CS6460 Assignment 1

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1 RESEARCH LOG

1.1 Background

It all began with a project I became a part of during my undergraduate studies - the Tapestry Tool, led by Dr. Barnes. The Tapestry Tool Beta has evolved into an open-source online learning platform that facilitates collaboration among users, authors, viewers, students, and instructors to create interactive, associative, and multi-modal content.

Tapestry structures the content in a "graph" format. What captivates me about Tapestry is how it simplifies the relevance of the content using edges, represents content as nodes, and transforms conventional linear teaching into three-dimensional software. Moreover, Tapestry cleverly leverages that humans recall information effectively through correlations to enhance teaching quality. This leads me to ponder whether other software or technology could similarly benefit different learning phases.

Given that I did not have a chance to research during my undergraduate years, I am eager to leverage the CS 6460 Research track as an opportunity to explore the following:

- Delve into the potential of ed software to aid learning, spanning aspects like involvement in syllabus development, delivery of course materials, evaluation of learning outcomes and beyond.
- Investigate the optimal junctures for students to engage with software in the learning process.

1.2 Papers

1.2.1 *Paper 1 – Peer Reviewed*

Ou, C., Joyner, D. A., & Goel, A. K. (2019). *Designing and Developing Video Lessons for Online Learning: A Seven-Principle Model*. Online Learning, 23(2), 82-104. doi:10.24059/olj.v23i2.1449.

This is a paper from a Google Scholar search.

Summary - The study explores the design and development of videos for online courses using seven principles from instructional design theories. Feedback from students over eight semesters was collected to assess the effectiveness of these video lessons and overall course quality. The paper presents the instructors' experiences and survey results and discusses implications for the design and future research in this field.

Key takeaways - This paper provides valuable insights and procedures for designing compelling instructional videos for online courses using seven instructional design principles. It also highlights the importance of gathering feedback and analyzing the data to assess the quality of these videos.

1.2.2 *Paper 2*

Hornback, A., Buckley, S., Kos, J., Bunin, S., An, S., Joyner, D. A., & Goel, A. K. (2023). *A Scalable Architecture for Conducting A/B Experiments in Educational Settings,* 373–377. https://dl.acm.org/doi/10.1145/3573051.3596190

This is a paper from a Google Scholar search.

Summary – This paper focuses on developing an infrastructure for A/B experiments, aiming to aid researchers in rapidly conducting and analyzing experiments in education. A/B experiments involve comparing variables in control and treatment groups, widely recognized as beneficial in education research. The software aims to fill the gap in creating efficient systems for education-focused experiments within an ecology-based conceptual modelling platform.

Key takeaways - This paper provides an excellent example of applying A/B experiments. It underscores the significance of such experiments in educational technology research, which I can leverage in future projects.

1.2.3 *Paper 3 – Peer Reviewed*

Hintzman, D. L. (1990). *Human learning and memory: connections and dissociations.* Annual Review of Psychology, 41(1), 109–139. https://doi.org/10.1146/annurev.ps.41.020190.000545

This is a paper from a Georgia Tech Library search.

Summary - This review explores two prominent trends in recent human learning and memory research: connection and dissociation models. Connectionism, represented by neural networks, has gained significant attention and hailed as a paradigm shift in psychology. Meanwhile, dissociation research has grown influential over time, driven by the need to compare different memory tasks and fueled by data from amnesiacs and renewed interest in conscious awareness.

Key takeaways - The author underscores the importance of explicit theory and the limitations of intuitive reasoning when interpreting experimental results, which is also crucial in my research afterwards.

1.2.4 *Paper 4 – Peer Reviewed*

Kimble, G. A. (1952). *Review of: The psychology of human learning. Psychological Bulletin*, 49(6), 660–662. https://doi.org/10.1037/h0050265

This is a paper from a Georgia Tech Library search.

Summary - This review assesses the revised edition of "The Psychology of Human Learning" by J. A. McGeoch and A. L. Irion. The reviewer notes that the revision has transformed the book into a discussion of learning theory and has successfully captured the spirit of the original work, providing an up-to-date summary of the field of human learning.

Key takeaways - For my future research, papers should be viewed through a critical and evolving lens, even regarding the industry's leading authorities and classics. Properly confronting research limitations and giving open-ended conclusions is sometimes necessary as well.

1.2.5 *Paper 5*

Tabibian, B., Upadhyay, U., De, A., Zarezade, A., Schoelkopf, B., & Gomez-Rodriguez, M. (2017). *Optimizing Human Learning.* https://doi.org/10.48550/arxiv.1712.01856

This is a paper from a Georgia Tech Library search.

Summary - This paper explores the concept of spaced repetition for efficient memorization and aims to find the optimal reviewing schedule to enhance long-term retention. The study demonstrates that the optimal reviewing schedule is influenced by the recall probability of the content being learned and presents an online algorithm called Memorize, which can potentially improve memorization efficiency, as evidenced by experiments on data from Duolingo.

Key takeaways - When collecting data in the study, leveraging an existing app with a large number of monthly active users can be very helpful, such as the data collected from Duolingo in this paper. The evaluation of the selected app is necessary to consider data limitations.

1.2.6 *Paper 6 – Peer Reviewed*

Wittrock, M. C. (2010). *Learning as a Generative Process*. Educational Psychologist, 45(1), 40–45. https://doi.org/10.1080/00461520903433554

This is a paper from a Georgia Tech Library search.

Summary - The paper presents a cognitive model of human learning with understanding called the generative model and summarizes empirical research that supports it. The proposed model integrates various research areas, including cognitive development, human learning, information processing, and aptitude-treatment interactions, focusing on transferring experience and abilities. This suggests a comprehensive framework for understanding how knowledge and skills can be applied and transferred across different contexts.

Key takeaways - This paper demonstrates the importance of longitudinal research and explores the possibility of extracting similarities and constructing a framework across disciplines - as long as it can address the research questions.

1.2.7 *Paper 7 – Peer Reviewed*

Shanks, D. R. (2010). *Learning: From Association to Cognition*. Annual Review of Psychology, 61(1), 273–301. https://doi.org/10.1146/annurev.psych.093008.100519

This is a paper from a Georgia Tech Library search.

Summary - This article addresses the tension between association-based and cognitive learning theories. Associationism explains various learning phenomena through concepts like excitation, inhibition, and reinforcement, while cognitive theories propose that learning involves hypothesis testing, cognitive models, and propositional reasoning. This article also explores the growing ideas that learning can be either noncognitive and unconscious (implicit) or cognitive and conscious (explicit), examining the evidence for and against these explanatory constructs.

Key takeaways – Both association-based and cognitive learning theories can be valuable for my research – they provided theoretical support for exploring what part of human learning that Educational Technology could play a role in. The tension between association-based and cognitive learning theories may also provide new perspectives for my research.

1.2.8 *Paper 8 – Peer Reviewed*

Shuell, T. J. (1986). *Cognitive conceptions of learning.* Review of Educational Research, 56(4), 411–436. https://doi.org/10.3102/00346543056004411

This is a paper from a Georgia Tech Library search.

Summary - This article highlights the recent shift towards a cognitive psychology perspective on learning, emphasizing factors influencing changes in human performance, knowledge structures, and conceptions, discussing the distinctions between behavioural and cognitive views of learning, emphasizing active learning, comprehension, the influence of prior knowledge, and the cumulative nature of human learning.

Key takeaways - Compared to traditional learning theories, this article emphasizes the importance of learning initiative, comprehension, knowledge antecedents, and the cumulative nature of human learning. In addition, the article suggests

that cognitive psychology provides valuable insights into the factors and variables that influence learning, guiding future research on learning and teaching.

1.2.9 *Paper 9 – Peer Reviewed*

Gobet, F., Lane, P. C. R., Croker, S., Cheng, P. C.-H., Jones, G., Oliver, I., & Pine, J. M. (2001). *Chunking mechanisms in human learning*. Trends in Cognitive Sciences, 5(6), 236–243. https://doi.org/10.1016/S1364-6613(00)01662-4

This is a paper from a Georgia Tech Library search.

Summary - The paper discusses the concept of 'chunking' and its importance in various perception, learning, and cognition processes in humans and animals. It distinguishes between deliberate, goal-oriented chunking and automatic, continuous chunking linked to perceptual processes. The paper highlights recent applications of perceptual chunking in computational models of human learning, including verbal learning, expert memory, language acquisition, and learning multiple representations.

Key takeaways - The part that connects Chunking mechanisms in human learning and practical applications can be helpful for my future research. It showed me some current educational technology applications and demonstrated how theory and reality can accomplish each other.

1.2.10 *Paper 10 – Peer Reviewed*

Sweller, J. (2020). *Cognitive load theory and educational technology*. Educational Technology Research and Development, 68(1), 1–16. https://doi.org/10.1007/s11423-019-09701-3

This is a paper from a Georgia Tech Library search.

Summary - Cognitive load theory suggests instructional strategies based on understanding human cognition. It categorizes knowledge into biologically primary (generic-cognitive skills) and biologically secondary (domain-specific) information. The theory emphasizes that secondary knowledge is processed through limited working memory capacity before being stored in long-term memory and recommends instructional procedures, often assisted by educational technology, to reduce working memory load when dealing with complex information.

Key takeaways - The ideas in this paper remind me of the cache mechanism in computer science principles - which makes me want to further explore the similarities between cognition load and machine memory in my research.

1.2.11 *Paper 11 – Peer Reviewed*

Van Den Broek, P. (2010). *Using Texts in Science Education: Cognitive Processes and Knowledge Representation.* Science (American Association for the Advancement of Science), 328(5977), 453–456. https://doi.org/10.1126/science.1182594

This is a paper from a Georgia Tech Library search.

Summary - The text discusses the importance of texts as practical tools for teaching scientific concepts and principles. It emphasizes that comprehension and learning from a text depend on constructing a coherent mental representation that integrates the text with existing background knowledge. The Landscape Model is introduced, which considers reader and text characteristics in the reading process, suggesting factors that can enhance or hinder learning science from the text.

Key takeaways - The article discusses the importance of texts in science education and explores how people learn science from text. Does this conclusion apply to the study of other subjects? This might be an interesting topic to investigate in my research.

1.2.12 *Paper 12 – Peer Reviewed*

Oudeyer, P.-Y., Gottlieb, J., & Lopes, M. (2016). *Intrinsic motivation, curiosity, and learning: Theory and applications in educational technologies.* Progress in Brain Research, 229, 257–284. https://doi.org/10.1016/bs.pbr.2016.05.005

This is a paper from a Georgia Tech Library search.

Summary - This chapter explores the bidirectional relationship between curiosity and learning, highlighting how this understanding can be applied in educational technology. It discusses how novelty, surprise, and intrinsic motivation can enhance learning and memory retention. The chapter also delves into computational models of curiosity and the learning progress hypothesis, suggesting a positive feedback loop between curiosity and learning, and concludes by

showcasing the application of these concepts in designing intelligent tutoring systems that promote curiosity and effective learning.

Key takeaways - This paper has inspired me - the bidirectional relationship between curiosity and learning. At which stage does it work best? Can educational technology be used to maintain long-term curiosity and self-drive to develop good study habits?

1.2.13 *Paper 13 – Peer Reviewed*

Cheung, A. C. K., & Slavin, R. E. (2013). *The effectiveness of educational technology applications for enhancing mathematics achievement in K-12 classrooms: A meta-analysis.* Educational Research Review, 9(1), 88–113. https://doi.org/10.1016/j.edurev.2013.01.001

This is a paper from a Georgia Tech Library search.

Summary - This review focuses on the impact of educational technology on math achievement in K-12 classrooms, using consistent inclusion criteria for studies that meet high methodological standards. The analysis includes 74 qualified studies with a total of 56,886 K-12 students, revealing a generally positive but modest effect (effect size = +0.15) of educational technology applications compared to traditional methods. The type of educational technology matters, with supplemental Computer-Assisted Instruction (CAI) having the most significant effect (ES = +0.18), while computer-management learning and comprehensive programs showed minor effects (ES = +0.08 and +0.07, respectively).

Key takeaways - The type of educational technology matters, with supplemental Computer-Assisted Instruction (CAI) showing the most significant positive effect, while computer-management learning and comprehensive programs have more minor impacts. The review emphasizes the importance of considering the specific type of educational technology and various study and methodological factors when assessing their impact on math achievement.

1.2.14 *Paper 14 – Peer Reviewed*

Yeung, K. L., Carpenter, S. K., & Corral, D. (2021). *A Comprehensive Review of Educational Technology on Objective Learning Outcomes in Academic Contexts.* Educational Psychology Review, 33(4), 1583–1630. https://doi.org/10.1007/s10648-020-09592-4

This is a paper from a Georgia Tech Library search.

Summary - This review examines the impact of digital technology on students' objective learning outcomes in educational settings. While technology is widely adopted, there needs to be more research explaining its effects on learning and why these effects occur. The findings suggest that technology is neutral when used for information presentation. It can enhance learning by offering unique affordances that align with effective learning principles, such as increased engagement, retrieval practice, and spacing. The review emphasizes the importance of evidence-based decision-making when implementing technology in education.

Key takeaways - Technology primarily used for information presentation does not show significant benefits or harm to learning. However, technology can be advantageous when it leverages unique features that align with effective learning principles, such as increased engagement and opportunities for retrieval practice and spacing.

1.2.15 *Paper 15*

UBC Department of Psychology. (2022). The tapestry tool creates space for accessible and engaged hybrid learning. https://psych.ubc.ca/news/tapestry-tool-creates-space-for-accessible-and-engaged-hybrid-learning/

This is a blog from a newsletter subscription to the Tapestry project.

Summary - The article discusses the challenges and opportunities in hybrid learning environments, particularly in the context of post-pandemic education. Dr. Steven Barnes, the creator of the Tapestry Tool, emphasizes the importance of creating dynamic and inclusive learning environments by leveraging technology. The tool facilitates collaborative content creation and aims to enhance social connectivity, community building, and collaboration in online learning, emphasizing accessibility and equitable access to education as crucial goals for the future of learning.

Key takeaways - Besides the traditional linear approach, the tapestry tool proposes a more three-dimensional approach to teaching, considering the learner's cognitive load.

1.3 Synthesis

The high-level trends and key takeaways from the provided information on educational technology research can be summarized as follows:

- Importance of Effective Instructional Design: One prominent trend is the emphasis on the significance of well-designed instructional videos and the need for robust A/B experiments in educational technology research (Papers 1 and 2). This highlights the critical role of pedagogical quality and the iterative process of improving educational content and technology.
- Diverse Approaches to Learning and Memory: Another significant trend is the recognition of the complexity of learning processes, as evident in the various theoretical frameworks discussed in Papers 3, 5, 7, 8, and 11. This highlights the importance of considering diverse perspectives and approaches to understanding and optimizing learning outcomes.

Open questions that arise from these trends and insights include:

- Optimal Integration of Educational Technology: While the papers emphasize the importance of effective instructional design and evidence-based decision-making, open questions remain about the most effective ways to integrate technology into education across various settings and subjects. How can educators strike the right balance between traditional teaching methods and technology-enhanced learning?
- Measuring and Assessing Learning Outcomes: While the effectiveness of educational technology is discussed in Papers 13 and 14, open questions persist regarding the best methods for measuring and assessing learning outcomes in technology-rich educational environments. What are the most reliable and valid metrics for evaluating the impact of technology on learning?
- Sustainability and Scalability: Given the evolving nature of technology, questions arise about the sustainability and scalability of educational technology solutions. How can educational institutions ensure their technology implementations' long-term viability and scalability while keeping pace with technological advancements?

Instead of evaluating education technology in multiple stages of learning, I would like to narrow down my research direction to the very early stage of learning – initial motivation of learning and explore how educational technology can facilitate this process for better learning outcomes and long-term habits.

1.4 Reflection

Since my involvement in the development of Tapestry, I have developed preliminary ideas regarding the topics I would like to explore within educational technology. Therefore, I primarily find sources by searching for pertinent keywords (e.g., cognitive load, human learning) on Google Scholar and the Georgia Tech Digital Library. While reviewing these papers, I mainly focus on the sections of Abstract, Introduction, and Conclusion to extract the necessary information efficiently. I took notes as I progressed through the materials to help structure my thoughts. Upon completing my reading, I simplified and synthesized my notes into summaries and key takeaways, comparing them to seek inspiration and refine my research direction.

Despite the relative ease of finding educational technology resources online, crafting concise summaries and making content-related decisions during the reading process can take time and effort. This challenge stems from my uncertainty in the early stages of research about whether my summaries and takeaways align with my future research's core objectives.

Over the first two weeks of exploration, I realized that the significance of intrinsic motivation and curiosity in human learning is more appealing than delving into the discussion of conventional human learning models. Moving forward, I am eager to collect more information on how and why intrinsic motivation and curiosity can enhance learning outcomes and how educational technology can facilitate this process.

1.5 Planning

For next week, I would like to go further with my research to:

- Focus on gathering literature related explicitly to intrinsic motivation and curiosity in the context of human learning.
- Search for keywords such as "intrinsic motivation in learning," "curiosity and educational technology," and "motivation-enhancing technology in education" in academic databases.

- Identify the key questions to address in the research. For example:
    - How does intrinsic motivation affect the learning experience?
    - What factors stimulate curiosity in learners, and how can technology support these factors?
    - Are there specific educational technology interventions or tools that have been proven effective in enhancing motivation and curiosity in learners?
- Define Research Objectives and discuss the possible methodologies with my mentor.

2 ACTIVITY

2.1 Paper 1 – Peer Reviewed

Ou, C., Joyner, D. A., & Goel, A. K. (2019). *Designing and Developing Video Lessons for Online Learning: A Seven-Principle Model*. Online Learning, 23(2), 82-104. doi:10.24059/olj.v23i2.1449.

Need - This study addressed the challenge of creating effective video lessons for online learning, a crucial aspect of online learners' educational journeys. The rapid growth of online education has generated increased interest in examining the effectiveness of instructional videos as a learning tool.

Method - Researchers applied a model based on seven principles from instructional design theories to develop video lessons for an online graduate course. They collected student feedback through surveys over eight semesters to assess video effectiveness and quality.

Audience - The study's audience likely includes instructors and online course designers involved in online education and individuals interested in creating online instructional videos. The participants were students enrolled in the online graduate course who provided feedback through surveys.

Results - The study's results indicate that most students, with a response rate of 65%, highly valued the video lessons. Over 90% agreed that the videos were informative, easy to understand, and valuable for their learning. Additionally, over 80% of students found in-lesson exercises engaging and the exercise feedback beneficial. Furthermore, a strong positive relationship was identified between students' perceptions of video lesson effectiveness and overall course ratings,

highlighting the significant influence of video lesson quality on student satisfaction with the course.

Critique - Some students should have used the optional end-of-lesson reflection, highlighting a need for more transparent communication about its purpose. The study also noted limitations, including the need for expert model evaluation, potential survey research constraints, and a lack of investigation into how video lessons impact learning performance, suggesting areas for future research.

2.2 Paper 3 – Peer Reviewed

Hintzman, D. L. (1990). *Human learning and memory: connections and dissociations.* Annual Review of Psychology, 41(1), 109–139. https://doi.org/10.1146/annurev.ps.41.020190.000545

Need - This article overviews two significant trends in human learning and memory - connectionist models and empirical research. It aims to connect these trends, highlighting their importance in psychology and discussing potential limitations and areas for theoretical improvement in dissociation research.

Method - The author employs a literature review and theoretical analysis to address these trends. They discuss the development of connectionist models, emphasizing their significance and presenting various models within this framework.

Audience - The primary audience comprises psychologists and researchers in cognitive psychology and memory and those interested in the advancements of connectionist models and dissociation research.

Results - The review underscores the value of explicit theory and the use of mathematical and computational models to enhance our comprehension of human memory. It highlights connectionist models to bridge the gap between neuroscience and behavioural evidence.

Critique - The intricacies of the brain pose a significant challenge, suggesting the need for simpler, modular connectionist systems to uncover fundamental principles. Collaboration among neuroscience, modelling, and psychology experts is essential for advancing our understanding of memory processes.

2.3 Paper 7 – Peer Reviewed

Shanks, D. R. (2010). *Learning: From Association to Cognition*. Annual Review of Psychology, 61(1), 273–301. https://doi.org/10.1146/annurev.psych.093008.100519

Need - This article addresses the need to reassess and reconcile two contrasting views in learning theory: traditional stimulus-response (S-R) behaviourism, which focuses on automatic reinforcement processes, and cognitive theories, which emphasize conscious thinking and problem-solving in learning. The author explores whether learning is inherently conscious and if concepts like reinforcement are necessary to explain learning phenomena.

Method - The article conducts a literature review and theoretical analysis of research conducted since 2000 in associative and contingency learning, implicit learning, and memory. The author critically examines evidence from these areas to determine if traditional S-R theory should be replaced by cognitive theories incorporating concepts like attention and awareness.

Audience - The primary audience for this article includes researchers and scholars in psychology, cognitive science, and learning theory.

Results - The article finds that awareness of experimental contingency typically accompanies learning, challenging the idea of unconscious learning. It also highlights that association concepts still play a significant role in explaining learning despite the current emphasis on entirely cognitive, inferential processes.

Critique - the need for more evidence to support two distinct learning systems and emphasizes the importance of associative principles in understanding conditioned behaviours. The review also needs future research to investigate the boundaries of association principles in explaining phenomena such as additivity and blocking, underlining the ongoing complexity of the debate between cognitive and associative perspectives on learning.

2.4 Paper 10 – Peer Reviewed

Sweller, J. (2020). *Cognitive load theory and educational technology*. Educational Technology Research and Development, 68(1), 1–16. https://doi.org/10.1007/s11423-019-09701-3

Need - The need is to offer instructional guidance based on understanding human cognition. This involves categorizing knowledge into biologically primary (generic-cognitive skills crucial for survival) and biologically secondary (domain-specific) information. The passage suggests that instructional methods should consider working memory's limited capacity and duration and leverage technology to reduce working memory load, especially for complex information.

Method - The text outlines fundamental cognitive load theory and instructional design principles, presenting a theoretical framework with five fundamental principles describing how humans acquire, process, store, and use information.

Audience - The audience includes educators, instructional designers, researchers in education and cognitive psychology, and those interested in how cognitive load theory and evolutionary psychology can inform instructional practices. It also explores how technology can facilitate more effective learning experiences.

Results - The emphasis lies in understanding human cognition, employing evolutionary psychology, and identifying effective instructional techniques. These findings are validated through cognitive load effects, helping refine the theory.

Critique - While the text provides a foundational understanding of cognitive load theory, it lacks empirical validation and specific practical applications. It briefly mentions technology-assisted instruction but needs to explore its implications, which might limit its relevance for educators and instructional designers in e-learning contexts.

2.5 Paper 12 – Peer Reviewed

Oudeyer, P.-Y., Gottlieb, J., & Lopes, M. (2016). *Intrinsic motivation, curiosity, and learning: Theory and applications in educational technologies.* Progress in Brain Research, 229, 257–284. https://doi.org/10.1016/bs.pbr.2016.05.005

Need - The need is to understand how novelty, complexity, and prediction errors improve memory retention and how the brain's intrinsic reward system responds to them. Additionally, there is a need to explore the Learning Progress (LP) hypothesis, which suggests a positive feedback loop between curiosity and learning.

Method - Researchers reviewed recent results, discussed psychological and neurological concepts related to curiosity and intrinsic motivation, and applied

computational reinforcement learning models to understand curiosity mechanisms. They experimented with robots to illustrate how LP-driven attention and exploration can facilitate efficient skill acquisition.

Audience - The audience comprises psychology, neuroscience, education researchers, educators, and educational technology designers. Participants in experimental protocols may include students or learners.

Results - The findings suggest that novelty, complexity, and prediction errors can enhance memory retention, and the brain possesses neural circuits treating information as an intrinsic reward. They emphasize the importance of engaging learning materials, personalization, and the dynamic interaction between active learners and teachers in educational practice and technology design.

Critique - The study acknowledges several open scientific questions, such as precisely defining intrinsically rewarding informational features and whether spontaneous exploration has a unified mechanism. While the findings provide valuable guidelines for educational practice and technology design, some questions remain unresolved, necessitating further research into the dynamics of active learners and teachers in curiosity-driven learning.