e-MEMENTO : a smartwatch experiment to investigate rote memorization in the connected age.

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Abstract: This article presents the results obtained by a qualitative study aiming at assessing the impact of innovative technologies on rote learning. The study involved students attending courses at Bachelor level. We compared the memorization of data provided on hard paper copies with data displayed on the smartwatch. We developed an application on the Apple Watch generating data batches. The participants involved in the study were asked to memorize data displayed on the smartwatch and that provided on hard paper copies, then we compared the recall rate of both formats. In addition to the figures obtained, we also mention the participants' impressions on their learning appreciation for both devices. Finally, this article connects with the state-of-the art research concerning the comparison between digital and hard paper devices. Lastly, this article hints at future possible research leads.

Introduction

Context

Every year, more than 20,000 students enroll in the different curricula proposed by the University of Applied Sciences Western Switzerland (HES-SO). This university offers students strong links with the real professional environment, either via very concrete courses (laboratory work, experiments, etc.) or by helping with developing projects ordered by professionals in action. It provides six different study fields: Engineering, Economics and Services, Healthcare, Social Work, Performing Arts and Music.
Globally, courses are provided by lecturers in frontal learning situations, but this University enriches its pedagogical concept by including blended learning to the curriculum. By now, more than 6,000 courses are provided on line to more than 20,000 users, published on its Moodle platform (http://cyberlearn.hes-so.ch). Most professors deliver knowledge using either online documents or paper textbooks.

The e-learning Centre Cyberlearn was created in 2004 to sustain the expansion of e-learning at the HES-SO. This Center offers now various services, ranging from LMS Moodle administration to specific resource development or online course certification.

Besides, Cyberlearn conducts various studies to analyze the impact of innovative technologies on the learning process, by gathering data among students, basing its approach on « self perceived learning » (Salamin, 2014).

The aim of the study presented in this paper is to assess the impact of wearable devices on rote learning.

The learning devices broadcasted digitally

In 2016, a large number of devices, whether mobile and/or connected can be used to support the learning process. Smith&Caruso (2010) report that 80% of college and university students own laptops, and that many purchase tablets, e-readers and other hand devices. However, some studies show that recalling and retrieving is less rich when reading from an e-text than from a physical book (Jeong, 2012), but the students having studied on e-textbooks and those having studied with hard-paper textbooks scored no differently during exams (Murray & Pérez, 2011). Moreover, reading on a screen display, takes up more time than reading a text printed on hard-paper, even with similar reading strategies (Chesebro & McCroskey, 2000). According to Amanda J. Rockinson- Szapkiw, Jennifer Courduff, Kimberly Carter, David Bennett (2013), perceived learning and grades did not differ based on the textbook format they choose for their courses.

For this study, the investigators collected four data items stemming from two different groups (a group of students using printed hard-paper textbooks, and the other group using e-textbooks): reading strategies, reading speed, exam grades and self-perceived learning. The data did not lead to significant different results concerning the type of device used. However, the results show that students using e-textbooks to study, believe to have better psychomotor competencies and better manage their affective learning: they learn more actively and appreciate this kind of learning process.

Description of study

We assume that reading not necessarily aims at storing information permanently. Students can read without concentration, move on in their reading without remembering relevant information, while retaining less important information. In order to efficiently answer exam items, they must have selected specific information, built links among the data items, by relying on their learning context, and have abstracted the data to use it later on. Therefore, the reading process becomes a sophisticated, mixed and difficult task to untangle, when drawing conclusions for determining whether digital versus hard-paper learning devices favor the learning process. Moreover, the analysis of grades obtained in exams, after learning via hard-paper or digital texts, gives little insight in terms of the learning process, as these grades, indeed indicating ranking, can also reflect the student's motivation, his previous knowledge, his capability for retaining data, for making connections between the various knowledge fields. The grades are also impacted by the intrinsic interest the student shows for the given subject. Rockinson- Szapkiw, A. & al. (2013), in fact, mention this element as a limitation in their study.

Therefore, we turned our interest towards a learning process, less widely spread in teaching, especially at university level, but nevertheless very useful and measurable: rote learning. We tried to find out whether this method was affected by the use of an innovative device. We opted for a wearable device, the smartwatch versus plain paper, and compared the results of both formats in terms of information storage and recall. The learning strategies used by the participants were not considered here, to deal only with the memorization process.

Rote learning

The notion of rote learning nowadays is a controversial issue. Asking learners to gather notions without understanding them, seems very inadequate, at a time when access to gigantic volumes of data via the Internet makes the process of memorizing data less pertinent.

Research conducted on the learning process, constructivist and socio-constructivist theories (Piaget, Vigotsky), pointed out the importance of the subject's own learning activity, as well as the learning context. Knowledge does not just consist in copying reality, but in rebuilding it. Additionally, interaction among peers, also proceed to the building up of rich and integrated learning objects, transferable to other real life cases, different from those elaborated in class situations. Rote learning for its part, is connected to behaviorist theories limiting learning to a reflex sequence: stimuli-answer. So, this type of learning nearly disappeared from the range of methods recommended to be used by professors.

However, a French research shows that 97% of professors at primary level (N=34), teaching pupils aged from 5 to 10, use the "by heart" as a learning method (Abernot, Audran & Penso, 2011). Multiplication tables, grammar rules, mental arithmetic, poems, dates and places in history, geography, form particularly well suited school subjects for this type of method. When asked about the targets aimed at when using rote learning, the teachers mention lexical enrichment (6/34), the ease of permanent retention (5/34), restitution speed (5/34) and the setting up of a solid base knowledge on which to build further learning (3/34). 84% of the people asked, estimated that the "by heart" becomes easier when the concept in need of learning is understood beforehand. Both aspects of the learning process must, therefore, be applied simultaneously and regularly in order to achieve efficient learning.

According to these results, Maulini (2016) considers that two learning loops are possible: a longer loop, where the concept is explained then understood before being applied until it becomes automatic, and a shorter loop, where knowledge is memorized and restituted very rapidly. The longer loop anchors long-term knowledge, while the shorter loop ensures a rapid and reliable use of information. Both approaches can be combined to better reach the goal aimed at. Indeed, Mayer (2002) points out that teaching aims at enabling information retention and recalling (« the ability to recall knowledge later in the same way it was presented during instruction ») and knowledge transfer (« the skill to solve new problems »). When transfer occurs, the learning process is completed. He reminds us that concentrating only on rote learning isolates it from its context and can only achieve two of the cognitive processes of the revised Bloom Taxonomy which contains 19 specific cognitive processes associated with six process categories (Anderson and al., 2001). He encourages educators to rely on more complex educational objectives to favor both retention and transfer.

Although a number of educators believe that learning by heart is an inefficient method for consolidating information to be stored in the long-term memory, Piaget himself claimed that “every discipline must include a certain body of acquired facts as well as the possibility of giving rise to numerous research activities and activities of rediscovery, it is possible to envisage a balance being struck, varying from subject to subject, between different parts to be played by memorizing and free activity. In which case, it is possible that the use of teaching machines will save time…” (quoted in Hilgard & Bower, 1975).

So, our claim is not to define rote learning as a « good» learning method, but to consider it as a method available in higher education and which is measurable. Memorizing verb tense endings in a foreign language, dates in history or road signals, constitute a first step in the complex process leading to competency.

Memory and rote learning

Memory is seen as a sophisticated process stated in three steps: encoding, storage and retrieval. Globally, two memories come into play when information is memorized: short-term memory (MCT) and long-term memory (MLT). Rote learning is mainly concerned by MCT.

The capacity of this memory depends on individuals. Blocks of information which can be assimilated at one time, the memory span, reaches from 2 to 9 items, but 7 on average (Hendrix & Joplin 1968).

Different strategies enable recalling of information at one time, for example repetition, cutting information into batches, work with the context and take into consideration the level of treatment (Shiffrin, 2003).

Cutting into batches is a process whereby the items to be recalled can be reconstituted by combining them. The context enables better recalling of retained information when the learning context and the questioning context are the same (Godden & Baddeley, 1975). The experiments conducted by Lockhart, R. S., & Craik, F. I. M. (1990) demonstrate that the higher the treatment level (associating a word with other various concepts) at the time of encoding, the more efficient the storage becomes.

On the contrary, distractions between the time when the information to be retained is presented and the time when it must be recalled, decrease the recall capacity. After 3 seconds, memory loss begins and after 18 seconds, it is total. Therefore, MCT weakens as time passes (Peterson & Peterson, 1959).

The study

We compared the memorization performances for a group of 19 students at Bachelor level, when using hard paper and a smartwatch, the Apple Watch. We chose this type of connected device, because it enables the display of small amounts of data, rapidly and with no other manipulation than just taking a glance at the watch.

We asked the participants to learn by heart the capitals of little known countries. This type of data was selected to decrease the possibility that participants might already know the data.

We opted for a qualitative study in order to be able to lead an open discussion with the students participating in the experiment. Moreover, as this audience rarely owns a smartwatch, we had to provide the necessary material, also impeding a large scale approach.

In this study, the sample includes19 students, 10 women and 9 men, 6 of them attend the School of Economics and Services, 6 the Social Work, 4 the Engineering and 3 the Healthcare. The average age was 23 years old.

Each student learnt a batch of 15 capitals[1] provided on hard-paper format, then a different batch provided on the watch. The data on paper used the same ratio font/size than the display on the watch. 2/19 already owned a smartwatch (not used in the experiment).

Basing our study on existing research about memory and rote learning, we limited the amount of data to be memorized at a time, to 3 pairs of capitals (memory span), planned two learning sequences (repetition) to facilitate memorization. We interrupted the learning process with a short discussion to somehow “empty” MCT of any data, not integrated yet but still available.

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[1] Paper :

Armenia (Yerevan)	Azerbaijan (Baku)	Bahrain (Manama)	Bangladesh (Deccan)	Belize (Belmopan)	Botswana (Gaborone)	Eritrea (Asmara)	Estonia (Tallinn)	Fiji (Suva)	Ghana (Accra)

Watch :

Honduras (Tegucigalpa)	Kazakhstan (Astana)	Madagascar (Antananarivo)	Oman (Muscat)	Yemen (Sanaa)	Zambia (Lusaka)	Zimbabwe (Harare)	Latvia (Riga)	Nigeria (Abuja)	Jordan (Amman)

An oral exam involving the investigator and the participant consisted in testing recalling of 10 out of the 15 capitals which were memorized. The second sequence, on the smartwatch used the same questioning protocol.

Description of the experiment

Session 1: on paper :

We randomly distributed15 files by the participant who has 5 sec. to memorize three pairs of country/capital. He repeats the operation 5 times. A 30 second discussion on a topic with no connection with the experiment takes place between the student and the investigator. Once all the 15 pairs of country/capital were dealt with, an approximately 1-minute discussion takes place between the student and the investigator. The investigator then shuffles the files and the whole operation is repeated a second time. When the participant revised all the pairs of country/capital twice, an oral exam takes place.

Session 2: on the smartwatch :

The student wears the Apple Watch, on which he receives a notification with 3 pairs of country/capital. He is given 5 seconds to learn each country/capital displayed on the Apple Watch. A 30 second discussion takes place between the student and the investigator. The operation is repeated 5 times. Once all the 15 pairs of country/capital were dealt with, an approximately 1-minute discussion takes place between the student and the investigator. When the participant revised all the pairs of country/capital twice, an oral exam takes place.

Between two sessions, resetting the watch takes about two minutes.

Description of the application

Connected to the smartphone via a Bluetooth connection and the notification configuration, the application displays pair words in batches of 3. A web application enables content modification of these pairs.

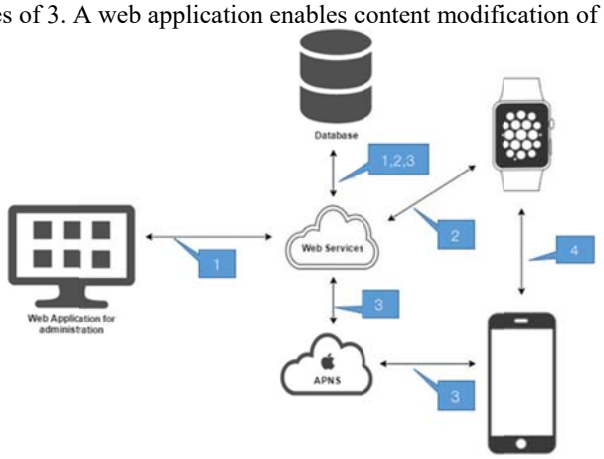

Figure 1 : Architecture of the e-memento application

- **1:** An administrator adds, edits or deletes a topic / question on the Web Application. The data is stored in the database via web services,
- **2:** The user configures his profile in the Apple Watch (chooses a time slot to receive notifications). The profile is saved in the database via web services. Once the profile set, Apple Watch will retrieve data from the user's profile in the database via web services,
- **3:** The user's iPhone searches the notification ID in the Apple Push Notification Server and saves it to the database via web services. Once the identifier stored in the database, a cron web service will push notifications on the smartphone each time a slot is specified by the user,
- **4:** As iPhone and Apple Watch are synchronized, notifications are displayed directly on the Apple Watch.

The visual output or data display of this application was intentionally made simple.

	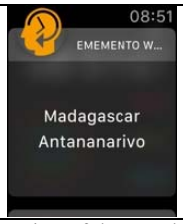	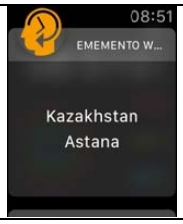	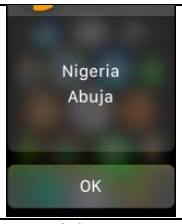
Apple smartwatch	Vibration of the watch to indicate that the first data batch must be memorized	After 5 sec, a new word pair is displayed	The participant presses the OK to end the session

Figure 2 : Smartwatch application screenshots

Findings

- Results on Paper :

All students recalled at least one capital. Results show that 2/19 students recalled one, 7/19 recalled 2, 1/19 recalled 3, 3/19 students recalled 4, 2/19 recalled 5 capitals, 1/19 recalled 6, 2/19 students recalled 7 pairs, 0/19 recalled eight data items, 1/19 student recalled 9 capitals out of 10 and none recalled 10 capitals.

On average, the participants recalled **3.68/10** capitals. All students recalled one capital, namely Suva, the capital of the Fijis. In Switzerland, this word corresponds to a very famous acronym, the SUVA, who is an insurance firm, very active and well-known in the public sector providing healthcare coverage for employees in case of accidents. It seems very likely that this association was called upon in the process of data recalling, which has increased the score on the paper device.

- Results on Watch :

We found that 4/19 students recalled no capital at all, 4/19 recalled 1, 4/19 recalled 2, 4/19 recalled 3, 0/19 recalled 4, 1/19 student recalled 5 capitals, 2/19 recalled 7, 0/19 recalled 8, 9 and 10 capitals.

On average, the participants recalled **2.26/10** capitals. The student who recalled 9 capitals when using the paper format, recalled 7 using the watch; the student with the best score, recalled 7 on both exams, regardless of the provided format.

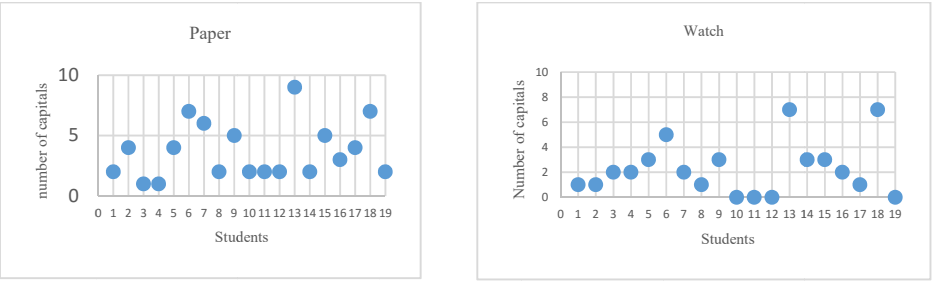

Figure 3 : Paper vs Watch examination – dispersal

As can be seen on the graph above, the results for learning on hard-paper are more scattered over the graph than those on the watch, which are globally more concentrated, although lower.

Feedback from students

We asked students for their interpretation to understand this result. To the question « *Which was your favorite learning device?* », 10/19 answer the paper one, 7/19 preferred the watch and 2/19 had no preference. We asked them to present their arguments in favor of each format. The paper format generates the following answers: 8/19 mention the fact that using paper is a habit, 7/19 feel that touching and manipulating hard-paper positively impacts their learning, 3/19 think that paper is more interactive than the watch, which merely displays data, 1/19 appreciates being able to create his own paper scraps for learning, 1/19 felt he lacked concentration using the watch, 1/19 finds the watch too narrow for reading it well, and 1/19 does not like technology.

The watch device generates the following answers : 5/19 appreciate the watch, because you wear it and so it is transportable and always at hand, 4/19 point out the motivation for using an innovative tool, 3/19 appreciate the notification system embedded in the watch, encouraging their learning, 1/19 appreciates not having to make his own learning card sets, 1/19 finds the system simple and easy to use without effort, 1/19 thinks the watch helps his concentration and 1/19 believes the widened range of the reception context (at a café, on the train, etc.) better anchors his learning.

To the question « *Do you believe you learnt better using the paper format or the watch device?* », 10/19 students believe to have performed better with the paper format, 3/19 with the watch and 7/19 claim to be indifferent to the type of format. 8/19 of those in favor of paper estimate that paper sets their mind to learning, 4/19 estimate that touching and manipulating paper helps the learning process, 1/19 finds the gesture to use the watch (to validate the data batch to be read) incompatible with learning, and 5/19 feel they lack concentration when using the watch. Finally, we note that 1/19 estimates the notification system on the watch too intrusive. On the contrary, 2/19 of the students in favor of the watch, estimate their concentration increases with the watch, 1/19 finds the system simple, rapid and effortless to use, 1/19 appreciates the notification system forcing focus on the watch, 1/19 appreciates innovation and 1/19 finds the system interactive. About learning formats, 5/19 of the students indicating to have no preference, claim that learning depends on coincidence (displaying a favorable country/capital pair) and not on the learning device. We noticed that 1/19 who believes that either watch or paper rally in the same way, so both formats can be considered as similar.

We wanted to find out *which format required the highest concentration effort*. The answers repartition is so: 10/19 has chosen paper, 5/19 the watch and 4/19 believe the concentration rate to be identical on both formats. The reasons mentioned in favor of the watch entail its novelty and the small screen size, while those in favor of paper list the need to show initiative in the learning method (cards, hidden question items etc.) and self-motivation.

In spite of the results collected in favor of data provided on hard-print paper, when asked the question « *Do you see a potential learning tool in the watch ?* », 16/19 replied yes, while 3/19 replied no. The possible reasons may lie in its availability (8/19), the notification system (7/19), the possible complement to paper (2/19) and the innovative aspect of technology (2/19). The counter arguments mention the watch as a « gadget » (2/19), as a distraction induced by technology (2/19). One person points out that the watch adds nothing more than what a smartphone already does.

We asked students to assess if *the smartwatch could help in sustaining memorization*. 15/19 think yes, while 4/19 answer negatively. Feedbacks show that 12/19 highlight the notification system which encourages learning, 3/19 think that the repetition feature induced by the watch is interesting, 1/19 points out that paper is a boring device. The other answers match those of the previous question.

At the end of the experiment, 1/19 wishes to buy a smartwatch. The reasons mentioned by the other participants for not purchasing such an item range from lack of utility (15/19), the over-estimated price of the item (2/19), to the wish for not overusing technology on top of already existing technology (1/19).

We note that the students' impressions match the facts: memorization is achieved more effectively when using paper devices. The reasons mentioned point towards two interesting elements: the close relationship with the device and how it symbolizes learning. Individual self-will is mentioned in more than 20 inputs.

Conclusion

We observe that the hard-paper format leads to better results compared with the use of the watch. Using paper, students retain more than a third of the proposed data, while a little less than the fifth is retained when the watch is used as the learning format. Although a small sized sample was taken into consideration here, this result is coherent with other research in this field. Some studies demonstrate how certain cognitive functions are more positively impacted by the use of a paper format, while others point out an equivalence. Niccoli (2015) conducted an experiment with 230 students, to analyze differences in recalling and comprehension between readers using tablet and paper. Randomly assigned, students read an article on leadership, either on digital format (n=119) or paper format (n=112). Readers using paper hit higher scores than readers using tablets, and showed a higher percentage of comprehension.

Dillon (1994)) suggested that reading was some 20 to 30% slower (in terms of proof-reading performance) from a computer screen than from paper. The watch presents other characteristics than the displays available at that time (flexible OLED display, font sf-compact), which suggests there might be a difference in the reading speed. However, although the data displayed on the watch is not voluminous, reading seems harder to perform on a small sized screen (4 :5=0.80).

Could the novelty of the smartwatch have influenced learning? We note that the positive impact of novelty on learning was identified in a number of studies, whether related to content, form (Von Restorff effect (Kohler & Restorff, 1933)) or context. Houillon, A., Lorentz, Boehmer, W. Rapp, M. A, Heinz, A., Gallinat, J. Obermayer K. (2013), demonstrated that novelty by itself enhances behavioral responses underlying reward processing, but also that novelty has a direct influence on reward-dependent learning processes, consistent with computational predictions. The effect of novelty can therefore, in theory, affect our study, even if the results suggest the opposite.

Research directions

This study aimed at assessing the impact of using a hard-paper format and using an innovative format (smartwatch), when performing rote learning. The results show lower performances when a smartwatch is used to memorize data, compared with the use of hard-paper.

On the contrary, the format seems to impact affective characteristics of the learning process, which explains that, although the scores were lower when using a smartwatch, and the fact that students adopted this format with less enthusiasm, they nevertheless saw it as efficient tool, improving the learning process, as for other similar objects than the one used in this experiment. A bias might actually have occurred, because students tested both formats one after the other. It is possible that the order in which the learning device was provided influenced the results, even though we tried to neutralize this bias by providing two different sets of similar data, but with different content for each format and proposed in a different order (paper-watch and watch-paper).

The immediate reach of an innovative device on rote learning remains to be demonstrated in a wider study. Moreover, a lead for future research consists in assessing if memorization improves or decreases over time with one or the other device, when the students create and use their own learning cards, on both types of devices.

We intend to conduct new sets of experiments, with other kind of innovative devices, such as virtual reality helmets, to measure their effect on rote learning, in assessing the importance of places in the memorization process (the loci method)[2].

References

Abernot, Y., Audran, J. & Penso, E. (2011). L'apprentissage par coeur, au-delà de la polémique. *Cahiers du CERFEE*, 30, 119-139.

Anderson, L.W., Krathwohl, D. R., Airasian, P.W., Cruikshank, K.A., Mayer, R.E., Pintrich, P.R., Raths, J. & Wittrock. M.C. (2001). *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*. Boston: Pearson Allyn and Bacon Education Group.

Chesebro, J.L. & McCroskey, J.C. (2000). The relationship between students' reports of learning and their actual recall of lecture material: a validity test. *Communication Education,* 49(3), 297–301.

Connell, C., Baliss, L. & Farmer, W. (2012). Effects of e-book readers and tablets computers on reading comprehension. *International Journal of Instructional Media*, 39(2), 131–140.

Dillon, A. (1994). *Designing usable electronic text: Ergonomic aspects of human information usage*. London: Taylor & Francis.

Godden, D.R., & Baddeley, A.D. (1975). Context-dependent memory in two natural environments: On land and under water. *British Journal of Psychology*, 66, 99–104.

Hendrix, J. & Joplin, J. (1968). Les trois mémoires du cerveau: une théorie. New York: Wood & Stock Press.

Hilgard, E.R. & Bower, G.H. (1975). *Theories of learning*. Englewood Cliffs: Prentice Hall.

Houillon, A., Lorenz, R.C., Boehmer, W., Rapp, M.A., Heinz, A., Gallinat, J. & Obermayer, K. (2013). The effect of novelty on reinforcement learning. In Chandrasekhar Pammi Narayanan Srinivasan, V.S (Ed.), Progress in Brain Research (pp. 415-439). Amsterdam: The Netherlands.

http://web.mit.edu/jrankin/www/teach_transfer/rote_v_meaning.pdf

Jeong, H. (2012). A comparison of the influence of electronic books and paper books on reading comprehension, eye fatigue, and perception, *The Electronic Library*, 30(3), 390–408. http://dx.doi.org/10.1108/02640471211241663

Natsuko H.N. (2012). *Library of Michigan, Demographic Data on Textbooks and Usage Statistics*: *Implications for Textbook Cost-saving Analysis*, [Slide Powerpoint]. Retrieved from http://www.lib.umich.edu/files/Cost-Analysis-Student-Survey.pdf

Lockhart, R.S. & Craik, F.I.M. (1990). Levels of processing: A retrospective commentary on a framework for memory research. *Canadian Journal of Psychology,* 44(1), 87-112.

[2] The location method is a means for retaining the order of a list of names or objects – or, for orators, to remember the various parts of a long speech – by associating a series of locations well-known to the orator.

Maulini, O. (2016). Que penser… de l'apprentissage par cœur à l'école ? Retrieved from http://www.unige.ch/fapse/SSE/teachers/maulini/publ-1614.pdf
Mayer, R. E. (2002). Rote Versus Meaningful Learning. *Theory into practice*, 41(4), 226-232.
Murray, M., & Pérez, J. (2011). E-textbooks are coming: are we ready? *Issues in Informing Science & Information Technology*, 8, 49–60.
Niccoli, A. (2015) Paper or tablet, reading, recall and comprehension. *EducauseReview*. Retrieved from http://er.educause.edu/articles/2015/9/paper-or-tablet-reading-recall-and-comprehension
Niccoli, A.M. (2015). The Effects of Reading Mode on Recall and Comprehension. *NERA Conference Proceedings 2014*, 2.
Peterson, L.R. & Peterson, M.J. (1959). Short-term retention of individual verbal items. *Journal of Experimental Psychology*, 58, 193-198.
Rockinson- Szapkiw, A. J., Courduff, J., Carter, K., & Bennett, D. (2013). Electronic versus traditional print textbooks: A comparison study on the influence of university students' learning. *Computers & Education,* 63, 259–266.
Salamin, A. D. (2014). *Using Google Glass to enrich printed textbooks in a blended learning environment to fulfill digital natives expectations*. Association for the Advancement of Computing in Education (AACE).
Shiffrin, R.M. (2003). Modeling memory and perception. *Cognitive science*, 27(3), 341-378.
Smith, S. D., & Caruso, J. B. (2010). The ECAR study of undergraduate students and information technology. Retrieved from https://net.educause.edu/ir/library/pdf/ERS1006/RS/ERS1006W.pdf
Kohler, W and v. Restorff. H. (1933). On the effect of field formations in the trace field. Analysis of processes in the trace field. *Psychologische Forschung*, 18, 299-342.
Wertsch, J. (1990). *The voice of rationality in a sociocultural approach to mind*. In Moll L.C. (Ed.) *Vygotsky and Education: Instructional implications and applications of sociohistorical psychology* (pp.111-126). Cambridge: Cambridge University.
Yonker, E. & Cummins-Sebree, S. (2009). To read or not to read: How student characteristics relate to textbook reading. *AURCO Journal*, 15, 163-172.