DIGITAL DOWNSIDE?
EFFECTS OF DIGITAL TECHNOLOGY ON LEARNING

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LEARNING OUTCOMES

At the end of the workshop, participants will be able to:

- Analyze the effectiveness of popular tech trends based on experimental research.

- Understand how these digital approaches impact students' reading and thinking.

- Incorporate evidence-based techniques into the classroom that improve student success.

NOTETAKING: TYPING VS. HANDWRITING

- Typing (Bui et al, 2012):
    - Transcription speed tends to be greater; result in higher note quantity; associated with better performance in experiments testing immediate recall of lecture material

    - Associated with higher degree of verbatim transcription, which increases accuracy of content (also associated with better immediate recall test performance)

    - Verbatim transcription minimizes the need to hold and manipulate information, which may be beneficial to students with poor working memory

NOTETAKING: TYPING VS. HANDWRITING

- However, Bui et al's (2012) study did not reflect real world conditions (tested immediate recall, did not include opportunity to study after a delay, and did not use conceptual questions)

- When students have been tested a week after learning the material, and are given an opportunity to review their notes before being tested, students who took hand written notes performed highest (particularly on conceptual questions) (Mueller & Oppenheimer, 2014).

  - Verbatim note-taking was significantly higher in laptop condition, which negatively predicting test performance (supported by Igo et al., 2005)

NOTETAKING: TYPING VS. HANDWRITING

- Amount of notetaking positively predicts test performance, but the benefit decreases when notes are taken indiscriminately, mindlessly transcribing content (Mueller & Oppenheimer, 2014).

- Longhand notetakers may be more selective in the information they write down, are more likely to "transform" information, engaging in more processing (Perez Alonso, 2015).

- Handwriting slows you down

- When typing, attention is also split between screen and keyboard

NOTETAKING: TYPING VS. HANDWRITING

- Research has shown that children and adults who are asked to reproduce letters or shapes by hand demonstrate significantly higher activation in brain regions associated with attention, sensory integration, pattern recognition, speech production, and language comprehension.

- Experimental research has also shown that when children composed text by hand, they expressed more ideas and showed greater increase in activation of reading and writing networks

(James & Engelhardt, 2012; Planton, 2013; Longcamp et al., 2008)

NOTETAKING: TYPING VS. HANDWRITING

Recommendations

- Make students aware of the benefits of each

- After the first test/quiz give them an opportunity to asses how they took notes and studied (what role do they think their approach played in their grade?)

- Since the trend of laptop use for notetaking is irreversible, trying to combine both methods may be best approach. Suggestions for increasing hand writing:
  - Provide access to lecture Powerpoints to reduce desire to mindlessly write what they see on the screen
  - Provide opportunity to free-write during class
  - Encourage students to handwrite short summaries or key points after reading content they need to know/understand.

READING FROM SCREENS VS. PAPER

- Screens studied in the literature are computers, iPads, Kindles, phones, and other e-readers and tablets

- In a research article, "Why the Brain Prefers Paper" (Ferris, 2013) several benefits to reading from paper is more beneficial than on a screen
  - People understand and remember text better on paper than on a screen
  - Screens inhibit comprehension by preventing navigation and mentally mapping long text
  - The author suggest screens are more mentally taxing than paper because scrolling demands conscious effort
  - Paper is just simpler; e-book and e-readers can be too distracting

SCREEN VS. PAPER AND THE BRAIN

- Ferris (2013) makes additional claims that reading from paper is better than screens

- The brain interprets text like a "physical landscape," meaning when we read we construct a mental representation of the text (when you are asked to recall something from a paper book you often remember where on the page it was written). Paper books allow for easier mental representations.

- Reading from a screen inhibits this intuitive navigation and does not allow the "physical landscape" to occur, which could affect our memory of the text itself, impairing comprehension

SCREEN VS. PAPER AND THE BRAIN

- Furthermore, reading from screens pose other mental and physical issues according to Ferris (2013)

- Self-illuminating screens cause eye-strain, headaches, and blurred vision

- Reading on screens might impair metacognitive learning regulation (re-reading sections that are difficult to understand, mentally checking to see how much you understand)

SCREEN VS. PAPER

- Kong, Seo, and Zhai (2018) completed a meta-analyses of 17 studies that focused on comparing reading on a screen or paper in terms of reading comprehension and reading speed
  - They found that reading comprehension was better when reading on paper than reading on a screen, regardless of year of publication, type of screen, and country.
  - Reading speed of screen vs paper had no significant results
- Researchers have found that students often skim e-books more than they skim text books (Rho & Gedeon, 2000) and Nielson (2006) found that students are more likely to just look for key words when they are reading an e-book
- 90 undergraduate students read a test digitally and printed (counterbalanced order) and students reported they would recall more information digitally, yet when tested, although they got the main idea correct from both digital and print readings, students recalled more key points with print version (Singer & Alexander, 2017).

SCREEN VS PAPER: IN SUPPORT OF SCREENS

- Visual impairments (blind or low vision) "participants demonstrated a slightly higher reading speed, equal comprehension rates, and decreased error rates using the iPad2 compared to paper" (McLaughlin & Kamei-Hannan, 2018).

- Rockinson- Szapkiw, Courduff, Carter, and Bennett (2013) found no difference in comprehension and recall when the text is **short**

- E-texts are more affordable and accessible

- Grades and cognitive learning are not impacted by screen vs paper use

SCREENS VS PAPER: LIMITATIONS IN THE RESEARCH

- Results are mixed when making conclusions on digital vs. screen and its impact on comprehension and retention

- Difficulties in assessing research on paper vs screen: the "screen" is consistently changing (its capabilities and readability)

- Gap in literature with diverse college students in the US. A lot of research internationally on elementary school and high school students

SCREENS VS PAPER: IMPLICATIONS

E-Book (screen) or Textbook (paper)?

- Consider length of text

- Should we be moving toward OER or low cost textbook options?

- If we are using an OER, make sure print versions are also available (most research is consistent that students prefer text and buy digital mainly because of affordability and accessibility).

- Talk to students about the research on e-book versus textbook.

- Use both e-material and print material in your classrooms so students can develop paper and digital literacy skills (Salter, retrieved August 3, 2018)

- Note* in an effort to not waste paper I read all of the research studies on my computer and found it took me longer to go back and forth to the pages I wanted to re-read and experienced eye strain and headaches.

GAMIFICATION AND INTERACTIVE EBOOKS

- Gamification: Using game elements in a non-game context (Hanus & Fox, 2015)

- Typically include badges, points, or other reward systems to incentivize behavior

- Often designed to fit the skill level of the user and/or have low-risk consequences to minimize frustration

- Believed to increase engagement and enjoyment of reading or doing other "tedious" tasks

Likely Benefits

- Gamification and other interactive elements increase engagement, allowing more opportunities for learning (Evans et al., 2017)

- Improves students' performance on skill-based assignments regardless of what gamification elements are used (De-Marcos et al., 2016)

- Leaderboards can be useful (Nebel et al., 2017)
  - Penalties that affect leaderboard standing improve retention and learning efficiency
  - Low difficulty in improving standing is related to increased detail knowledge

- Gamification that builds a sense of community is best at increasing engagement (Luo et al., 2017; Sun & Hsieh, 2018) and exam performance (de-Marcos et al., 2016)

Areas of Concern

- Even though engagement is high initially, this might be a novelty effect (Evans et al., 2017; Tsay et al., 2018)

- Gamification decreases intrinsic motivation (Hanus & Fox, 2015)
  - Reduced intrinsic motivation decreases recall (Dewar et al., 2016; Hanus & Fox, 2015) and reading comprehension (Guthrie et al., 2006)
  - Higher intrinsic motivation results in increased activation of areas of the brain related to memory and reward (DePasque & Tricomi, 2015)

- Competition between classmates can harm performance if it results in upward social comparison (Christy & Fox, 2014) or stereotype threat (Albuquerque et al., 2017)

Implications

- Gamification and interactive ebooks have a variable effect on student learning
  - More useful for practical assignments involving application but less helpful for recall tasks
  - Initial motivation of students is important
  - Gamification typically requires reading from a screen, so outcomes from that topic apply here

- Most likely, it depends on the quality of digital elements being used and how closely aligned they are to learning outcomes (Huang & Hew, 2018)

- Findings are different if looking at game-based learning

Recommendations

- When choosing to incorporate gamified elements into your course, ask:
  - Will this rate high on Bloom's Taxonomy?
  - Is this closely aligned with learning outcomes?
  - Will this promote a sense of community and belonging?
  - Is this time efficient?

- Include components that promote curiosity, a sense of agency and choice, competence, and positive feedback

OVERARCHING CONSIDERATIONS

- Students tend to view digital approaches favorably, even if research suggests it is not helpful to them

- Digital approaches often promote media multitasking, which negatively impacts working memory – how do we combat this?

- Will students who grow up in the age of digital technology recall and comprehend information differently? If so, how do we account for this in the classroom?

  - Issues of cognitive overload, continuous partial attention, preference for small chunks of information vs. vertical reading, etc. (Cavenaugh et al., 2016)

OVERARCHING RECOMMENDATIONS

- Offer a variety of learning tools and multiple delivery systems to best accommodate a diversity of learning needs (Hortsch, 2015)
- Encourage students to avoid copying information verbatim
- Comprehension seems to take a toll when reading on a screen
- Gamification can negatively affect recall and motivation, so stick to approaches that promote a sense of belonging and choice, and that align with learning outcomes