Problem Statement:
Emerging research suggests that learners who take electronic notes may not engage in as much content reflection as those who take written notes; yet, many clinicians engage in electronic note-taking behaviors when completing continuing medical education offered through electronic platforms.

Purpose:
E-learning and mobile electronics are increasingly being used to take, secure and store educational notes during CPD. In an effort to reduce cost and/or waste, many CPD providers no longer provide hard-copy, paper handouts, and instead provide learners with electronic copies of handouts, presenter notes, and resources. While these advances in technology mean that learners have more access to original sources of information, the converse is that there are few opportunities to engage in handwritten notes to supplement reflection and functional encoding. There is very little information available in the literature on the implications that this can have on memory retention and quality of reflection within the context of CME. Our team has previously found that participants who take handwritten notes retain more knowledge than those who are instructed to type notes. In this study, we extend these results to explore the effects of voluntary note-taking style on memory retention and quality of reflection, following a typical live CPD program.

Theoretical Background:
- Note-taking has two functions:
  1. Accelerating the encoding of novel information and
  2. Facilitating later review of content
- Creating notes draws on processes used for the acquisition, processing, and recording of information from an external source.
- Those processes typically accelerate memory for information.
- With these processes, the learner recontextualizes the instructional content to match their own mental models.
- The encoding process of note-taking can occur through long-hand or typed notes; however, information is processed differently according to the tools used.
- The production of writing, speaking, and typewritten language all involve different synaptic mechanisms in the brain (Kellogg, 2004; Kellogg, 2001a; Kellogg, 2001b).
- The self-reference effect refers to the superior memory for words and concepts judged in relation to self, the optimal way of achieving good retention (Rogers, Kuiper & Kirker, 1977; Klein & Loftus, 1988).
- Reflection also draws on the effects of this encoding process.
- Typing notes is associated with a more automatic approach to recording information, drawing less on encoding strategies.
- Typed notes typically offer information verbatim.
- Typing notes using technology offers more opportunity for distraction (Hembrooke & Gay, 2003).
- When performing more than one cognitive task simultaneously, performance is impaired in each task (Hembrooke & Gay, 2003).
- Orthographic and motor execution processes contribute to encoding through handwritten means.
- Planning the content of a handwritten note engages visual working memory, self-reference, planning and translation, in order to identify and record the most appropriate information given the constraints of the motor ability to write (Olive, Kellogg, & Piatka, 2007).

Methodology:
The pilot of the study employed a mixed methods design including:
1. Survey addressing note-taking preference and demographics
2. Pre and post-test evaluation of knowledge regarding content of a live CPD event on addictions;
3. Participant reflections, in either written or typed format (according to participant preference)

Research Questions:
1. "Is there an effect of preferred note-taking style (written or typed) on the memory retention of information provided through continuing medical education (CME)?"
2. "Is engagement in reflection effected by the participant's preference to type or to write reflective content?"

Discussion:
Considering the widespread movement toward innovative electronic CPD and the use of electronic technology to provide CPD, it is important that CPD providers and consumers understand the strengths and limitations of handwritten and typed note-taking, including its resultant impact on memory retention and changes to practice. Our preliminary results suggest that:
- Reflection is enhanced by handwriting, with greater depth and insight-quality of thought presented in handwritten reflections.
- Memory for new CPD content is significantly greater in health professionals who prefer to handwritten their notes and do handwritten notes, as compared to those who type notes. Of note is that participants who prefer to type notes, but attempt to handwritten notes, perform significantly lower on post-test knowledge tests.
- Careful analysis and reflection on these results suggest that judgment and confidence in pre-event knowledge may be compromised by encoding new information using technology. Participants who performed poorly on tests measuring the recall of content and the conceptual application of content presented during the learning activities.
- There are fragmented clusters of information on the impact of note-taking style of memory retention, found within the areas of:
  - Psychological sciences (Kellogg, 2001a; Kellogg, 2001b; Kellogg, 2004)
  - Linguistics (Cleland & Pickering, 2006)
  - Information technology (Bui, Myrason & Hale, 2013)
  - Education research (Williams & Eggert, 2012)

Literature Background:
- Electronic notes are more comprehensive, easy to decipher, and verbatim (Mueller et al., 2015).
- However, electronic notes associated with less reflection, less understanding of material.
- Even when learners are instructed not to type notes verbatim, they continue to do so.
- When compared to undergraduate students instructed to take written notes longhand, students who created comprehensive typeset notes performed significantly better on tests measuring both the recall of content and the conceptual application of content presented during the learning activities.
- There are fragmented clusters of information on the impact of note-taking style of memory retention, found within the areas of:
  - Psychological sciences (Kellogg, 2001a; Kellogg, 2001b; Kellogg, 2004)
  - Linguistics (Cleland & Pickering, 2006)
  - Information technology (Bui, Myrason & Hale, 2013)
  - Education research (Williams & Eggert, 2012)

Results:
Q: "Is there an effect of preferred note-taking style (written or typed) on the memory retention of information provided through CME?"
A: YES!
- At 3 months post-intervention a modest effect was noted. Participants who reported that they preferred to write notes, and took notes by writing, recalled significantly more information than they knew prior to the CPD event.
- At 3 months post-intervention, this effect was stronger in participants who wrote their notes, as compared to those who typed notes.

Limitations:
- The CPD event that was featured received very poor participant feedback related to the educational content and appropriateness of learning objectives.
- Several participants who completed the post-test noted that they had taken written notes, but would have preferred to take typed notes. These participants tended to demonstrate a loss of knowledge related to the subject material.
- Further investigation will be conducted in order to explore these effects.

Table 1: Statistical Analysis of values and data, paired t-tests.
|                  | Mean (post-Pre) | SE | t   | p-value (>|0) | Written |
|------------------|-----------------|----|-----|--------------|---------|
| Typed            | 0.0567          | 0.1052 | 3.2749 | 0.0113         | 0.1137  |
| Written (Controlled) | 0.1407          | 0.0430 | 3.1407 | 0.002**         |

Q: "Is engagement in reflection effected by the participant’s preference to type or to write reflective content?"
A: YES!
- Typed reflections tended to be short and simple, very blunt and reflect bias.
- Typed reflections echoed pre-test "perceived learning needs" e.g. "My clients lie to me when they do not have their...drug cards"
- Handwritten reflections tend to build on pre-test perceived learning needs and reflect misconception or emergent learning needs e.g. "Substance abuse becomes addiction when it represents an all-consuming, meaningful activity – planning how to obtain the substance, implementing the plan, and relying on a social network that is linked to the substance use."
- "One area that often becomes relevant in regards to social identity: when an individual can become accepted as a part of a community simply based on their substance use, their identity becomes ingrained in the substance use".
- "The most pressing need and difficulty is helping clients move from pharmacological interventions to cognitive, social, and environmental supports. It seems that when clients are dependent on medication alone we see many client issues focus on complimentary therapies."

Key References: