Student Information Consumption Strategies: Implications of the Google Effect

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ABSTRACT
Previous research in the area of distributed cognition within the educational process has revealed several new and emerging phenomena regarding student behavior. Students appear to be strategically discriminating in their learning strategies, taking the opportunity to offload learning when information is easily accessible and retrievable. This paper reviews several current research findings, and offers societal implications.

Categories and Subject Descriptors
H.1.2 [Human/Machine Systems]: human information processing. 
H.5.2. [User Interfaces]: Interaction styles

General Terms
Human Factors, Standardization.

Keywords
Distributed cognition, Google effect.

1. INTRODUCTION
Technology has often been used to reduce the workload or improve the productivity of workers. Enhancing the workplace with technology has occurred so often and routinely that we generally do not question the long-term implications of new technologies. The reduction of physical labor, for example, has provided workers with safer workplaces and shorter work-weeks. The use of technology tools has allowed the individual productivity of workers to soar, to the extent that some now begin to discuss “single-actor practices” in which (at the extreme) there is one person assisted by technology who does the work previously done by many [1]. Some refer to this euphemistically as the “perfect factory” that consists of a man and a dog. The man’s purpose is to feed the dog, while the dog’s purpose is to keep the man from touching anything and messing up the factory. Of course, this is not a universal prediction of the future – there are doubters, and many alternative futures. This paper begins with a discussion of workforce implications of the perfect factory idea, and discusses related research including the “Google Effect” [3]. A set of recent research studies are then reported, which support the Google effect and provide additional insight into the motivation of educational information consumers.

2. BACKGROUND
The downside of increased technology in the workforce is sometimes referred to as “de-skilling” the workforce. As knowledge becomes embedded within tools and technologies, this same knowledge tends to not reside in the heads and hands of workers. So, while the knowledge becomes “public” in the sense that it can be purchased within a technology at a price, the knowledge as human performance becomes more rare – perhaps to the point of obsolescence within the species.

We worry about the extinction of biological species on the earth. Unbeknownst to the masses, a species becomes isolated and fails to flourish, sometimes due to human intervention and sometimes due to ecological and environmental changes. Simple mathematics shows how quickly a species can vanish when its death rate exceeds its birth rate, yet it often takes us by surprise. Inventor and futurist Ray Kurzweil, for example, claims that humans are not good at grasping exponential growth [2]; it takes us by surprise even though we see it coming. The same seems to be true of exponential decline – it surprises us, even though we understand it.

Consider now the impact of the Internet and ubiquitous mobile devices on society. The quick and sudden rise in popularity of these information sources and the resultant easy access to information has created a sense that this information is always going to be available. Common information and facts can be “Googled” in a moment’s notice, any time and any place. There is presumably not much value in memorizing this type of information, because of its easy access.

Recent research has noted the Google effect in which subjects in laboratory settings do not store the details of information that can be accessed in digital form [3]. This finding has been supported by qualitative examination of student self-described information consumption strategies of look-up and learn [4].
The possibility of knowledge extinction seems remote—an after all, digital information can be reproduced with such minimal cost as to be considered “free.” However, despite a hundred years of psychological research, educational research, and the improvements in learning sciences, there are still few laws or certainties regarding the complex relationships between our cognitive systems and outside information. As research Daniel Wegner notes, “It is surprising, actually, that the psychological study of memory has dwelt so little upon the extraordinary human tendency to record items in external storage media.” [5, p. 187].

Within the educational process, students can be considered as information consumers. This general phrase is not intended to gloss over the distinguishable forms of learning that have been isolated in various skill taxonomies, typified by the work of Gagne and Briggs [6], Merrill [7], or Horn [8]. The information consumption idea is a shorthand based on the idea that (1) information (in the form of images, sounds, words, text, guidance, etc.) is required for learning; (2) in a formal instructional system, this information may be presented by teachers, books, computers, or digital sources; and (3) students always have a choice as to where to direct attention, which means that they must make decisions regarding information consumption.

### 2.1 Skill Building and Knowledge Retention

One of the most basic distinctions related to information consumption is between “knowledge in the head” and “knowledge in the world” [9]. This simple distinction enables us to begin by charting the flow of information as “from the outside” of the learner “to the inside” of the learner. Such an information flow is documented and described in numerous information processing models from cognitive psychology, as typified by [10]. In these models, information is seen as existing outside the human system and in turn becomes input to the system, filtered initially through sensory registers such as eyes and ears, and processed internally.

A long-standing debate within psychology and the learning sciences concerns the constructivist nature of knowledge [11]. Fundamentally, it is claimed that knowledge is not transmitted from source to student, but instead knowledge is constructed in the heads of the learners. This constructivist approach is not completely at odds with the information consumption idea. From this perspective, constructivist learning processes are simply a general way of describing the information processing activities that occur within the individual learner. There seems to be little debate that information enters the cognitive system and becomes combined with existing knowledge. Existing mental models and structural knowledge [12] are generally thought to always mediate the processing and construction of knowledge. Recent efforts [13] are trying to connect biological neuroscience with experiential theories [14], showing that these approaches are not antithetical to each other and, in fact, describe many similar processes. Constructivism, biological neuroscience, and experiential learning theories therefore are not in conflict with the idea of information consumption.

### 2.2 Distributed Cognition in Learning

Distributed cognition [15, 16, 17] is a paradigm that explicitly explores the relationship and sharing of knowledge between entities in a complex system. The idea dates back to the earliest factory approaches and was first formalized in the work of Taylor’s Scientific Management at the turn of the last century. Taylor emphasized task analysis, artifact developments and consistent processes to improve the productivity of workers. [18]

Within the HCI community, distributed cognition is a primary assumption within the design of interfaces and artifacts. For example, product designers or performance support specialists consciously make the decisions regarding the distribution of knowledge as they determine the complexity of an artifact versus the learnability of the artifact. There is often a trade-off between the time and effort to “improve” an interface and the time it takes to learn and ultimately use the system. Classic examples of this trade-off and refinement are discussed by Cooke and Durso [19] as they review the cognitive systems engineering that occurred in the re-design of a call center operation. In this example, researchers determined that “improvements” to the call center would actually cost money rather than save money.

Knowledge in the world may be designed for distributed use, such as the case in airplane cockpit design, or may exist as more raw, more unfiltered input in which the distributed relationship evolves over time, such as the manner in which one finds a unique means of reading a newspaper [4].

### 2.3 Distributed Education

Within the educational community, the discussion of distributing tasks is often confined to distributing the work of the teacher or instructional system. For example, mediated instructional materials, such as video tapes, audio recordings, and texts, have been studied in the instructional technology and communications field and, generally speaking, they are as effective as the “human” counterparts. The distribution of the learning task has been less discussed. The relationship between students and educational technologies was described as “partners in cognition.” The effect on student performance with technology was described as a situation in which “the tool assumes part of the intellectual burden of information processing.” [20, p. 3]. They noted that performance without the technology may not improve at all—the technology becomes part of the cognitive system and generalized skills may not occur. Within the Performance Support community a similar idea exists [22]: the proper
design of artifacts could enable expert performance without expertise. While considered to be an economic benefit for organizations and businesses, the lack of skill development within employees has long-term ramifications. An employee that does not gain skill over time may be bored or unmotivated. From a societal perspective, an employee that does not gain skill is forever trapped in a dead-end job, without promotion or progression. A student that does not learn – that can only perform skills on a limited basis, with large amounts of scaffolding and support – has not really gained much at all.

2.4 Performance Without Learning
Due to the lack of understanding of the assessment process in education, many instructors do not test for learning. In fact, many assignments, grades, group projects, etc. reward and assess only student performance. This is problematic if performance can be achieved without any real learning.

An example may clarify. Perhaps the student is given the graded assignment that requires writing a report about world politics. It might be fully possible for a student to “Google-write” such a report by simply pulling together many web sites, existing reports, etc. The existence of the report itself does not signify that any knowledge was truly learned or retained. In fact, informal discussions with many students over the years describe a strategy consisting of: looking up chunks of information, paraphrasing them (to avoid plagiarism detection), and then ultimately combining them into a shallow, but acceptable report. This process can largely be done with little to no real learning, despite the fact that a very impressive artifact is created. This is an example of a student using technology to assist in the performance of a task (report writing) rather than actually learning. Like the worker that cannot rise out of a performance-supported job, students who work in this manner find themselves devoid of any real knowledge or skill, beyond the superficial creation of educational artifacts. Zull [13] describes the biological basis of such a case where a student is light on knowledge but able to create shallow work nonetheless.

When assignments of this type are rewarded (as they often are) with good grades, students are encouraged to use an artifact-creation performance approach rather than a learning approach. A recent study by the Josephson Foundation [22] supports this idea as many students admit to breaking ethical rules to achieve the goal of good grades. One in three admitted to paraphrasing work from the Internet to complete an assignment. These cases suggest that learning is secondary to performance as reflected by grades.

In prior research [4] we referred to this as the student-task: a situation in which as student takes performance in the classroom (rather than learning) as the main objective of an educational encounter.

During a typical college lecture, students are faced with the decision to attend to the lecture, take notes, check facts, follow their own thoughts and creative ideas, write down references, or ignore the material completely. Other than fully focusing on the lecture, many of these activities involve creating memory support or transactive memory artifacts. Wegner [5] describes transactive retrieval, as a process that requires “determining the location of information and sometimes entails the combination or interplay of items coming from multiple locations.” More concisely, transactive retrieval occurs when a memory item must be obtained from another entity, whether it is another human or an information device.

Sparrow, Liu, and Wegner [3] examined the factors that influenced students as they made distributed cognition decisions regarding information consumption in the student-task. The Google effect described students that used the Internet as a form of transactive memory in situations where access to computing resources was assured. A series of tests showed that subjects were often able to find where information was stored, although they might not remember the information itself. This is a clear example of a distributed cognitive task, in which the digital system is a partner in the cognitive process.

Our own work has investigated a “lookup or learn” decision, set within a classroom, (rather than laboratory) environment. We believe that the findings of Sparrow et al. are concordant with our results. That prior work [4] asked students to describe the situations in which they would learn material or look it up later.

3. Research Study
A grounded theory approach was used to explore the area of decision making in the student-task. Grounded theory is best used in exploratory situations for the purpose of deriving a hypothesis or taking initial steps in theory construction [23]. With a grounded theory approach, there are no hypotheses to be tested. Instead, hypotheses emerge from data collection generally using various forms of content analysis to find meaning in the unstructured data. Because there has been little focused research or existing theoretical guidance in the area of decision making in the student-task, grounded theory development was needed and warranted.

3.1 Part 1
In the first phase of the study, 26 graduate students were asked an open-ended question:

How do you decide whether to “learn” something now or to “look it up” on the Internet later? What educational conditions, work conditions, or subject matter affect your decisions?

and asked to write their responses. Responses were open-ended and transcribed verbatim to a master sheet. Two researchers then individually coded the set of responses.
Content analysis was used to discover patterns in the data. Initially, each researcher attempted to use phrases from the data as category titles or themes, as suggested by Bogdan and Biklen [24].

A consolidation step in the study allowed researchers to share and discuss patterns. A common set of themes, using shared meanings from the two original sets, was created. This was used to then re-code the data using the consolidated themes. Initial inter-rater agreement was 94%. Discussion of the themes and the comments continued until inter-rater agreement assigning themes to comments was 100%. Themes were judged as preferring look-up or learning. In almost all cases when a theme was mentioned, an indication was given of how it would affect the student’s decision to lookup or learn. However, there were several cases in which the theme was noted, but the effect that it might have on decision-making was not clear to reviewers.

Ten major themes emerged from this content analysis (see Table 1). Noted is the count of the number of times the theme was mentioned, and whether it would impact the decision to look up or learn information.

<table>
<thead>
<tr>
<th>THEME</th>
<th>Learn</th>
<th>Not Clear</th>
<th>Lookup</th>
</tr>
</thead>
<tbody>
<tr>
<td>When I encounter concepts</td>
<td>12</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>When material has details</td>
<td>3</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>When material is easy</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>When I am interested</td>
<td>4</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>When it is needed for exams or relevant</td>
<td>6</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>When there is easy access to material</td>
<td>0</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>When I need additional information</td>
<td>1</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>When I have enough/ not enough time</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>When it is a skill that is frequently used</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highly quantitative content</td>
<td>5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Themes from content analysis

From this content analysis, several clear patterns emerged. Abstract conceptual material was almost always preferred to be learned, while details and facts would be looked up at a later time. Also clear was that when material was clearly indicated as being important, or would be included on an exam, that material was learned. Access to the Internet was cited as a theme associated with look-up.

3.2 Part 2

To triangulate this information, a second group of 16 students were given a list of themes and asked to use a Likert-type scale to judge whether they were likely to look-up or learn information in the various theme situations. For example, two of the questions are replicated below.

When I will need details or facts about a subject, I tend to:

If information is needed frequently, I will tend to:

Student responses were scaled on a 1 to 5-point Likert scale with categories of always learn, sometimes learn, no priority, sometimes look-up, always look-up. Brief definitions of the terms look-up and learn were also provided.

Results of part two are shown below in Figures 1 and 2. For reference, themes and question numbers are listed.

1. Abstract concepts
2. Details or facts
3. Material is easy
4. Interested in subject
5. Not interest in subject
6. Needed for exam or relevant
7. Topic is accessible
8. Much related information
9. Time to spend
10. Skill needed frequently
11. Content is mathematical
From this study certain patterns emerge that could begin to suggest a theory. Frequency of use (Q10) was the most often reason cited for learning. In fact, there were no responses other than always learn and sometimes learn. This actually shows a remarkable clarity in the decision-making process. Students appear to be aware of situations in which it is more efficient to learn something rather than continually look it up. The implication for business process analysts might be to use these same criteria of efficiency as they made decisions for the distribution of work tasks.

The most responses regarding look-up of information were related to accessibility of information (Q7). Most responses were sometimes look-up or always look-up. This result is further corroboration for the Google effect in which easily accessible information is retained, and instead the Internet is used as a transactive memory.

The comparison of means and medians in Figure 2 shows that Lack of Interest (Q5) and Accessibility of information (Q7) produce the highest mean and median, suggesting that these are reasons for look-up rather than learning. However, the distribution of responses regarding interest is curious. Interest in a subject (Q4) is often cited as a reason for learning, while lack of interest (Q5) has a much more univariate distribution of responses across the Likert scale. Theoretically, this would suggest that interest is a strong motivation, while lack of interest produces less predictable decisions.

4. CONCLUSION

There is little doubt that the Google effect actually occurs. Students seem to be conversant and quite deliberate about many of their lookup or learn decisions as they face the task of being a student. Interest, frequency of use, and necessity for an exam seem to be the largest factors to influence a student to learn. Accessibility and lack of interest seem to be the major factors that lead to lookup of information. Although the quality of the information itself (such as highly quantitative, factual, or conceptual) was frequently cited as a theme in the earlier content analysis, these themes did not provide consistency in the Likert scale responses.

The long-term ramifications of this effect are not as clear. Because students will lookup information when it is accessible, and because so much information is accessible on the Internet, it raises fundamental questions of what should be taught in our educational systems. No specific mention was ever made of technical information – although conceivably, that is what students may have meant as they described facts and details. Although the first open-ended comments often cited this as a reason to look-up information, the survey did not clearly agree.

The frequency of use criterion for learning is one that might be based on a certain degree of rational thinking. It is simply faster to retain information in memory than to continually look it up.

The implications for the Google effect are many and mixed. The idea that students are making efficient use of resources, by taking into consideration frequency of use and accessibility of information means that students seem to be making what Simon [10] would refer to as satisficing decisions, based on coming up with a quick, acceptable decision, even if not necessarily optimal.

The negative potentials of excessive lookup were described earlier in the paper. The potential for students to supplant learning with lookup of easily accessible information is a danger that faculty need to be aware of. Educationally, faculty need to think carefully about the actual tasks that students are performing, to ensure that superficial lookup is not always occurring, and that some deep learning is involved.

5. REFERENCES


