tendency to adopt an elementary interpretation, which may have an impact on the depth of their critical thinking abilities. This gives us an insight into the cognitive effects of constant

internet use by arguing that the abundance of online information may encourage a style of interaction that values convenience over critical thought processes and speed over depth. This observation prompts further investigation into the complex relationship between internet usage and critical thinking skills and raises significant questions about the changing nature of cognitive processes in the digital age.

Carr [35] presents a varied viewpoint on the connection between internet usage and memory in connection with findings. Their research points to a more complex dynamic than the theory that depending on the internet's vast external memory might replace natural memory. According to the research, people do not always choose not to include information from the internet in their internal memory systems. This discovery adds viewpoint to the effects of internet use on memory, suggesting that the effects are not completely harmful and that reliance on external digital sources and information collaboration into natural memory systems interact carefully.

This investigation is further enhanced by [36]Ward's study, which highlights some possible drawbacks of internet accessibility. According to his research, people sometimes overestimate their level of expertise on a subject because they confuse what they learn online with what they already know in their cognitive collection. This phenomenon raises the possibility that people's perceptions of their expertise may be influenced by their easy access to a wealth of information on the internet, which could unintentionally lead to an exaggerated sense of personal knowledge.

After studying the historical function of inorganic storage media in transactive memory structures, we logically move on to the internet's revolutionary impact as highlighted by recent research [37]. Higher education has undergone a paradigm change because of the digital landscape, driven primarily by search engines. Search engines have significantly changed higher education, making it more cutting-edge and open to students, faculty, and researchers. Higher education institutions are actively involved in teaching, learning, evaluation, and research in a time of information explosion where the search for knowledge and its practical application cuts across many fields. Students themselves are embracing the most recent technology to broaden their knowledge horizons, and academics and faculty are not just adopting this trend. As a result, there has been an increase in internet usage, which has led to the creation of numerous programs for data and information

collection. Search engines stand out among these tools as a key resource for information.

The influence of technology on cognitive processes is a subject of interest, as revealed in a study [6]. It seems that when faced with challenging questions, individuals are more likely to think of computers. This implies that they are more likely to consider using a computer or search engine to find the answers when presented with challenging questions. The studies also show that people's actual recall of information decreases when they anticipate having access to it in the future (such as looking it up online later). Instead, it appears that remembering how to access that information in the future takes precedence in their memory. In other words, the impact of technology on memory and cognitive processes may cause people to become less likely to remember specific details when they know they can easily find them online. This demonstrates how technology has become a crucial component of how we process and remember information in the digital age, where there is a dynamic relationship between human cognition and technology.

Exploring the accessibility of information on the Internet, research [22] uncovers an interesting link between individuals' confidence in finding information online and the actual time taken to do so. Metacognition, the awareness of one's thought processes, becomes crucial, especially when individuals are assessing both their existing knowledge and their ability to use external information effectively. Their research found an important relationship between how quickly someone thinks they can find information online and how long it takes them to do so. When people lacked the knowledge to answer a question, their "feeling of findability" - how confident they felt about being able to find the information online - accurately predicted the length of time it took them to find the solution online. This gives us a suggestion that people have an accurate awareness of how simple it is to find information online. Regarding findability individuals typically find the solution more quickly when they do not know the answer but are confident, they can find it online. This emphasizes the importance of metacognition where people assess both their knowledge and their ability to use outside information effectively. It helps shed light on the dynamics of information retrieval in the digital age when users' perceptions of information accessibility have a significant impact on their actions and choices.

Considering the impact of pre-search thinking, a study by Liu [2] emphasizes the benefits of careful information retrieval over hasty searches. the aim was to determine how participants' recall was affected when they either thought about the answers to trivia questions before using the internet (referred to as "thinking-before-googling") or when they turned to Google right away without pausing to think (referred to as "googling-right-away"). To understand these four experiments were used in the study, and the findings consistently showed that planning ahead of time led to significantly better recall of the information than doing so immediately. It is interesting to note that the study also found that a large majority of participants, specifically 81%, reported a propensity to instinctively search the internet without first considering the questions rather than spending the time to consider the answers. These results highlight the benefits of careful information retrieval over hurried searches and draw attention to how common the latter is.

The propensity to access additional information online is further explored in [38] showcasing that a person's propensity to access additional information online is significantly influenced by their choice to use the Internet to retrieve information. Participants who depended on Google to find answers to challenging trivia questions were more likely to do the same when attempting a new set of relatively simple trivia questions compared to participants who had answered the initial questions from memory. These results show that if you rely on the internet to access information in one context, the likelihood that you will do so in other contexts increases noticeably. This study sheds light on the cognitive effects of our increasing reliance on technology.

Addressing the "Google effect," where easy access to information online appears to reduce the effort people invest in memorization, research [21] examines the potential effects of the Internet on cognitive abilities. While claims of negative effects on memory are debated, the study emphasizes two interconnected goals: first, to examine the potential effects of the Internet on cognitive abilities; and second, to propose an evaluative framework for these effects.

The authors argue that claims of negative effects on memory caused by the Internet are not strongly supported by current empirical evidence in cognitive psychology. Before making firm conclusions, they argue that more reliable and ecologically valid

data need to be gathered. Along with highlighting the fundamental value of cognitive skills, the paper argues that in today's information-driven societies, mastering the skills necessary to efficiently navigate, evaluate, compare, and generate online information frequently exceeds the benefits of storing vast amounts of data in one's biological memory.

Expanding the scope beyond search engines and shifting focus to spatial memory, [28] investigates the impact of GPS on spatial memory. While GPS aids wayfinding, they compared the experiences of people who used GPS to follow a predetermined route with those of people who did so on their own. When both groups were asked to navigate the route again without any help, it was discovered that the GPS users did worse than the non-GPS users. This gives a hint that using a GPS to handle wayfinding tasks may be damaging to spatial memory. This highlights the delicate balance between the convenience of technology and the preservation of cognitive spatial abilities and has potential consequences, especially when people are forced to navigate the same route without the aid of a GPS.

This theme of GPS on spatial memory resonates with [39]. which investigates how taking pictures of objects affects memory later, exposing complex relationships between technology and memory preservation. On a guided tour of an art gallery, participants were told to either closely examine specific pieces or take pictures of others. The "photo-taking-impairment effect". Researchers discovered that when participants photographed an entire object, their memory suffered; compared to those who had just observed the objects without taking pictures, participants remembered fewer objects and retained fewer details about the objects and their locations in the museum. Nevertheless, there was an amazing turnaround when participants opened in to capture specific details of an object. In this instance, their reliable memory and subsequent recognition remained unaffected. It was also found that their recall of non-zoomed features was considerably more powerful than that of features that were zoomed in. This finding emphasizes the significant differences between a camera's memory and human memory, highlighting the concept that targeted photography can reduce the negative consequences.

This thorough review provides a complex and rich understanding of the complex interactions between people and the internet, making it an essential component in the

synthesis of current research. Investigating cognitive integration with the internet world [36]raises important issues that are particularly relevant when considering how easily one's self-perception can change in the digital age.

CHAPTER 3

METHODOLOGY

The advent of the internet has transformed information retrieval, especially with the widespread use of search engines. However, our understanding of how search engine usage influences subjective experiences (feeling of knowing, willingness to answer questions, feeling of findability,) and cognitive processes remains limited. This chapter outlines the methodology employed to investigate the relationship between search engine usage and subjective experiences, cognitive performance, and cognitive self-esteem.

The study aims to address the gap in knowledge by exploring the impact of search engine usage on various dependent variables. The research questions guiding this investigation are as follows:

RQ1: Cognitive Self-Esteem Transition

Does the cognitive self-esteem of participants change significantly when transitioning from difficult general knowledge questions to easier ones, depending on their access to the search engine?

Null Hypothesis (H_0): There is no significant difference in cognitive self-esteem when transitioning from difficult to easier general knowledge questions, irrespective of access to search engines.

Alternative Hypothesis (H_1): There is a significant difference in cognitive self-esteem when transitioning from difficult to easier general knowledge questions, depending on access to search engines.

2a. Participants' Willingness to Answer

Are participants more willing to answer the questions when Google is accessible or not?

Null Hypothesis (H_0): There is no significant difference in participants' willingness to answer questions with or without access to search engines.

Alternative Hypothesis (H_1): Participants are more willing to answer questions when the search engine is accessible compared to when it is not.

2b. Feeling of Knowing

Research Question 2b: Does the feeling of knowing change significantly based on the availability of search engines?

Null Hypothesis (H_0): There is no significant change in the feeling of knowing based on the availability of Google.

Alternative Hypothesis (H_1): The feeling of knowing changes significantly depending on the availability of Google.

Research Question 2c: How does the findability of information vary when participants have access to search engines or not?

Null Hypothesis (H_0): There is no significant variation in the findability of information with or without access to a search engine.

Alternative Hypothesis (H_1): The findability of information significantly varies when participants have access to search compared to when they do not.

2d. Recognition Abilities

Research Question 2d: Do recognition abilities show significant differences with or without access to search engines?

Null Hypothesis (H_0): Recognition abilities do not show significant differences with or without access to the search engine.

Alternative Hypothesis (H_1): Recognition abilities show a significant difference with access to search engines.

Research Question 3: Over two weeks, as participants transition from difficult general knowledge questions to easier ones, does their performance in providing short answers and selecting multiple-choice options for general knowledge questions significantly change?

Null Hypothesis (H_0): There is no significant change in performance over two weeks in providing short answers and selecting multiple-choice options.

Alternative Hypothesis (H_1): Participants' performance significantly changes over two weeks.

3.1 RESEARCH DESIGN

The aim of employing an experimental research design is to quantify the impact of an experimental treatment. This study focuses on the students selected from Atilim University (Atilim University is a private university established in 1997. It is in Ankara, the capital of Turkey.) through convenience sampling and is conducted within the confines of a computer lab, providing a controlled environment for experimentation. The selection of an appropriate research design is crucial to ensuring the validity of the study's conclusions.

As outlined by Pebrioni[40], various experimental research designs exist, encompassing classical, pre-experimental, quasi-experimental, and special designs. In this investigation, a within-subject experimental design is adopted, with no control group being utilized. This design allows for an in-depth exploration of the effects of search engine usage on diverse cognitive aspects, including participants' willingness to answer questions, feelings of knowing, findability, recognition, retention ability, and their overall performance on general knowledge questions of varying difficulty levels (difficult, medium, and easy).

According to Edward[41], a within-subject experimental design involves exposing each participant to all conditions or treatments under investigation. In our "within-subject" designed experiment, individuals experience both "Access" and "No Access" conditions, enabling a comprehensive comparison of their responses across different general knowledge question scenarios. This approach is particularly valuable for studying how participants navigate various cognitive challenges when transitioning between conditions, providing nuanced insights into the impact of search engine access on cognitive processes.

This experimental design not only ensures a rigorous examination of the research questions but also allows for a thorough exploration of individual variations in

response to different levels of question difficulty. The methodology aims to capture the dynamic interplay of cognitive factors under the influence of search engine access, contributing to a comprehensive understanding of the research objectives.

In adopting a within-subject design for this study, potential order effects were addressed through the implementation of a counterbalancing strategy [42] encompassing six distinct versions of participant groups. Order effects, which can introduce biases based on the sequence of experimental conditions, were systematically mitigated by varying the presentation order across participants. This counterbalancing approach was instrumental in ensuring that any systematic variations tied to the order of conditions were evenly distributed across the participants. Notably, the absence of order effects during data collection confirms the effectiveness of the counterbalancing procedure. This methodological safeguard not only increases the internal validity of the research but also reinforces the credibility of the findings, highlighting the careful thought that was given to minimizing any possible order effects during the investigation.

3.1.1 Population and Sample

The population in this research was 134 students from the Atilim University campus selected through convenience sampling due to accessibility and willingness to participate.

The gender distribution within the participant sample was 90 (67.20%) identified as male and (32.8%) as female. Academic performance, as measured by Grade Point Average (GPA), varied across the participant group. The GPA ranged from 1.95 to 3.91, with a mean GPA of 2.30. Participants' internet usage data of several key factors, including frequency, device preference Desktop (45%), Tablet (17.5%), and Smartphone (37.5%), and experiences related to online activities and search engine frequency.

To optimize the practicality of this experimental study, convenience sampling[43] was employed as the chosen sampling method. This decision was driven by the benefits associated with convenience sampling, particularly its quick recruitment process and ease of participant accessibility. The approach facilitated a streamlined

data collection process, ensuring a more efficient implementation of the study within resource constraints. Additionally, convenience sampling proved advantageous when studying specific populations or rare characteristics, aligning with the study's objectives. While acknowledging potential limitations such as sampling bias, the strategic use of convenience sampling was instrumental in enhancing the overall feasibility and timely completion of this experimental investigation, enabling us to address research questions with practical efficiency.

3.1.2 Data source

Data is the information that researchers uncover because of their research efforts [44]. In this investigation, only primary data is used. Primary data are data directly collected from the research sample, in this study; data was collected under six distinct conditions, with three general knowledge questions throughout the entire data collection. Each is designed to assess various aspects of memory and cognitive abilities. The data is collected in six different conditions using general knowledge questions.

The six Conditions across the experiments:

Condition 1 - Difficult questions with no access to a search engine.

Condition 2 - Difficult questions with access to a search engine.

Condition 3 - Medium-difficulty questions with no access to a search engine.

Condition 4 - Medium-difficulty questions with access to a search engine.

Condition 5 - Easy questions with no access to a search engine.

Condition 6 - Easy questions with access to a search engine.

The three general knowledge questions:

In the pursuit of gathering general knowledge questions for my research, I used the seminal work of Nelson and Narens published over three decades ago in 1980. Their comprehensive study involved the creation of a set of 300 questions spanning various domains of knowledge, accompanied by an assessment of cognitive and metacognitive measures, including the probability of recall and the latency to

general. These norms have since been widely utilized in research endeavors exploring the intricacies of long-term memory processes. I drew upon the updated and expanded general knowledge norms derived from the Nelson and Narens [45] study to formulate the questions for my research. For instance, the difficulty levels of the questions were stratified into three categories: difficult, medium, and easy. An example of each includes the difficult question, "What is the highest mountain in South America?" (probability of recall =0%) the medium question, "What is the name of the legendary one-eyed giant in Greek mythology?"; (probability of recall =51%) and the easy question, "What is the name of the horse-like animal with black and white stripes?"(probability of recall =93.3%) This reliance on established norms not only lends credibility to my research but also underscores the enduring impact of Nelson and Narens' foundational work in shaping investigations into general knowledge and memory

3.1.3 Procedure of the data collection

Within-subject design experiment (repeated measure design) was conducted participants experienced all the conditions of No access and the access condition with the three general knowledge questions (difficult, medium, and easy), and the data was collected from all the conditions for analysis.

Condition 1: Difficult Question - No Access. Participant were presented with difficult questions, and they were instructed not to use search engines, they were asked to answer their feeling of knowing, how instant they would find the answer, their cognitive self-esteem, and if they recognized the questions, their response was collected.

Condition 2: Difficult Question – Access - Participant were presented with a difficult question and were instructed to use the search engine, they were asked to answer their feeling of knowing, how instant they would find the answer, their cognitive self-esteem, and if they recognized the questions, their response was collected.

Condition 3: Medium Question - No Access. Participant were presented with medium questions, and they were instructed not to use search engines, they were asked to answer their feeling of knowing, how instant they would find the answer,

their cognitive self-esteem, and if they recognized the questions, their response was collected.

Condition 4: Medium Question – Access. Participant were presented with medium questions, and they were instructed to use search engines, they were asked to answer their feeling of knowing, how instant they would find the answer, their cognitive self-esteem, and if they recognized the questions, their response was collected.

Condition 5: Easy Question - No Access. Participant were presented with easy questions, and they were instructed not to use search engines, they were asked to answer their feeling of knowing, how instant they would find the answer, their cognitive self-esteem, and if they recognized the questions, their response was collected.

Condition 6: Easy Question – Access. Participant were presented with difficult questions, and they were instructed to use search engines, they were asked to answer their feeling of knowing, how instant they would find the answer, their cognitive self-esteem, and if they recognized the questions, their response was collected.

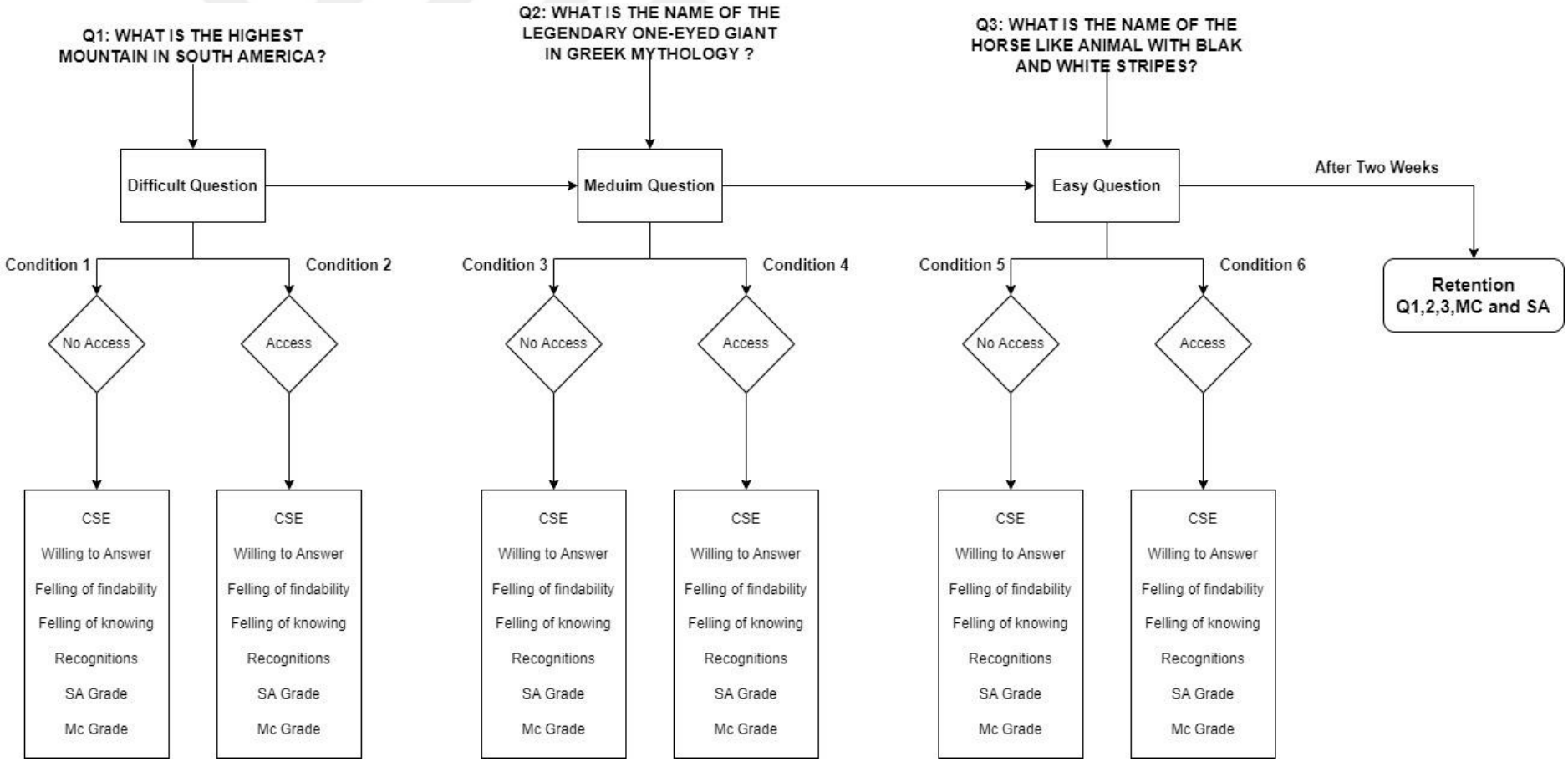

Figure 3.1 Research design approach of the within-subject experiments

3.2 MEASURES

Any entity having multiple possible values is considered a variable. There are various ways to classify variables. Whether they are categorized as dependent variables or independent variables, the most crucial classification depends on how they are used in the study that is being studied [46].

Independent Variable (IV): This is what the researcher changes or controls in an experiment. The factor is thought to have an impact on the outcome. In many cases, there is typically one key independent variable known as the "treatment variable." it is the variable that receives different levels or conditions, and it is the focus of the experiment.

In this study the independent variable “search engine” is examined from a variety of angles, considering participants' access to search engines and No access,

Dependent Variable (DV): The dependent variable is what you measure in the experiment. It is the outcome that you observe and record. The dependent variable is expected to change based on the manipulation or changes made to the independent variable.

The dependent variables, which represent cognitive factors and retention capacity, include willingness to respond to a question, feelings of knowing, information findability, cognitive self-esteem, recognition ability, and retention capacity. The way one feels about one's cognitive ability and how well one completes tasks have an impact on cognitive self-esteem. The processes of memory and information retrieval are intertwined with recognition ability, and the initial difficulty of the questions all have an impact on retention ability.

3.2.1 Measuring Participants Cognitive Self-esteem.

By the methodology established by Ward [20]the measurement of participants' Cognitive Self-esteem (CSE) in the present study was undertaken through a crafted procedure. Ward, in previous research, had undertaken two pilot studies (Pilot Study 1 and Pilot Study 2) to develop a scale specifically designed to capture individual

differences in Cognitive Self-esteem and to explore the hypothesis that internet use may impact this measure. Subsequently, participants (n = 134) from Atilim University were assigned to either the "Access" or "No access" conditions, where they responded to general knowledge questions of varying difficulty levels (Difficult, Medium, and Easy).

Following the completion of the general knowledge questions, participants across both conditions were administered the 14-item CSE Scale, a product of Ward's Pilot Study 2 (refer to Appendix B in Ward, 2013). This scale, developed by Ward, was adeptly incorporated into our methodology to assess Cognitive Self-esteem, ensuring the reliability and validity of the measurements collected. The utilization of Ward's established scale provides a standardized and well-validated instrument for evaluating the cognitive aspects influenced by internet use, thereby fortifying the credibility and consistency of our approach.

3.2.2 Measuring Participants' Willingness to Answer Questions

To assess participants' willingness to respond to questions both with and without access to a search engine, the study implemented a straightforward yet effective approach. Each participant encountered three general knowledge questions, as detailed in the procedure section. Subsequently, participants were prompted to express their willingness to answer each question through a binary response format. Specifically, participants were provided with the following options for each question:

"Yes, I am willing to answer this question."

"No, I am not willing to answer this question."

This concise binary format facilitated an unambiguous indication of participants' willingness to engage with the questions under both conditions—namely, with access to a search engine and without. The simplicity of this response format aimed to minimize participant burden while ensuring a precise assessment of their inclination to provide answers under varying circumstances.

3.2.3 Measuring Participant's Feeling of Knowing

To evaluate participants' confidence in their knowledge, both with and without access to a search engine, the study employed a concise and informative procedure. Participants encountered three general knowledge questions, as outlined in the procedure section, and were prompted to indicate their "feeling of knowing" for each question using a binary response format: "I know" or "I don't know." Following this initial response, participants received further clarification, being informed, "You are allowed to use an electronic device or a search tool, like Google, on the internet. Do you know the answer to the question?" This additional step aimed to capture participants' confidence in their ability to find the answer using external resources, thus providing a nuanced understanding of their perceived knowledge in the presence of information-seeking tools.

3.2.4 Measuring Participant's Feeling of Findability

In alignment with the established procedure for assessing the feeling of knowing, participants were directed to make a feeling-of-findability judgment. Using a 9-point Likert scale, participants were tasked with estimating the speed at which they could retrieve the answer to each question with the aid of a search engine. The Likert scale ranged from 1, signifying the ability to find the answer almost instantly, to 9, indicating the expectation of finding the answer within a few minutes. This approach sought to capture participants' subjective assessments of the ease and speed with which they believed they could access information using online resources. By employing a Likert scale tailored to the feeling of findability, this procedure provided a more detailed insight into participants' perceptions of their capability to easily locate information online, contributing to a comprehensive understanding of their information-seeking attitudes**.**

(1: - I would find it almost instantly.

(9: - I would find it in a few minutes).

3.2.5 Measuring Participant's Recognition Abilities.

In alignment with the procedures employed for assessing the feeling of knowing and feeling of findability, participants were engaged in evaluating their recognition ability within the context of having access to a search engine. Utilizing a 9-point Likert scale, participants were prompted to estimate the likelihood of recognizing the answer to each question. The Likert scale ranged from 1, indicating a lack of confidence in recognizing the answer, to 9, expressing a high level of certainty in the ability to recognize the answer. Participants were instructed, "Please rate using the scale below how likely you think that you would be able to recognize the answer to this question when you saw it." This approach aimed to capture participants' subjective assessments of their recognition capabilities, aligning with the parallel evaluations of their knowledge and findability. By employing a consistent Likert scale, this procedure facilitated a cohesive and comprehensive examination of participants' cognitive processes about recognition when utilizing a search engine.

“Please rate using the scale below how likely you think that you would be able to recognize the answer to this question when you saw it.

1 - I am sure I would NOT recognize the answer.

9 - I am sure I would recognize the answer

Note: if participants select 1 it means that it will take me some time to recognize the answer so lower scale less recognition and greater scale more recognition “

3.2.6 Measuring the performance of short answer and multiple-choice format

Each participant underwent a session where they responded to a set of short-answer and multiple-choice questions of general knowledge.

Participants were all exposed to two conditions: one with access to a search engine during the test ("Search Engine Access" condition) and the other without access to any external resources ("No Search Engine Access" condition). The order of conditions was counterbalanced to reduce potential order effects. Half of the participants experienced the "Search Engine Access" condition first, followed by the "No Search Engine Access" condition, while the order was reversed for the

remaining participants. in the "Search Engine Access" condition they were instructed to use an electronic device or a search tool, such as Google, to find information while answering the questions.

Participants' responses to both short-answer and multiple-choice questions were recorded and scored for each condition. The performance metrics, including accuracy and response times, were collected for both conditions. Following a two-week interval, participants engaged in a second session where they were presented with the same set of questions encountered during the initial testing phase. Participants were not given access to a search engine during this retention phase.

Participants' responses to the repeated short-answer and multiple-choice questions were collected and scored for both conditions. Retention metrics, comparing the accuracy and consistency of responses over the two weeks, were analyzed, considering the order in which conditions were experienced during the initial testing phase. This adapted procedure, incorporating a within-subject design with counterbalancing, ensures that each participant serves as their control, experiencing both conditions in a systematic order. This approach enhances the internal validity of the study and allows for a more nuanced analysis of how search engine access influences short-term performance and long-term retention for both types of questions. To measure the participant’s retention of the information they accessed from the internet. Participants were invited again to answer the questions that were presented before. In the form of short answer and multiple-choice format.

3.3 DATA ANALYSIS

The data analysis for this study employed a within-subject experimental design, where participants experienced all conditions, allowing for the investigation of changes within the same group across different conditions. Statistical analyses were chosen based on the nature of the research questions and the experimental design. Repeated measures ANOVA was conducted. This parametric test is suitable for examining changes within the same group across multiple related conditions, making it appropriate for assessing variations over different levels of Google accessibility. All statistical analyses were carried out using the SPSS software program.

CHAPTER 4

RESULTS

This chapter presents the results, the analysis, and the interpretation of data gathered from the experiments. The foundation of this experiment is composed of six different conditions designed to examine how participants' cognitive processes are affected by the degree of difficulty of the questions and their ability to access search engines. SPSS software program was utilized for analyzing the data and a repeated measure design approach was used.

4.1 Experimental Conditions of the Study

Six different conditions, each thoughtfully created to generate a different response from participants, were the starting point of our experimental design. These requirements are listed below:

Condition 1 – Difficult question with No access to search engine

Condition2 – Difficult question with access to search engine

Condition3 – Medium question with No access to search engine

Condition4 – Medium question with access to search engine

Condition5 – Easy question with No access to search engine

Condition6 – Easy question with access to search engine

These conditions were purposefully chosen to provide a thorough understanding of the cognitive processes involved by offering a complex exploration of the relationship between search engine access and question difficulty.

These conditions are used for the entire experiment and to collect data from all the dependent variables. Cognitive self-esteem (CSE), the feeling of knowing (FOK), findability, willingness to answer the questions, recognition, and retention ability of

the participants after two weeks through assessing them with short answer and multiple-choice form of the questions.

RQ1. Does the cognitive self-esteem of participants change significantly when transitioning from difficult general knowledge questions to easier ones, depending on their access to search engines?

Table 4.1 Descriptive Statistics of Cognitive Self-esteem (CSE)

Different conditions	Mean	Std. Deviation
Condition0 (On-set)	3.8172	.49707
Condition1	3.6746	.60891
Condition2	3.8422	.53661
Condition3	3.7833	.55474
Condition4	3.8422	.55289
Condition5	3.8401	.60602
Condition6	3.8499	.59969
Note: N=134		

Descriptive statistics indicated variations in means across conditions based on question difficulty and access to the search engine (See Table 4.1). The CSE value on the set was 3.82 (SD = .50). On the first condition where there was no access to a search engine, and students had to respond to a difficult general knowledge question, the average CSE was decreased to 3.67 (SD = .61), And with the access condition, the average increased to 3.84 (SD = .54). On the second condition where there was no access to the search engine and the student had to respond to a medium general knowledge question, the average was increased to 3.78 (SD = .55) compared to the difficult question. Nevertheless, for both access and no access, the average remained stable for easy questions at 3.84 (SD=.55)

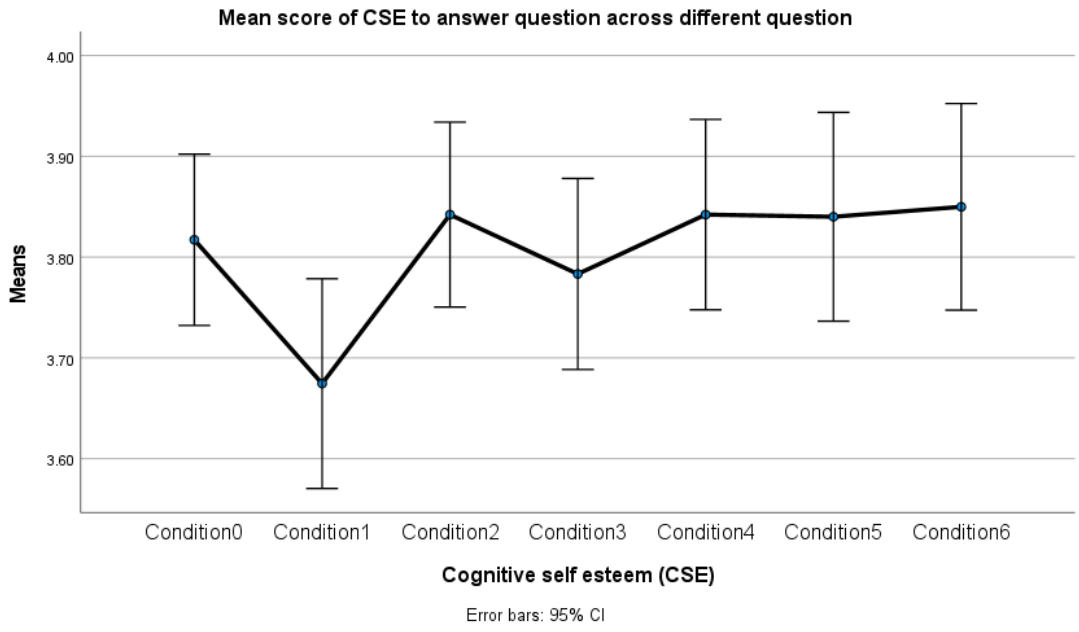

Figure 4.1 Mean scores of CSE for the onset and across all the conditions.

Repeated-measure ANOVA was used to answer the study questions. If there are more than two repeat measures in a repeated-measure ANOVA, the sphericity assumption must be tested using Mauchly's test (Field, 2017). The assumption was violated when this test was significant. There were two possibilities in this scenario, which were mostly revising the analysis results depending on the degrees of freedom. Greenhouse-Geisser or Huynh-Feldt values were used in these selections. To select the best alternative, the sphericity estimate was determined, and if it is less than 75, the Greenhouse-Geisser value should be used; if it is greater than 75, the Huynh-Feldt value should be used. This assumption was expressly validated for the current study's analysis, and the approach described above was used.

A repeated-measure ANOVA analysis was performed. Mauchly's test of sphericity yielded a significant result, Mauchly W = .257, $\chi 2$ (20), $p < .01$. so, the assumption was violated. For that reason, Greenhouse-Geisser corrected values were presented (ϵ = 0.732); as suggested by Field (2017). The analysis revealed that there is a significant difference for both multivariate and within-subject significant effects, Wilk's λ = .799, F (6, 128) = 5.363, $p < .01$, partial $\eta 2$ = .201 indicating 20.1% of

explained total variance, and F (4.390, 583.81) = 6.326, $p < .001$), partial $\eta 2 = .041$ indicating 4.1% of explained total variance.

Underscoring the influence of access to search engines on participants' cognitive self-esteem in response to varying question difficulties. The multivariate analysis indicated a significant overall effect across the combined dependent variables (CSE), with 20.1% of the variance attributable to the independent variable (search engine). Meanwhile, the within-subject analysis emphasized the individual significance of the effect, with 4.1% of the variance in the individual dependent variables associated with access to search engines. These findings reinforce the notion that access to search engines plays a crucial role in shaping participants' cognitive self-esteem, with both analyses yielding statistically significant results and effect sizes suggesting practical significance.

Table 4. 2 Pairwise Contrast comparison of CSE across conditions.

Mean difference	Control set	C1	C2	C3	C4	C5	C6
Control set	-						
C1	-.143*	-					
C2	0.25	-.168*	-				
C3	-0.34	-.109*	-0.59	-			
C4	0.25	-.168*	-	.059	-		
C5	0.23	-.166*	0.002	.057	-.002	-	
C6	0.33	-.175*	.008	.067	.008	.010	-

Pairwise comparisons (Table 4.2) unveiled the influence of question difficulty on cognitive self-esteem. Participants encountering difficult questions without access to a search engine (Difficult question NA = 1.43*) exhibited the lowest self-esteem scores compared to other conditions, including difficult questions with access, medium questions with access, and no access among others. Notably, the mean difference between "Difficult question with No access" and "Medium question with Access" was significant (mean difference = .168*). Furthermore, the "On-Set"

condition, denoting the absence of search engine access, displayed an average cognitive self-esteem score of .143*, indicating that the lack of external assistance significantly impacted self-esteem.

The finding reveals a significant association between search engine availability and cognitive self-esteem. Participants showed improved self-esteem across difficulty levels (difficult, medium, and easy) when utilizing search engines. Notably, even with easy questions, self-esteem remains stable with or without search engine access, indicating that question ease has limited influence. Overall, the findings emphasize the significant positive impact of search engines on cognitive self-esteem, highlighting lower self-esteem when participants lack access to search engines. This underscores the role of external support in enhancing confidence in responding to questions of diverse difficulty levels.

RQ2. When transitioning from general knowledge questions with different difficulty levels (Difficult, Medium, and easy), do participant's perceptions undergo significant changes in the presence or absence of access to the Google search engine? Specifically:

2a. Does the feeling of knowing (FOK) change significantly based on the availability of search engines?

For this research question, we examine six conditions, encompassing difficult, medium, and easy questions, each presented with and without access to search engines. Notably, there is no onset or control condition. The emphasis of this research question is on measuring participants' perceptions, including feelings of knowing, feelings of findability, willingness to answer questions, and their perception of recognition abilities.

Table 4. 3 Descriptive statistics of FOK across the different conditions

Descriptive Statistics	Mean	Std. Deviation
Condition1	.12	.325
Condition2	.68	.469
Condition3	.31	.463

Condition4	.72	.449
Condition5	.98	.148
Condition6	.99	.122
Note N= 134		

Descriptive statistics (Table 4.3) revealed variations in mean scores across different conditions, considering question difficulty and access to the search engine, suggesting potential influences on individuals' feelings of knowing. In the condition without search engine access, where participants responded to a difficult general knowledge question, the average feeling of knowing with no access was 0.12 (SD = 0.325), while in the access condition, the average increased to 0.68 (SD = 0.469). In the medium question condition without access, the average increased to 0.37 (SD = 0.55) when compared to the difficult question without access. Interestingly, for easy questions, both conditions resulted in a relatively high mean feeling of knowing scores, with only a marginal difference of 0.98 (SD = 0.148).

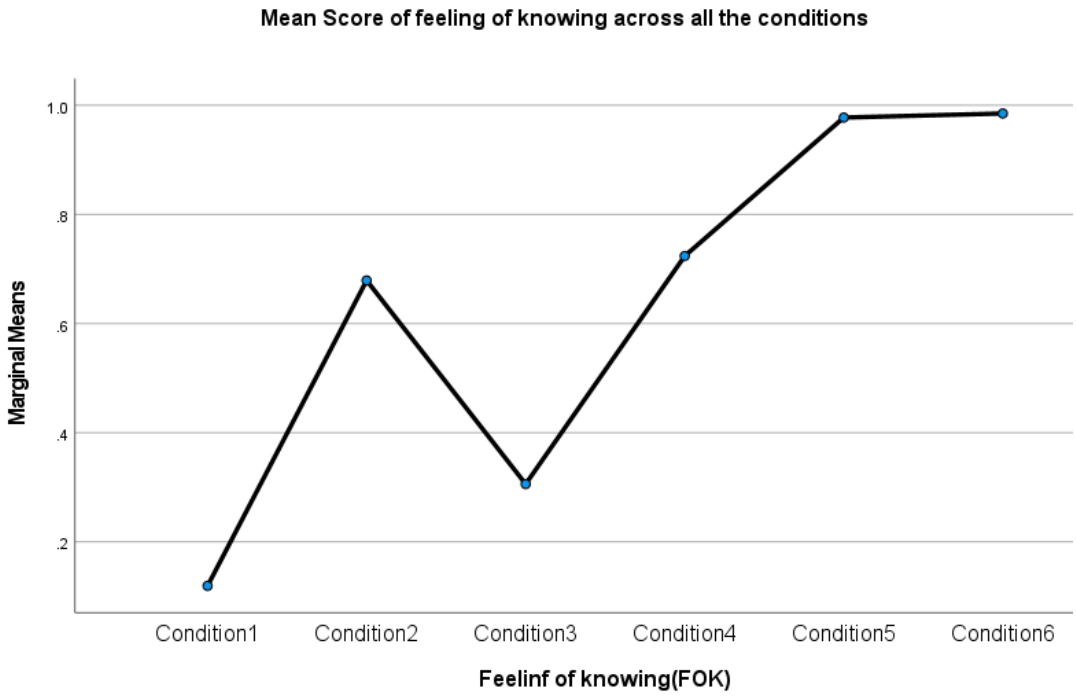

Figure 4.1 Mean scores Feeling of knowing (FOK) across the conditions.

Repeated-measure ANOVA was used to answer the study questions. If there are more than two repeat measures in a repeated-measure ANOVA, the sphericity assumption must be tested using Mauchly's test (Field, 2017). The assumption was violated when this test was significant. There were two possibilities in this scenario, which were mostly revising the analysis results depending on the degrees of freedom. Greenhouse-Geisser or Huynh-Feldt values were used in these selections. To select the best alternative, the sphericity estimate was determined, and if it is less than 75, the Greenhouse-Geisser value should be used; if it is greater than 75, the Huynh-Feldt value should be used. This assumption was expressly validated for the current study's analysis, and the approach described above was used.

A repeated-measure ANOVA analysis was performed. Mauchly's test of sphericity yielded a significant result, Mauchly W =0.050, $\chi 2$ (14), $p < 0.01$) so, the assumption was violated. For that reason, Greenhouse-Geisser corrected values were presented ($\epsilon = 0.705$); as suggested by Field (2017). The analysis revealed that there is a significant difference for both multivariate and within-subject significant effects, For the multivariate effect, Wilk's λ was remarkably low at 0.115, $F (5, 129) = 199.40$, $p < 0.01$, with a substantial partial eta squared (partial η^2) of 0.885. This indicates that an extensive 88.5% of the variance in the combined dependent variables can be attributed to the independent variable (access to search engines), underscoring a notably large effect size. Additionally, concerning the within-subject effect on feelings of knowing, $F (3.52, 468) = 10.68$, $p < 0.001$, with a partial η^2 of 0.525, suggests that 52.5% of the variance in feelings of knowing is explained by access to search engines, marking a moderate to large effect size. These findings strongly support the notion that access to search engines significantly influences participants' feelings of knowing across questions of varying difficulty, emphasizing the practical relevance of the observed effects.

Pairwise contrast comparisons (see Table 4.4) emphasized the significant impact of search engine accessibility on participants' self-reported feelings of knowing when given general knowledge questions of moderate and difficult difficulty levels. Notably, participants reported higher confidence in their knowledge under the "Search Engine Access" condition for difficult (effect size = 0.560) and medium (effect size = 0.604*) questions compared to the "No Search Engine Access"

condition. However, for easy questions, there was no significant difference between the two conditions, indicating that participants felt equally confident regardless of search engine accessibility for easier questions.

Table 4.4 Pairwise contrast comparison of FOK across the conditions.

Mean Scores	C1	C2	C3	C4	C5	C6
C1	-					
C2	.560	-				
C3	.187*	-373*	-			
C4	.604*	0.45*	.418*	-		
C5	.858*	.299*	.672*	.254*	-	
C6	.866*	.306*	.679*	.261*	0.007	-
Note: dashed means Zero ***Means p<0.059significant)** **C-rep conditions**						

The results (see Figure 4.2) emphasize the significant impact of search engine access on participants' self-reported feelings of knowing in response to general knowledge questions of varying difficulty. Access to a search engine notably increased confidence for challenging and medium-level questions, while for easy questions; participants consistently reported high confidence, regardless of search engine accessibility. These findings underscore the complex relationship between technology and self-perception with search engines serving as external tools for shaping individuals' perceptions of their knowledge.

2b. Are participants more willing to answer the questions when Google is accessible or not?

Table 4.5 Descriptive statistics of willingness to answer the questions.

Descriptive Statistics	Mean	Std. Deviation
Condition1	.60	.491
Condition2	.93	.251
Condition3	.72	.452
Condition4	.93	.251
Condition5	.98	.148
Condition6	.97	.171
Note: N=134		

Descriptive statistics showed variations in means across different conditions, for difficult questions, the contrast between "No Access" .60(SD=.491) and "Access" 0.93(SD=.251) conditions was different. Similarly, for medium-difficulty questions, a significant increase in mean willingness to answer was observed when participants had access 0.72(SD=.452. Remarkably, for easy questions, both conditions resulted in relatively high mean willingness to answer scores, with only a marginal difference of .98 (SD=.148).

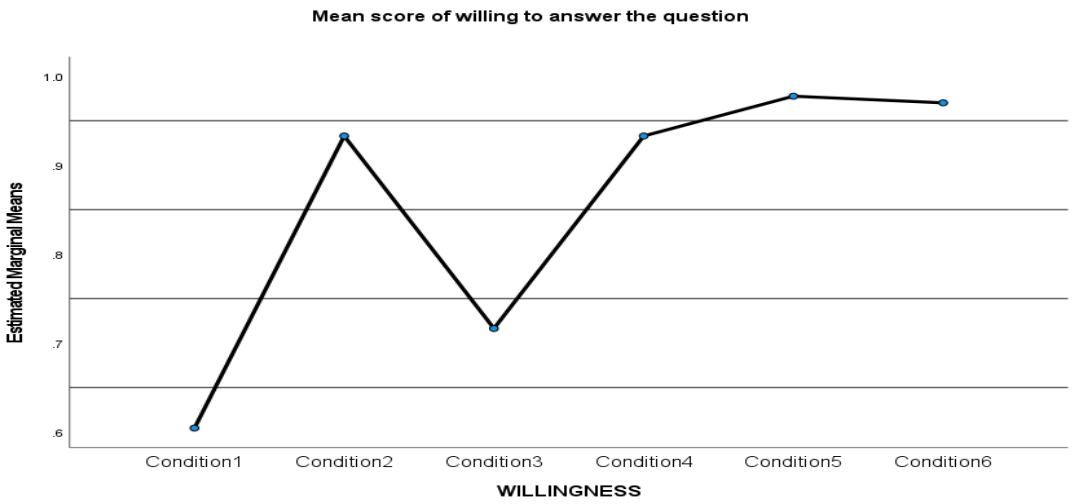

Figure 4. 2 Mean scores of willingness to answer across the conditions.

Repeated-measure ANOVA was used to answer the study questions. If there are more than two repeat measures in a repeated-measure ANOVA, the sphericity assumption must be tested using Mauchly's test (Field, 2017). The assumption was violated when this test was significant. There were two possibilities in this scenario, which were mostly revising the analysis results depending on the degrees of freedom. Greenhouse-Geisser or Huynh-Feldt values were used in these selections. To select the best alternative, the sphericity estimate was determined, and if it is less than 75, the Greenhouse-Geisser value should be used; if it is greater than 75, the Huynh-Feldt value should be used. This assumption was expressly validated for the current study's analysis, and the approach described above was used.

A repeated-measure ANOVA analysis was performed. Mauchly's test of sphericity yielded a significant result, Mauchly W = 112, $\chi 2$ (14), $p < .001$ so, the assumption was violated. For that reason, Greenhouse-Geisser corrected values were presented ($\epsilon = 0.578$) as suggested by Field (2017).

The one-way repeated measures ANOVA yielded significant effects both in the multivariate and within-subject analyses, suggesting an influence of access to search engines on participants' responses to questions of varying difficulty levels. The multivariate effect, as indicated by Wilk's Lambda ($\lambda = .607$, $F (5, 129) = 16.724$, $p < .01$), demonstrated an impact, with a large effect size (partial $\eta^2 = .393$), signifying that 39.3% of the variance in the combined dependent variables can be attributed to the independent variable. Furthermore, the within-subject analysis revealed a highly significant effect ($F (16.398, 55.602) = 39.244$, $p < .001$), with a moderate to large effect size (partial $\eta^2 = .228$), indicating that 22.8% of the variance in the individual dependent variables is explained by access to search engines. These findings underscore the statistical and practical significance of the observed effects, emphasizing the notable impact of access to search engines on participants' willingness to respond to questions with different difficulties.

Pairwise contrast comparisons (see Table 4.6) indicated that individuals in the "Access" condition exhibited a higher willingness to answer the question compared to the "No Access" condition. This signifies that search engine accessibility significantly influences participants' self-reported willingness to respond when given general knowledge questions of moderate and difficult difficulty levels.

Table 4.6 Pairwise contrast comparison on willingness to answer the question.

Mean score	C1	C2	C3	C4	C5	C6
C1	-					
C2	.328*	-				
C3	.112*	-.216*	-			
C4	.328*	-	.216*	-		
C5	.373*	.045	.216*	.045	-	
C6	.366*	.307	.254*	.037		-
Note: dashed means Zero ***Means p<0.059significant)** **C- rep conditions**						

The finding indicates that search engine accessibility significantly influences participants' willingness to answer questions. Access to search engines led participants to be more willing to respond, especially for difficult and medium-difficulty questions, highlighting its value as a resource for tackling challenging queries.

For easy questions, participants were equally willing to respond in both conditions, indicating that they felt self-sufficient in answering straightforward questions and did not rely on a search engine for assistance.

2c. Does the speed of finding answers to a question vary for participants when they have access to a search engine compared to when they do not?

Table 4.6 Descriptive statistics of the feeling of findability.

Descriptive Statistic	Mean	Std. Deviation
Condition1	3.48	2.841
Condition2	2.34	2.299
Condition3	3.06	2.733

Condition4	1.98	2.069
Condition5	1.83	2.136
Condition6	1.84	2.190
N=134		

Descriptive statistics indicated variations in means across conditions based on question difficulty and access to the search engine, hinting at potential influences on participants' feelings of findability.

On the first condition where there was no access to a search engine, and students had to scale on how instant they would find the answer to the difficult general knowledge question, their average was 3.48 (SD = 2.841), and with the access condition the average decreased to 2.34(SD = 2.30). For the medium with no access to the search engine, the average was reduced to 3.06(SD =2.733) compared to the question, with easy the average remained stable at 1.84 (SD=2.90)

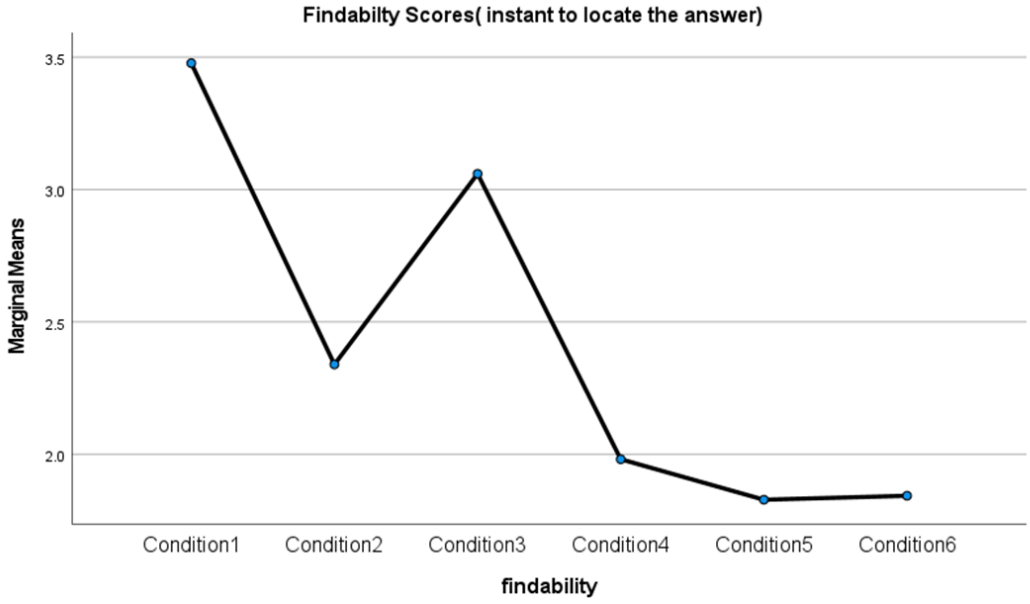

Figure 4. 3 Mean score difference of FOF across different conditions.

Repeated-measure ANOVA was used to answer the study questions. If there are more than two repeat measures in a repeated-measure ANOVA, the sphericity assumption must be tested using Mauchly's test (Field, 2017). The assumption was violated when this test was significant. There were two possibilities in this scenario, which were mostly revising the analysis results depending on the degrees of freedom. Greenhouse-Geisser or Huynh-Feldt values were used in these selections. To select the best alternative, the sphericity estimate was determined, and if it is less than 75, the Greenhouse-Geisser value should be used; if it is greater than 75, the Huynh-Feldt value should be used. This assumption was expressly validated for the current study's analysis, and the approach described above was used.

A repeated-measure ANOVA analysis was performed. Mauchly's test of sphericity yielded a significant result, Mauchly W = .4.02 $\chi 2$ (14), $p < .01$ so, the assumption was violated. For that reason, Greenhouse-Geisser corrected values were presented ($\epsilon = .736$) as suggested by Field (2017).

The one-way repeated measures ANOVA revealed significant effects in both the multivariate and within-subject analyses, providing evidence of the impact of access to search engines on participants' feelings of findability regarding the speed of finding answers to general knowledge questions. The multivariate effect, as indicated by Wilk's Lambda ($\lambda = 4.02$, $F (5, 129) = 9.923$, $p < .01$), showcased an influence, accompanied by a large effect size (partial $\eta^2 = .278$). This implies that a significant 27.8% of the variance in the combined dependent variables can be attributed to the independent variable. Additionally, the within-subject analysis demonstrated a highly significant effect ($F (3.681, 489.52) = 18.00$, $p < .001$) with a moderate effect size (partial $\eta^2 = .119$), indicating that 11.9% of the variance in the individual dependent variables is explained by access to search engines. These robust findings reinforce the assertion that access to search engines significantly affects participants' feelings of findability in terms of how quickly they anticipate locating answers to general knowledge questions.

Pairwise contrast comparisons (see Table 4.7) indicated that individuals in the "No Access" condition took a longer time to find the answers compared to the "No Access" condition. This signifies that search engine accessibility significantly

influences participants' self-reported feeling of findability to find answers when given general knowledge questions of moderate and difficult difficulty levels.

Table 4.7 Pairwise contrast comparison of the feeling of findability.

Condition1	Condition2	Condition3	Condition4	Condition5	Condition6
-					
-1.138*	-				
-.418	-720	-			
-1.496*	-.358	-1.078*	-		
-1.649*	-.511	-1.231*	-.153	-	
-1.634*	-.496	-1.216*	-.138	0.15	-

Table 4.8 (continued)

Participants in the "No Access" (-.418, $p < .05$) condition expected a longer search time compared to those in the "Access" (-1.138*)condition. This suggests that the presence of a search engine notably affects how quickly participants believe they can locate answers to general knowledge questions, particularly for questions of moderate and difficult difficulty levels.

However, interestingly, for easy questions, the average reported time remained stable regardless of whether participants had access to a search engine or not. This finding implies that participants may not feel the need to rely on a search engine for straightforward questions, as they are confident in their ability to answer them independently.

2d. Do recognition abilities show significant differences with or without access to search engines?

Table 4.8 Descriptive statistics of recognition ability across different conditions.

Descriptive Statistics	Mean	Std. Deviation
Condition1	6.40	2.398
Condition2	5.79	2.829

Condition3	6.45	2.724
Condition4	6.94	2.647
Condition5	8.22	1.963
Conditon6	8.14	2.132
N=134		

Descriptive statistics revealed variations in recognition abilities across different conditions. Participants' recognition ability is high for the access in all the conditions.

A difficult question with no access was 6.40 (SD=2.398) but with access to the search engine, it decreased to 5.79 SD(= 2.83). The medium question with no access was 6.45(SD=2.724) but with access increased to 6.95(SD=2.647). For the easy question, the score is high for both the access and no access. In the absence of search engine access, participants exhibited lower levels of recognition of the questions

Figure4.4 Recognition scores access and no Access to search engine

Repeated-measure ANOVA was used to answer the study questions. If there are more than two repeat measures in a repeated-measure ANOVA, the sphericity assumption must be tested using Mauchly's test (Field, 2017). The assumption was

violated when this test was significant. There were two possibilities in this scenario, which were mostly revising the analysis results depending on the degrees of freedom. Greenhouse-Geisser or Huynh-Feldt values were used in these selections. To select the best alternative, the sphericity estimate was determined, and if it is less than 75, the Greenhouse-Geisser value should be used; if it is greater than 75, the Huynh-Feldt value should be used. This assumption was expressly validated for the current study's analysis, and the approach described above was used.

A repeated-measure ANOVA analysis was performed. Mauchly's test of sphericity yielded a significant result, Mauchly W = .308, $\chi 2$ (14), $p < .01$ so, the assumption was violated. For that reason, Greenhouse-Geisser corrected values were presented (ϵ = .740) as suggested by Field (2017).

The one-way repeated measures ANOVA results highlight both multivariate and within-subject significant effects, shedding light on the impact of access to search engines on participants' self-perceived recognition. In the multivariate analysis, Wilk's Lambda (λ = .581) revealed a highly significant effect ($F (5, 129) = 18.624$, $p < .01$), with an s partial eta squared (partial η^2) of .419. This implies that 41.9% of the variance in the combined dependent variables can be attributed to the independent variable, signifying a large effect size. Furthermore, the within-subject analysis displayed a highly significant effect ($F (3.700, 492.055) = 33.93$, $p < .001$), accompanied by a moderate effect size (partial $\eta^2 = .203$), indicating that 20.3% of the variance in the individual dependent variables can be explained by access to search engines. These robust findings underscore the statistical and practical significance of the observed effects, demonstrating that access to search engines significantly influences participants' self-perceived recognition, with reduced confidence in their ability to identify and acknowledge questions in the absence of external cognitive support.

Table 4.9 Pairwise contrast comparison of recognition ability.

Mean score	C1	C2	C3	C4	C5	C6
C1	-					
C2	-.608	-				

C3	.049	.657	-			
C4	.541	1.149*	.493	-		
C5	1.817*	2.425*	1.276*	1.276*	-	
C6	1.743*	2.351*	1.694*	1.201*	-.075	-
Note: dashed mean Zero ***: p<0.05(significant)** **C-rep conditions**						

A graphical representation of the data further illustrates this effect(see Figure). Participants displayed high recognition ability across all levels of question difficulty (difficult, medium, and easy) when they had access to the search engine (0.608, 1.149*, 1,276*), emphasizing the decline in recognition ability when the search engine was not accessible.

These findings provide compelling evidence that the presence of a search engine has a significant impact on individuals' recognition abilities, leading to an increase in their perceived recognition abilities to recognize information when access to the search engine is provided.

RQ3. What is the level of retention among participants for both short-answer and multiple-choice questions after two weeks? Additionally, how does the performance of short-answer and multiple-choice questions vary when participants have access to a search engine compared to when they do not? Furthermore, which question type, short-answer or multiple-choice, demonstrates a higher level of retention among participants, and is this difference statistically significant?

3a. How does the performance of participants in both short-answer and multiple-choice grades, as well as their retention of these grades, differ for difficult questions when participants have no access versus access to a search engine?

The research question aimed to investigate how participant performance in both short-answer and multiple-choice grades, as well as their retention of these grades,

varies for difficult questions in the absence versus the presence of access to a search engine.

4.2 Short Answer Question

i. Short answer grade for difficult questions with no access to a search engine (SA-DQ-NA).

ii. Short answer grade for difficult questions with access to a search engine (SA-DQ-A.)

iii. Retention of short answer grades for difficult questions after a specified period(R-SA-DQ).

4.3 Multiple Choice Questions

i. Multiple-choice grade for difficult questions with no access to a search engine (MC-DQ-NA).

ii. Multiple-choice grade for difficult questions with access to a search engine (MC-DQ-A).

iii. Retention of multiple-choice grades for difficult questions after a specified period(R-MC-DQ).

Participants scored lower in short-answer grades without access to the search engine (Mean = 0.6, SD = 0.238) compared to when they had access (Mean = 0.75, SD = 0.437). The retention score of short-answer grades significantly dropped after two weeks (Mean = 0.1567, SD = 0.3650). Similar trends were observed for multiple-choice grades, with scores increasing from 1.3 (SD = 0.334) without access to 0.93 (SD = 0.392) with access and further dropping to 0.7090(SD=.4559) for retention.

Table 4.10 Descriptive Statistics of SA and MC Grade for difficult questions.

Short Answer Scores		Mean	Std. Deviation
	SA-DQ-NA	.06	.238
	SA-DQ-A	.75	.437
	R-SA-DQ	.1567	.36490
Multiple Choice Scores	MC-DQ-NA	.13	.334
	MC-DQ-A	.93	.392
	R-MC-DQ	.7090	.45595

Repeated-measure ANOVA was used to answer the study questions. If there are more than two repeat measures in a repeated-measure ANOVA, the sphericity assumption must be tested using Mauchly's test (Field, 2017). The assumption was violated when this test was significant. There were two possibilities in this scenario, which were mostly revising the analysis results depending on the degrees of freedom. Greenhouse-Geisser or Huynh-Feldt values were used in these selections. To select the best alternative, the sphericity estimate was determined, and if it is less than 75, the Greenhouse-Geisser value should be used; if it is greater than 75, the Huynh-Feldt value should be used. This assumption was expressly validated for the current study's analysis, and the approach described above was used. A repeated-measure ANOVA analysis was performed. Mauchly's test of sphericity yielded a significant result, Mauchly W = .894, χ^2 (2), $p < 0.01$ so, the assumption was violated. For that reason, Huynh-Feldt corrected values were presented (ϵ = .904) as suggested by Field (2017).

The one-way repeated measures ANOVA unveiled significant multivariate and within-subject effects for both short-answer and multiple-choice grades, shedding light on the impact of search engine access on participants' performance and retention. In the multivariate analyses, Wilk's Lambda (short-answer: λ = .261; multiple-choice: λ = .261) indicated highly significant effects (short-answer: F (4, 530.00) = 126.700, $p < 0.01$, partial η^2 = .489; multiple-choice: F (4, 530.00) = 126.700, $p < 0.01$, partial η^2 = .489), signifying substantial proportions of variance in

both short-answer (48.9%) and multiple-choice (48.9%) grades attributable to search engine access.

Further, the within-subject analyses revealed similarly robust effects. For short-answer grades, the F-statistic ($F(1.831, 243.57) = 165.876$, $p < 0.01$) and the associated partial eta squared (.555) indicated a large effect size, accounting for 55.5% of the variance in individual short-answer grades. Likewise, for multiple-choice grades, the F-statistic ($F(1.997, 265.535) = 179.984$, $p < 0.001$) and the substantial partial eta squared (.575) emphasized a significant influence, explaining 57.5% of the variance in individual multiple-choice grades. These collective results underscore the consistent difficulty participants faced in retaining information related to challenging questions, whether in short-answer or multiple-choice formats when provided access to search engines. The large effect sizes highlight the practical significance of the observed effects, offering comprehensive insights into the impact of search engine access on both initial performance and subsequent retention across different question types.

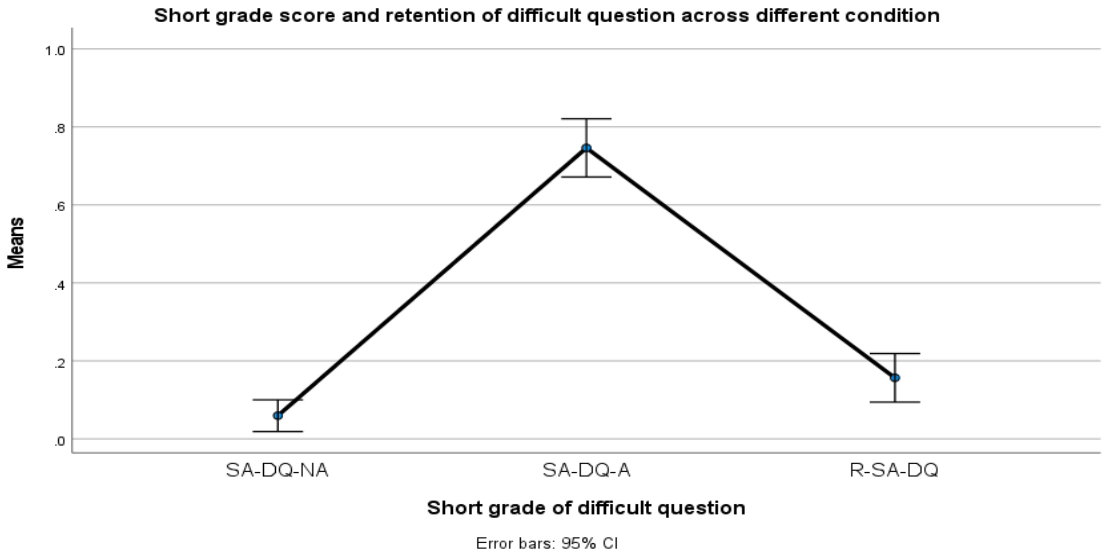

Figure 4.5 Mean scores of SA, retention of SA for difficult questions.

Note:

SA-DQ-NA= short answer to a difficult question with no access

SA-DQ-A = short answer to a difficult question with access

R-SA-DQ = retention of short answer difficult question

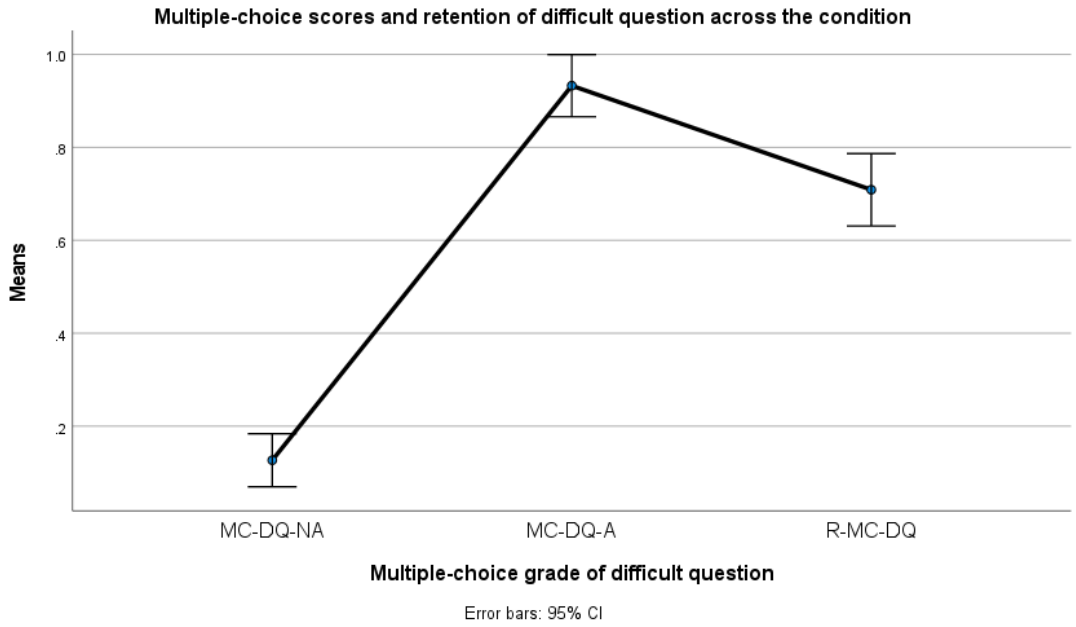

Figure 4.6 Mean scores difference of MC and SA and retention across conditions.

Note:

MC-DQ-NA= short answer to a difficult question with no access

MC-DQ-A = short answer to a difficult question with access

R-MC-DQ = retention of short answer difficult question

Both short-answer and multiple-choice performance were significantly impacted by access to a search engine, with participants experiencing greater difficulty in retaining information over time, especially for difficult questions. While both question formats experienced a decline in retention, multiple-choice questions showed a comparatively higher level of retention over the two weeks.

Table 4.11 Pairwise comparison of SA, MC, and retention across condition

Mean score	No Access	Access	Retention
SA-DQ-NA	-		
SA-DQ -A	-.687*	-	
R-SA-DQ			-590*
MC-DQ-NA	-		
MC-DQ-A	.806*	-	
R-MC-DQ			-.224*
Note: dashed mean Zero ***: p<0.05(significant)**			

The pairwise contrast comparisons presented in (see Table 4.12) provide a comprehensive insight into participant performance on difficult questions in both multiple-choice and short-answer formats. Participants showed a higher performance on multiple-choice questions compared to short-answer questions, with a greater decline in the retention of short-answer grades (-687*) after two weeks. Graphical (figure 2 and Figure 4) representation further illustrates these trends, showing a low level of performance without access, an increase with access, and a decline in the absence of a search engine. This decline is particularly high in short-answer questions, emphasizing the challenges participants face in retaining information from memory without hints. The findings underscore the critical impact of search engine access on participant performance.

3b. How does the performance of participants in both short-answer and multiple-choice grades, as well as their retention of these grades, vary for medium questions when participants have no access versus access to a search engine?

The research question aimed to investigate how participant performance in both short-answer and multiple-choice grades, as well as their retention of these grades, varies for medium questions in the absence versus the presence of access to a search engine. The findings from both short-answer and multiple-choice formats revealed

significant multivariate and within-subject effects, providing valuable insights into the impact of search engine access on participant performance and retention.

4.4 Short Answer Question:

SA-MQ-NA: Short answer grade for medium questions with no access to a search engine.

SA-MQ-A: Short answer grade for medium questions with access to a search engine.

R-SA-MQ: Retention of short answer grades for medium questions after a specified period.

4.5 Multiple Choice Questions:

MC-MQ-NA: Multiple-choice grade for medium questions with no access to a search engine.

MC-MQ-A: Multiple-choice grade for medium questions with access to a search engine.

R-MC-MQ: Retention of multiple-choice grades for medium questions after a specified period.

Table 4.12 Descriptive Statistics of SA and MC Grade for the medium question.

		Mean	Std. Deviation
Short answer Score	SA-MQ-NA	.34	.474
	SA-MQ-A	.83	.378
	R-SA-MQ	.5522	.49913
Multiple-Choice Scores	MC-MQ-NA	.54	.515
	MC-MQ-A	.96	.190
	R-MC-MQ	.8881	.31648

Participants scored lower in short-answer grades without access to the search engine (Mean = 0.34, SD = 0.474) compared to when they had access (Mean = 0.83, SD =

0.378). The retention score of short-answer grades significantly dropped after two weeks (Mean = 0.5522, SD = 0.4991). Similar trends were observed for multiple-choice grades, with scores increasing from 0.54 (SD = 0.515) without access to 0.96 (SD = 0.190) with access and further dropping to 0.881(SD=.3165) for retention

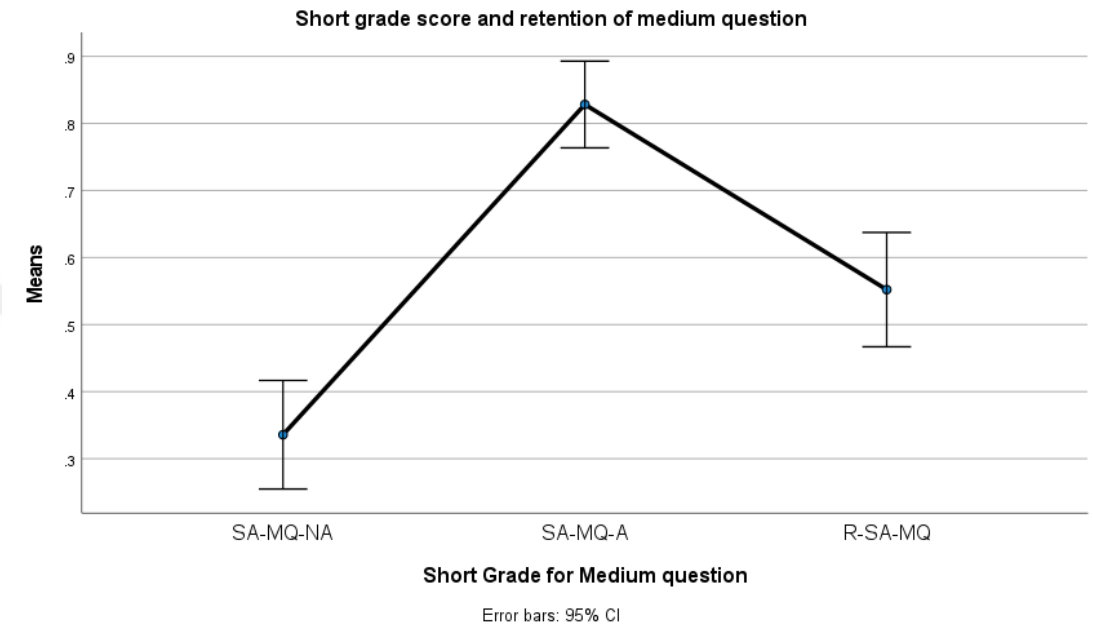

Figure 4.7 Mean scores of SA and MC for medium questions across conditions.

Note:

SA-MQ-NA= short answer grade medium question with no access

SA-MQ-A = short answer grade medium question with access

R-SA-MQ = retention of short answer grade for medium question

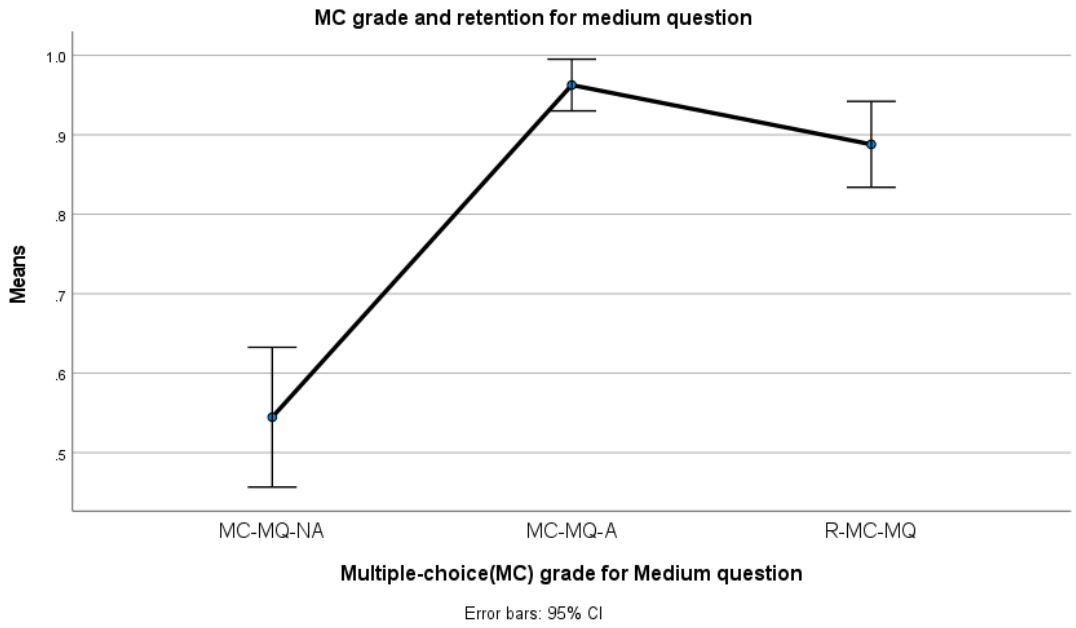

Figure 4. 8 Mean scores MC and retention of medium questions across conditions.

Note:

MC-MQ-NA = short answer grade medium question with no access

MC-MQ-A = short answer grade medium question with access

R-MC-MQ = retention of short answer medium question

Repeated-measure ANOVA was used to answer the study questions. If there are more than two repeat measures in a repeated-measure ANOVA, the sphericity assumption must be tested using Mauchly's test (Field, 2017). The assumption was violated when this test was significant. There were two possibilities in this scenario, which were mostly revising the analysis results depending on the degrees of freedom. Greenhouse-Geisser or Huynh-Feldt values were used in these selections. To select the best alternative, the sphericity estimate was determined, and if it is less than 75, the Greenhouse-Geisser value should be used; if it is greater than 75, the Huynh-Feldt value should be used.

This assumption was expressly validated for the current study's analysis, and the approach described above was used. A repeated-measure ANOVA analysis was performed. The Mauchly's test of sphericity yielded a significant result, Mauchly W = .951, χ^2 (2), p < .0036,). (Mauchly's W = .746, χ^2 (2), p < 0.001, ϵ = .798). so, the

assumption was violated. For that reason, Huynh-Feldt corrected values were presented (ϵ = .953) were used for short answers and Greenhouse-Geisser was used for multiple-choice format as suggested by Field (2017

In the short-answer format, the one-way repeated measures ANOVA showed a significant multivariate effect (Wilk's λ = .578, F (4,530) = 41.735, $p < 0.01$), accompanied by a substantial partial eta squared (partial η^2) of .240. The within-subject analysis indicated a significant effect (F (1.91, 253.59) = 56.67, $p < 0.001$) with a large effect size (partial η^2 = .299). These results suggest that 24% to 30% of the variance in participant performance and retention in short-answer grades can be attributed to the independent variable (search engine access), emphasizing a noteworthy impact on both initial performance and subsequent retention.

Similarly, in the multiple-choice format, the one-way repeated measures ANOVA revealed a significant multivariate effect (Wilk's λ = .578, F (4,530) = 41.735, $p < 0.01$), with a substantial partial eta squared (partial η^2) of .240. The within-subject analysis demonstrated a significant effect (F (1.595, 212.190) = 58.984, $p < 0.001$) with a large effect size (partial η^2 = .307). These results indicate that 24% to 30.7% of the variance in participant performance and retention in multiple-choice grades can be attributed to the independent variable (search engine access).

Table 4.13 Pairwise comparison for SA& MC for medium questions

Mean score	No Access	Access	Retention
SA-MQ-NA	-		
SA-MQ-A	-.493*	-	
R-SA-MQ			-.276*
MC-MQ-NA	-		
MC-MQ-A	-.418. *	-	
R-MC-MQ			-.075*
Note: dashed mean Zero ***: p<0.05(significant)**			

Participants performed better on multiple-choice questions (see Table 4.14), evident in a significant effect on short-answer grade performance on medium questions (=-493*) without access and a lesser effect (. -216*) with access. This indicates participants' proficiency in recognizing correct answers for multiple-choice questions but challenges in recalling information for short-answer questions.

3c. How does the performance of participants in both short-answer and multiple-choice grades, as well as their retention of these grades, differ for easy questions when participants have no access versus access to a search engine?

4.6 Short Answer Question:

SA-EQ-NA: Short answer grade for easy questions with no access to a search engine.

SA-EQ-A: Short answer grade for easy questions with access to a search engine.

R-SA-EQ: Retention of short answer grades for easy questions after a specified period.

4.7 Multiple Choice Questions

MC-EQ-NA: Multiple-choice grade for easy questions with no access to a search engine.

MC-EQ-A: Multiple-choice grade for easy questions with access to a search engine.

R-MC-EQ: Retention of multiple-choice grades for easy questions after a specified period

Table 4.14 Descriptive Statistics on Retention on SA and MC for Easy Questions

Short Answer Scores		Mean	Std. Deviation
	SA-EQ-NA	.96	.190
	SA-EQ-A	.98	.148
	R-SA-EQ	.9403	.23782

Multiple Choice Scores	MC-EQ-NA	1.01	.287
	MC-EQ-A	1.00	.000
	R-MC-EQ	.9478	.22334

Descriptive statistics indicate that there is minimal impact on short-answer and multiple-choice scores, as well as their retention, with or without access to search engines. This suggests that participants, facing easy questions, did not heavily depend on search engines to answer.

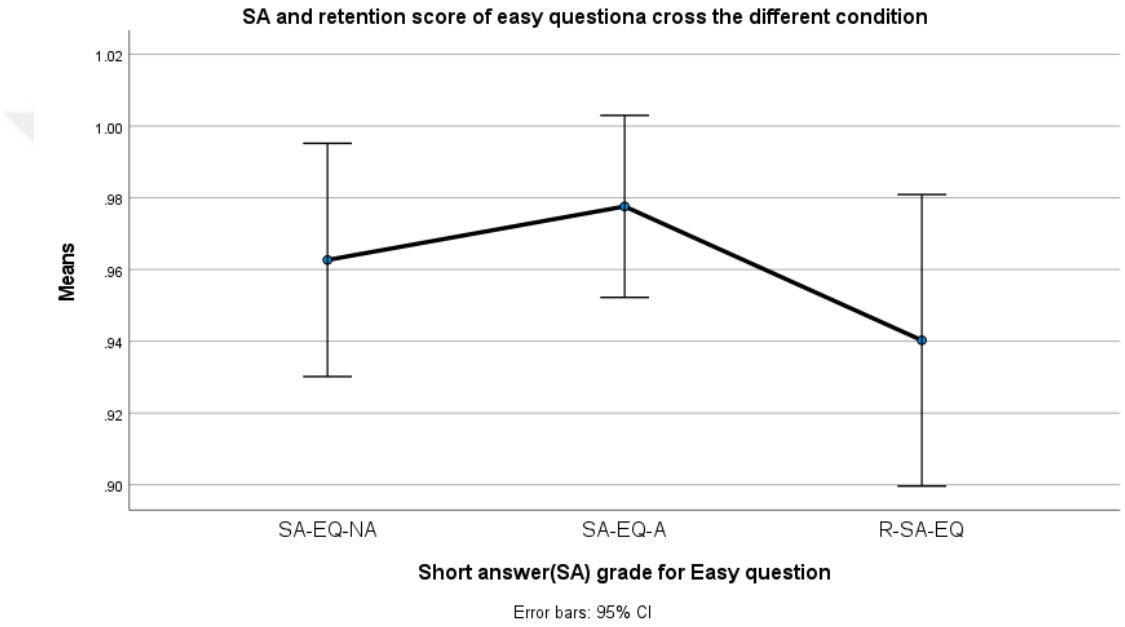

Figure 4.9 Mean of SA, retention for easy questions across conditions.

Note:

SA-EQ-NA: Short answer grade for easy questions with no access to a search engine.

SA-EQ-A: Short answer grade for easy questions with access to a search engine.

R-SA-EQ: Retention of short answer grades for easy questions after a specified period.

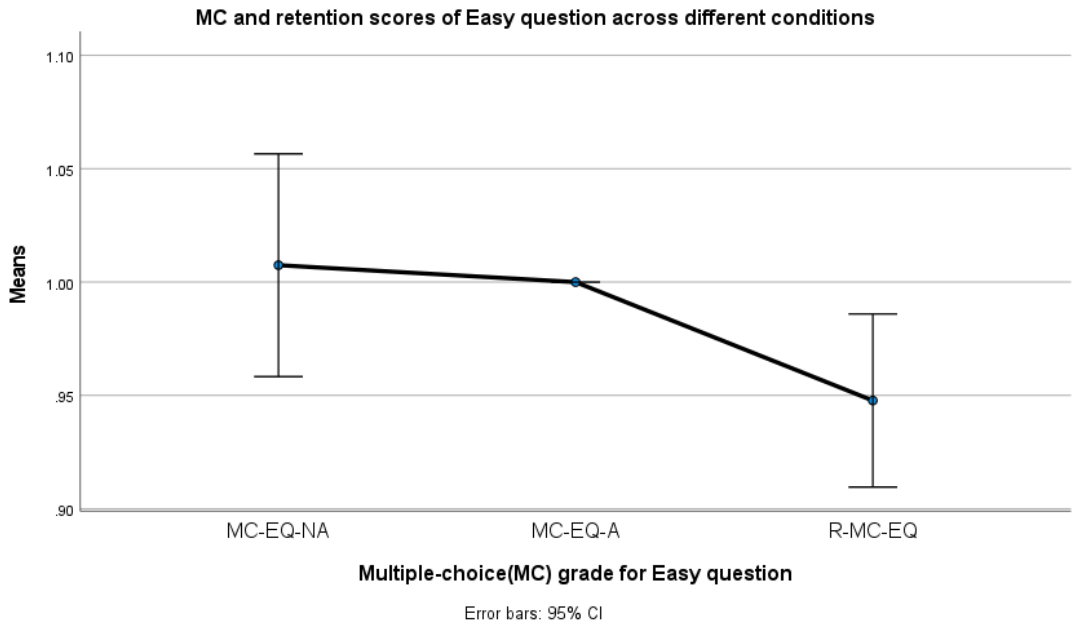

Figure 4.10 Mean scores of SA and retention medium questions across conditions

Note:

MC-EQ-NA: Multiple-choice grade for easy questions with no access to a search engine.

MC-EQ-A: Multiple-choice grade for easy questions with access to a search engine.

R-MC-EQ: Retention of multiple-choice grades for easy questions after a specified period

Repeated-measure ANOVA was used to answer the study questions. If there are more than two repeat measures in a repeated-measure ANOVA, the sphericity assumption must be tested using Mauchly's test (Field, 2017). The assumption was violated when this test was significant. There were two possibilities in this scenario, which were mostly revising the analysis results depending on the degrees of freedom. Greenhouse-Geisser or Huynh-Feldt values were used in these selections. To select the best alternative, the sphericity estimate was determined, and if it is less than 75, the Greenhouse-Geisser value should be used; if it is greater than 75, the Huynh-Feldt value should be used. This assumption was expressly validated for the current study's analysis, and the approach described above was used. A repeated-measure ANOVA analysis was performed. The Mauchly's test of sphericity yielded a

significant result, (Mauchly's W = .657, χ^2 (2), p < 0.001, ϵ = .743) and multiple-choice grades (Mauchly's W = .708, χ^2 (2), p < 0.001, ϵ = .774). so, the assumption was violated. For that reason, Greenhouse-Geisser values were presented (ϵ =. <0.75) as suggested by Field (2017).

The one-way repeated measures ANOVA revealed significant multivariate and within-subject effects for both short-answer and multiple-choice grades, shedding light on the impact of search engine access. The statistical analyses revealed a significant overall effect for short-answer grades (Wilk's λ = .973, F (4, 530) = 1.845, p < 0.01), with a relatively small partial eta squared (partial η^2 = .014), signifying a limited but statistically significant influence of search engine access on short-answer performance.

Similarly, for multiple-choice grades, the analyses showed a significant multivariate effect (Wilk's λ = .973, F (1.489, 198.100) = 1.361, p = .256) with a small partial eta squared (partial η^2 = .010), suggesting a modest impact of search engine access on multiple-choice performance. Additionally, another set of results for multiple-choice grades indicated a nonsignificant F-statistic (F (1.548, 205.933) = 1.361, p = 0.55) and a small partial eta squared (partial η^2 = 0.24), further highlighting the limited practical significance of the observed effects.

Table 4.17 Pairwise comparison of SA and retention across different conditions.

Mean difference	Condition1	Condition2	Condition3
Condition1	-	.	
Condition2	-.015	-	
Condition3	0.22	0.37	-
Condition1	-		
Condition2	.007	-	
Condition3	.060	0.52*	-
Note: dashes mean zero *p<0.05(significant)			

In summary, while statistically significant, the small partial eta squared values emphasize that the observed effects of search engine access on both short-answer and multiple-choice grades are relatively modest. Participants demonstrated consistent

performance across conditions, indicating a self-dependent reliance on memory irrespective of search engine access.

The finding concludes that for easy questions, there is less dependency on search engines, leading to minimal impact on both initial scores and retention.

CHAPTER 5

DISCUSSION AND CONCLUSION

5.1 Discussion

This first research question delves into the dynamics between search engine access and cognitive self-esteem, investigating how participants' perceptions of their cognitive abilities evolve across different difficulty levels of general knowledge questions. The results illuminate a compelling association between search engine availability and cognitive self-esteem, revealing an interplay between external information access and individuals' confidence in their cognitive prowess. The significant improvement in cognitive self-esteem observed across difficulty levels—from challenging to medium and easy—when participants utilized search engines underscores the pivotal role of external support in shaping confidence during cognitive tasks. Notably, the stability of self-esteem, irrespective of search engine access, challenges the conventional notion that question difficulty alone dictates individuals' cognitive self-esteem[47]

Our experimental evidence suggests that accessing search engines increases the perception of one's cognitive capabilities. This aligns seamlessly with our hypothesis that internet access contributes to heightened cognitive self-esteem. Participants appear to regard themselves as more adept at thinking, remembering, and locating information when utilizing search engines. The specificity of these effects suggests that individuals, in engaging with the internet, assimilate its attributes into their self-concepts, blurring the distinction between where the internet ends and where they begin Ward[4].These findings resonate with prior research conducted by Ward[13], who reported a similar pattern of increased cognitive self-esteem when individuals had access to external information during cognitively demanding tasks.

This consistency strengthens the validity of the observed phenomenon. Furthermore, our results align with Gilbert's (2016) proposition that individuals often rely on external aids, such as search engines, to augment their problem-solving capabilities in complex scenarios. The identified consistency in results supports the notion that search engine access may act as a cognitive crutch, particularly in the face of difficult questions. As we consider the practical implications of these findings, it becomes apparent that integrating external support mechanisms into educational curricula and workplace practices may contribute to a more positive perception of one's cognitive abilities. This aligns with a broader paradigm shift towards acknowledging and leveraging external aids to foster learning and problem-solving in an increasingly information-rich world.

The second research question delves into measuring participants' self-perception of their metacognition abilities, the first study investigates the manipulation of the "feeling of knowing" by varying task difficulty (difficult, medium, and easy) with access and no access to the search engine in a general knowledge question. The aim is to explore how access to search engines influences participants' perception when answering questions of different difficult levels. when faced with difficult and medium-difficulty questions, the presence of search engines as a readily available external tool led to an increase in participants' confidence. This suggests that individuals perceive search engines as valuable resources that enhance their self-assurance when confronting challenging queries. However, for easy questions, participants consistently reported high confidence levels irrespective of search engine accessibility, indicating self-sufficiency in handling straightforward inquiries without external assistance. The core hypothesis tested here is that the feeling of knowing is significantly influenced by the availability of a search engine. When individuals sense they know a piece of information but cannot immediately recall it, the internet's rapid and discrete ability to provide that information may affirm their initial feelings, creating an illusion of prior knowledge.

This finding underscores the adaptive use of search engines to boost confidence, especially in scenarios demanding higher cognitive effort. It suggests that external support from search engines is more pronounced in complex problem-solving, where

additional information strengthens understanding. This study aligns with prior research done by Smith[14] Johnson & Brown[15], emphasizing the crucial role of search engine accessibility in supporting participants' confidence, especially in the face of challenging and moderately difficult questions. highlighting search engines as tools that enhance cognitive abilities, contributing significantly to perceived self-efficacy in mentally challenging tasks and facilitating information retrieval.

The second study on participants' self-perception of their metacognitions also reveals a significant impact of search engine accessibility on participants' willingness to answer questions. Participants showed an increase in willingness to respond, particularly for difficult and medium-difficulty questions when search engines were available. This suggests that individuals recognize the value of search engines in assisting with more challenging queries, influencing their motivation to engage with and attempt to answer such questions. Conversely, for easy questions, participants demonstrated a consistent willingness to respond regardless of search engine accessibility. This finding suggests that participants feel self-sufficient in addressing straightforward questions, indicating a level of confidence in their ability to independently navigate and respond to queries of lower complexity.

The observed increase in participants' willingness to tackle difficult questions in the presence of search engine access aligns with the findings reported by Wang [15]. This shared recognition among participants reinforces the notion that search engines play a crucial role as valuable aids in overcoming cognitive challenges, thereby motivating individuals to take on more demanding knowledge inquiries. The influence of search engine accessibility on participants' perceived findability was investigated, specifically focusing on their ability to answer general knowledge questions of varying difficulty levels.

The results revealed insights into the relationship between search engine access and participants' self-reported feelings of findability. The findings underscored a clear pattern when examining responses to medium and difficult-level questions. Participants in the "Access" condition consistently reported an increased sense of findability, taking significantly less time to locate answers compared to their alternatives in the "No Access" condition. This outcome aligns with the hypothesis

that access to search engines positively impacts individuals' confidence in finding answers to challenging questions, presumably due to the readily available external cognitive support offered by search engines Bilandzic [16].

Interestingly, the study identified a deviation in participant behavior when confronted with easy questions. Contrary to expectations, the reported average time to find answers remained relatively stable across both "Access" and "No Access" conditions. This unexpected outcome suggests that participants may not perceive the need to leverage search engines for straightforward questions, implying a high level of confidence in their ability to independently address such queries. The observed differences in response times and self-reported findability underscore the nature of individuals' reliance on search engines in information retrieval. The study's results imply that participants strategically deploy external cognitive resources based on their perceived task difficulty. While search engine accessibility significantly enhances perceived findability for complex questions, participants appear to rely less on such tools for simpler inquiries.

The investigation into participants' recognition abilities in the context of search engine access revealed interesting trends and significant implications. This study sought to understand how the availability of search engines influences individuals' self-perceived recognition abilities when presented with questions of varying difficulty levels. The results of the experiment indicated a significant impact on participants' recognition patterns between the "Access" and "No Access" conditions. In the absence of search engine access, participants exhibited lower levels of recognition for the questions, suggesting that the unavailability of external cognitive support led to reduced confidence in their ability to identify and acknowledge the questions. This finding aligns with the notion that search engines serve as cognitive aids, bolstering participants' recognition abilities when faced with unfamiliar or challenging queries for easy questions. Participants consistently demonstrated higher recognition, regardless of search engine access. This intriguing outcome implies that for straightforward questions, participants feel confident in their recognition abilities irrespective of external cognitive assistance.

This may be attributed to the inherent simplicity of easy questions, leading participants to rely on internal cognitive resources rather than seeking external validation through search engines.

This finding suggests that the mere presence of a search engine, even if not utilized for information retrieval, positively influences participants' confidence in recognizing and comprehending the questions posed. This phenomenon raises questions about the psychological impact of the symbolic presence of search engines, potentially serving as a reassurance or a cognitive scaffold even when not actively utilized. The observed influence of search engine accessibility on participants' recognition abilities underscores the dynamic interplay between external cognitive tools and individual perceptions of cognitive self-efficacy. The study contributes to our understanding of how search engines not only facilitate information retrieval but also play a role in shaping users' confidence in their cognitive abilities.

The final research question explored the intricate relationship between search engine accessibility and participants' performance and retention across questions of varying difficulty levels (difficult, medium, and easy) and formats (short-answer and multiple-choice). This section aims to seamlessly integrate the discussion on access conditions (Access and No Access) with the analysis of question types. The findings uncovered a significant interplay between search engine availability and participant performance on questions of different difficulty levels and formats. The comparison between the Access and No Access conditions offered insights into the impact of external support mechanisms on cognitive processes. In the Access condition, participants demonstrated improved performance on difficult questions, highlighting the potential benefits of search engine utilization in tackling complex problems. Conversely, the No Access condition emphasized the reliance on internal cognitive resources, revealing the challenges individuals face when external aids are unavailable.

For medium and easy questions, the presence of search engine access showcased varying effects. Participants may have leveraged search engines for confirmation or additional insights, influencing overall performance dynamics. Understanding these

variations is crucial for tailoring educational and workplace practices to the diverse needs of individuals across different difficulty levels. The examination of long-term retention further enriched our understanding of the implications of search engine usage. While question types were initially the focus, the incorporation of access conditions deepened our insights. Questions, especially of a difficult nature, where participants had search engine access during the initial attempt, demonstrated higher long-term retention. This highlights the potential role of external aids not only in immediate problem-solving but also in reinforcing knowledge retention over time. Beyond the categorization of question types, the analysis incorporated the impact of search engine accessibility. Certain question types, when coupled with search engine access, demonstrated enhanced retention, suggesting a synergistic effect between question format, external support, and long-term memory.
consolidation [48].

The investigation into retention scores after two weeks uncovered an interesting trend. While both short-answer and multiple-choice formats exhibited a decline in retention, the drop was more for short-answer grades. This suggests that participants faced greater challenges in retaining information related to difficult questions when responding in a short-answer format. The observed decline in retention scores emphasizes the importance of considering the long-term impact of question format on participants' ability to recall information.

The difference in retention rates between short-answer and multiple-choice questions raises questions about the cognitive processes involved in encoding and retaining information, particularly for complex material. Analysing the difference in retention between short-answer and multiple-choice questions, the findings of Richard[49] indicate a statistically significant advantage for multiple-choice questions. Participants demonstrated a comparatively higher level of retention for multiple-choice grades over the two weeks, suggesting that this format may offer a more robust mechanism for retaining information related to difficult questions. This outcome challenges conventional assumptions about the superior retention associated with short-answer formats. It underscores the need to consider the interplay between question type, cognitive processes, and the influence of external cognitive aids when assessing the long-term retention of complex information.

5.2 Implications and Recommendations

The implications of these findings are profound, especially in educational and workplace settings. The integration of external support mechanisms, such as search engines, could lead to a more positive perception of one's cognitive abilities and significantly enhance problem-solving capabilities. This approach aligns with the evolving paradigm in education and workplace practices, which increasingly acknowledges the role of external aids in fostering learning and efficient problem-solving.

An essential aspect that emerges from these findings is the daily use of search engines. In educational and workplace settings, where problem-solving is a routine task, the habitual use of search engines can become a valuable skill. Understanding how individuals integrate search engines into their daily problem-solving routines sheds light on the evolving nature of information-seeking behavior and its impact on task efficiency.

In the context of educational assessments, the evidence suggests a potential shift towards incorporating multiple-choice questions, particularly for difficult content, as they appear to offer advantages in both initial learning and long-term retention. Educators and curriculum designers are encouraged to consider these insights when developing learning materials and assessment methods.

5.3 Limitations of the Study

In conducting this research, we explored the depths of cognitive self-esteem, feeling-of-knowing (FOK), feeling-of-findability (FOF), willingness to answer questions, recognition, and retention performance about general knowledge questions under varying conditions of search engine access. While these findings offer significant insights, it is essential to consider certain limitations to fully appreciate the study's scope and implications.

A notable limitation pertains to the potential impact of individual differences and external factors on the participants' responses. The diversity in participants' prior

experience with search engines, inherent cognitive abilities, learning styles, and familiarity with the question topics could have influenced their performance and perceptions. Such individual variability suggests that the effects we observed might not be universally applicable, highlighting a need for caution in generalizing these results.

The study's design centred around the binary conditions of having or not having access to a search engine, presents another limitation. This approach, while highlighting the impact of digital tools on cognitive processes, may not fully encapsulate the nuanced and varied ways individuals engage with these tools in real-life scenarios. The simple dichotomy of 'access' versus 'no access' may not adequately reflect the complex interplay between digital resources and cognitive functions in everyday use.

5.4 Future work

These limitations illuminate critical pathways for future research. Studies that incorporate a more detailed examination of individual differences, perhaps through exploring participants' internet usage patterns, familiarity with search engines, their experience levels in utilizing search engines, the frequency of their search engine interactions, and preferences for specific devices could contribute valuable insights. Additionally, exploring scenarios that mimic more realistic, varied levels of digital tool access and proficiency could provide deeper insights into the integration of these tools in daily cognitive activities.

In conclusion, while this study contributes valuable perspectives on the intersection of digital tools and cognitive processes, the outlined limitations highlight the need for further, more detailed explorations to build upon the foundational understandings we have established.

5.5 Conclusions

This dissertation has explored the intricate interplay between search engine access and various cognitive processes, providing a nuanced understanding of how digital tools influence cognitive self-esteem, metacognition, and information retention. The study's findings reveal that access to search engines significantly enhances participants' willingness to engage with challenging queries, underscoring the pivotal role of external information sources in boosting confidence and perceived competence. Particularly notable is the effect of search engine access on the participants' feeling of findability and recognition abilities, where individuals displayed heightened efficiency and confidence in locating and recognizing information across varying levels of question difficulty.

In assessing the impact of search engine accessibility on performance and retention, a distinctive pattern emerged. Participants exhibited higher performance levels in both short-answer and multiple-choice formats when they had access to search engines, with a more pronounced effect on multiple-choice questions. This suggests that multiple-choice formats may be more effective in fostering long-term retention of complex information, a finding that could significantly influence the design of educational assessments and curricula. The study's insights into participants' metacognitive perceptions, such as the 'feeling of knowing' and the ability to recognize and recall information, shed light on the profound impact of digital tools on cognitive processes.

The implications of this research extend far beyond academic settings, suggesting a re-evaluation of how digital tools are integrated into various learning and professional environments. As we navigate an increasingly information-rich world, understanding and leveraging the benefits of external cognitive aids like search engines become crucial in enhancing learning outcomes and problem-solving abilities. Future research should delve deeper into the cognitive mechanisms underpinning these effects and explore the implications across diverse demographic groups and individual differences in information-seeking behaviour.

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APPENDIX

Appendix A: Cognitive Self-Esteem Scale.

I am smart .83
I am smarter than the average person
My mind is one of my best qualities
I am good at thinking
I feel good about my ability to think through problems
I am capable of solving most problems without outside help.
I am proud of my memory.
I feel good about my ability to remember things.
I have a better memory than most people.
I have a good memory for recalling trivial information
I know where to look to answer questions I don't know myself
When I don't know the answer to a question right away, I know where to find it.
I know which people to ask when I don't know the answer to a question.
I have a knack for tracking down information

Appendix B. Feeling of Knowing Questionnaires

"WHAT IS THE NAME OF THE LEGENDARY ONE-EYED GIANT IN GREEK MYTHOLOGY?
Are you willing to answer the question above when you are allowed to use an electronic device or a search tool, like Google, on the internet?
Yes, I am No, I am no

Appendix C Feeling of Findability Questionnaire

Please rate using the scale below how quickly you can find the answer to the question
when you are allowed to use an electronic device or a search tool, like Google, on the internet?
1 – I would find it almost instantly
9 – I would find it in a few minutes

Appendix D willingness to answer question Questionnaire.

Are you willing to answer the question above when you are allowed to use an electronic
device or a search tool, like Google, on the internet?
Yes, I am No, I am no

Appendix E Recognition Abilities Questionnaire

Please rate using the scale below how likely you think that you would be able to
recognize the answer to this question when you see it.
1 - I am sure I would NOT recognize the answer.
9 - I am sure I would recognize the answer