Measuring Effects of Reflection on Learning: A Physiological Study

Abstract. As an economical and feasible intervention, reflection demands learners using critical thinking to examine presented information, questioning its validity, and drawing conclusions based on the resulting ideas. The aim of this study is to gain insight into the effects of practicing short, frequent and structured reflective breaks interspersed with the reading process of learning material. The study tries to reveal whether physiological signals can be used as appropriate indicators to study the actual changes of cognitive states while introducing reflection during learning. The recorded physiological signals in this study include skin temperature, blood volume pulse, pulse volume amplitude, and pulse rate. The results show that while these embedded reflection rituals do not affect performance, they have significantly impact on time on task, perceived learning and some learners' physiological (cognitive) states. Physiological data returned significant differences between reading and reflection activity. Temperature and pulse rate are lower when covering the course equipped with additional reflection affordances while blood volume pulse and pulse volume amplitude are higher. In addition, applying statistics analysis to physiological data exhumes significant differences between different types of reflection activities for skin temperature, pulse volume amplitude and pulse measurements.

Keywords: reflective break, physiological signals, learning, online

1 Introduction

Educating the knowledge workers of tomorrow demands to simultaneously foster the mastery of domain content and the development of transversal (domain-independent) skills. The latter empowers individuals to cope with requests for new knowledge acquisition and ongoing personal development. For providers of initial instruction, this responsibility to prepare students to be mindful, engaged and responsible learners in a lifelong learning society is not a trivial one. It implies finding ways to help students to learn how to become expert students [1, 2] or to act as reflective practitioners [3] in their daily duties as learners already. Game based learning (GBL) makes good uses of competitive mechanism that pits the learners against each other or provides challenging for learners in order to motivate them to learn better. Reflection is a mental process applied to the process of learning that challenges learners. As an economical and feasible intervention, reflection demands learners using critical thinking to examine presented information, questioning its validity, and drawing conclusions based on the resulting ideas. This paper probes two research topics in GBL: the effectiveness

of physiological signals as indicators to measure and monitoring the cognitive state during reflection and non-reflection period and the potential of tidy frequent and structured reflective breaks interspersed with the reading process of learning material to advance such a student professional development.

2 Related Work

Physiological Signals and Learning Student workload or stress caused by that has commonly been recognized as an important variable in designing and proposing learning techniques. Scales or items referring to workload are often used to evaluate the quality of learning and teaching. Mental workload can be affected by numerous factors that make it difficult to have definitive measurement . The major reason for measuring workload is to quantify the mental cost of performing learning tasks in order to predict learner performance. Psychophysiological measurements may be especially valuable when subjective methods or performance measures become insensitive. In the past, physiological measurements often required cumbersome, invasive equipment, which is unsuitable for most applied settings. This has changed dramatically recently because advances in technology have made the equipment much more portable and capable.

Physiological signals have been used by researchers as indicators of mental workload and stress [5, 4]. Psychologists use physiological measurements as special identifiers of human emotions such as anger, nervousness, and sadness [6]. However, physiological data have not been employed widely to identify learners' experience states, such as engagement and reflection. Based on previous research on using psychophysiological techniques, it is believed that capturing and measuring autonomic nervous system (ANS) activity directly will provide researchers and developers of learning technologies with access to the experience of the learner. Integrated with other evaluation methods (e.g. subject reports and video analysis), a complex, detailed account of both conscious and subconscious learning experience could be formed. Even though there are few researches on using physiological signals as an indicator of reflection activity during learning, it has been used in other domains as a metric of evaluation.

Reflective breaks John Dewey has stated, "We do not learn from experiencewe learn from reflecting on experience." [7] Reflective breaks have received attention from research when applied to face-to-face lectures [8, 10, 9]. Despite the availability of theoretical models of reflection [11–13] and a clear drift towards the promotion of thinking skills [14–16], finding practical means to introduce learners to the reflective habits remains a challenge for researchers [17, 18]and practitioners [19, 20].

3 Experiment Design

3.1 Research Questions

In this comparative study, an online course was delivered at 2 different conditions: with and without reflective breaks (RBs). In addition, records of physiological data were performed with some students in both conditions. The intervention variable was the exposure to RBs. The dependent variables were performance (score at the final test), time spent in the course, accounts of learning experience (open and closed questions) and physiological changes and processes. Two research questions guided the experiment.

A. Question one We assume that the biofeedback measurement can bring extra information about possible contrasts between distinct activities performed within the learning process. Therefore, the first question was whether the absence/presence of reflection amplifiers impacts upon the physiological measurements of the control/treatment group. Reflection amplifiers refer to deliberate prompting approaches offering learners brief episodes of thinking while studying [21].

B. Question two In this study, we incorporate three types of reflection breaks to establish learning as an object of attention and reflection and, so doing, to introduce students to essential components of academic literacy:

- questioning: previous research highlight the importance of encouraging students to generate questions about the study material [22, 23, 26]. In this study, students deliberately and systematically exerted a questioning strategy called student set the test.
- evoking: an evocation brings or recalls to the conscious mind what has been previously read. Conceptual works of the "mind management" theory [24, 25] suggest that this process of mental imaging allows readers to somehow transform what they have read into a mental object [27, 28] and so doing to anchor it in their mind.
- self-assessing: research show that self-assessment can lead to significant enhancements in learning [29] by developing students habit to evaluate the strengths and weaknesses in their own study.

Therefore, the second question was that whether or not physiological parameters differ between various reflection periods.

3.2 Method and Materials

Sample The sample population consisted of secondary-school students physically present in computer rooms during the experiment. In that sense, the context of this study was close to regular schooling practice. It sought to provide more stable experimental conditions, more homogeneity in the sample and a contrast regarding the target audience of the reflective breaks.

Fig. 1. The page design bundles content (purple frame) and affordances to develop thinking habits: reflective breaks (light green) and learning dashboard (dark green).

Course The online course designed for this experiment was a shortened version (1H) of the 4-hour online course Seks en de evolutie (Sex and the evolution) created [30] and offered in Dutch by the Open University of the Netherlands. The course covered non trivial and interrelated notions and mechanisms as defined by Darwin and his followers: reproductive value, paternity uncertainty, mating strategies, differential investment in parenthood, etc. The course invited learners to use this theory as an interpretation grid of gender-related aviours observable in everyday life. The course was made of 5 chapters of 5 pages each, which contained about 200 words and one or two illustrations (Fig. 1). In order not to bias the use of the different reflective breaks (see next section) by uneven levels of difficulty in the content, special attention was paid to ensure equivalence between all chapters. Each of them underwent the Flesch reading ease test [31] which returned an average comprehension difficulty level of 52 (SD = 4) which is comparable to the level of the Time news magazine. A systematic concept mapping procedure of each chapter additionally ensured that they presented an even level of complexity regarding the number of new concepts introduced.

Reflection break design The study exposed participants to 3 types of RBs: questioning, evoking and self-assessing. To support and condense the reflective processes of questioning, evocating and self-assessing (pedagogical rationale in the next section), 3 miniature Web applications (called portlets on the Liferay platform) were developed (Fig. 2). They displayed, in a clear and identified graphical style, a single interaction point with the structured reflective rituals to apply on the first-order activity (studying the content of the page).

- questioning: The Question break portlet offered a note-taking tool where the students wrote down their questions (Fig. 2a).
- evoking: The Evocation break portlet combined a I start the evocation button and a I stop the evocation button (Fig. 2b).
- self-assessing: The Self-assessment break portlet presented as a 5-star visual scale (Fig. 2c) that the students used to indicate their current level of mastery

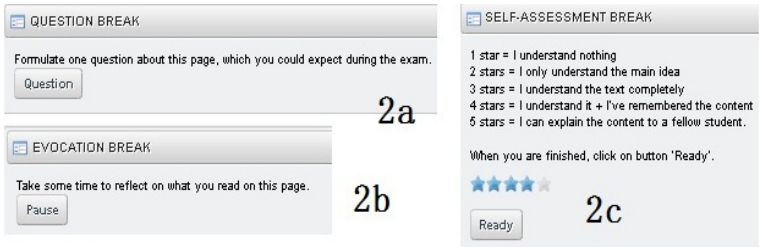

Fig. 2. The reflection portlets: question (2a), evocation (2b), self-assessment (2c).

of a defined portion of content (for each level a standardized explanation was given).

The treatment group studied chapter 1 just like the control group: without any reflective break. This arrangement opened to participants a possibility of contrast within the learning experience and provided an internal yardstick to the chapters studied with support tools. In chapters 2-3-4, students got acquainted with one reflective technique (see the combination chapter/type of reflective pause in (Table 1). In chapter 5, all techniques were available. Based on their experience in the previous chapters, students could decide which one to use after each visited page. The students had to deliberately practise the offered

Table 1. Compact view of the course chapters with offered reflective breaks

Course chapter	Question breaks	Evocation breaks	Self-assessment breaks
1	-	-	-
2	Yes	-	-
3	-	Yes	-
4	-	-	Yes
5	Yes	Yes	Yes

RBs after each page visited or re-visited. In order to consolidate this systematic reflective approach of the course content, a learning dashboard (Fig. 3) was set up. It contained a built-in reminder of the importance to practice the reflective breaks. A colour scheme indicated whether or not the number of (re-)visited page matched the number of use of the RBs. In case of match, the number appeared in green and in case of discrepancy in red.

Fig. 3. The learning dashboard for chapter 4. In green, the number 4 mirrors that the student practised self-assessment each time he/she visited a page of this chapter.

3.3 Physiological measures

Physiological data was collected with the appliance Biofeedback 2000 x-pert from SCHUHFRIED (Fig. 4). This non-invasive biofeedback system (Fig. 4) recorded the following physiological signals: a) skin temperature (TEMP), b) blood volume pulse, viz. the pulse component of the surface blood flow (BVP), c) pulse volume amplitude, viz. the amplitude of the blood volume pulse (PVA), and pulse rate (PR). The sampling pace was one measure every 25 milliseconds (Fig. 5). The learning sessions of the students were also screen-recorded with the software Camtasia in order to grab supplementary information about the sequencing of reading and reflecting periods.

Fig. 4. During the experiment, the module is fastened with Velcro strap to the index finger of the non-dominant hand.

3.4 Procedure

Taken prior to the course study, the background questionnaire evaluated the students pre-knowledge of the course topic with 6 multiple-choice questions. Meta-cognitive ability was assessed for each student by their teacher on a 3-item Likert scale. After a pre-test, participants individually studied in one version of the course (with or without reflection breaks) according to a random distribution. Study time was not strictly constrained. Both groups were evenly invited to practice a thoughtful study freed from time pressure in order to gain as much mastery as possible of the learning material. The tracked data was the time in the course (total and per chapter), the number of pages visited (total and per chapter) and the number of time a reflective break was used. The logs also stored

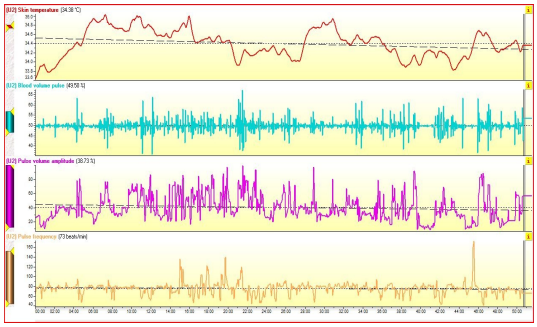

Fig. 5. Visualisation of the 4 measured physiological signals for one subject (treatment condition).

the choices made by learners in chapter 5 regarding the reflective breaks. After the course completion, students filled in a post-test. This questionnaire gathered:

- a) evaluative feed-back: open and closed questions collected students perceptions of overall satisfaction, sense of control, feeling of learning. Questions relating to the instructional intervention were added for the participants to the treatment group.
- b) performance measures: a test assessed the knowledge and comprehension. Ten multiple choice questions were selected among a pool of questions tested by 137 students in a previous experiment based on the same study material. The discrimination index was of .67 in average. For this index, values above 0.4 are desirable [32], which located the test at a medium-high level of difficulty. Three open questions asked students to comment pictures with what they learnt in the course. This was consistent with the design of the course that displayed carefully selected pictures on each page.

A follow-up questionnaire was administered one month after the experiment in an attempt to evaluate possible persistent effects. The follow-up questionnaire asked students to give to an imaginary friend who ought to take the same course some advice regarding 8 study strategies, including the 3 reflective breaks. The perceived relevance of the strategies was rated with sliders on 100-point scales, an asset available on the survey software Qualtrix.

Participants received a 15 euro iTunes voucher for their participation and were debriefed before leaving. The physiological measures were collected in a separate setting with two additional volunteers covered the course with the reflection amplifiers first, and then the version of the course without the reflection amplifiers. This setting was favoured for a practical reason (only one device was available for this study) and methodological reason (repeated measures allowed to control individual variations).

4 Results

The experiment convened 42 subjects at the same time. The data sources for this study were the returns from the questionnaires (pre, post, follow-up), the logging data and the physiological measures. Students who missed either the pre or the post questionnaire were removed from the analysis. It was the case for 2 participants in the treatment group. 40 test persons (mean age = 17 years old, 37% female, 63% male) composed the final sample: 21 participants in condition 1 (control) and 19 in condition 2 (reflective breaks).

4.1 Physiological data

Physiological data was collected from 4 students (2 at the control group without reflection breaks and 2 at the treatment group with reflection breaks) because limited amount of physiological sensors are available. T-tests were conducted on 130773 paired sampled measures to compare TEMP, BVP, PVA and PR in the with reflection breaks and without reflection breaks conditions. This returned significant differences for the 4 physiological signals (Table 2). Temperature and pulse rate are lower when covering the course equipped with additional reflection affordances while blood volume pulse and pulse volume amplitude are higher. The accuracy of the measure is acceptable (the observed difference in temperature is far above the variations that could be imputed to the recording system (0.01C) and the other measures embed compensations for interference and automatic averaging of data at baseline).

Table 2. Results for the physiological signals in with/without reflection amplifiers condition between the control and treatment groups)

Results	**Mean**	**SD**	
TEMP with	33.65	1.05	$p< 0.02$
TEMP without	30.98	3.12	
BVP with	49.37	12.35	$p<0.02$
BVP without	49.52	13.04	
PVA with	31.18	19.57	$p<0.02$
PVA without	34.53	24.8	
PR with	68.69	12.74	$p<0.02$
PR without	60.11	12.85	

In order to refine the analyses, the screen recordings of the learning session from the subjects in the treatment group were analysed to identify reading versus reflection periods. According to this timing information, the sampled physioloical measures matching respectively each category were put together. Applying One-Way ANOVA also exhumed significant differences ($p<.0005$) for

the 4 physiological signals but with a slightly different pattern: in the periods of structured reflection (use of the reflection amplifiers), temperature, PR and PVA are higher while BVP is lower (Table 2). Following the same process, the sampled measures corresponding to the periods of use of the different types of reflection amplifiers were contrasted against each other and with the reading activity (Table 3). Applying One-Way ANOVA exhumed significant differences for three signals except BVP ($p < .002$).

Table 3. Mean and standard deviation for the physiological signals in different reflection amplifiers conditions)

Results	**reading**	**questioning**	**evoking**	**self-assessing**
TEMP (mean)	33.350	34.055	33.722	33.634
(SD)	1.193	0.590	0.717	0.641
BVP (mean)	49.334	49.441	49.389	49.503
(SD)	11.184	17.524	11.276	9.442
PVA (mean)	28.415	45.817	26.190	24.146
(SD)	17.928	25.509	15.747	11.702
PR (mean)	66.893	68.721	70.912	64.874
(SD)	11.553	17.096	12.383	8.562

4.2 Performance

Analysis of the performance scores for the multiple-choice questions revealed no significant differences between the control group ($X = 4.5$, $SD = 2.24$) and the treatment group ($X = 4.7$, $SD = 1.59$), $t(38) = .41$, $p = .67$, $d = .08$. A 3-level scoring rubric was used to control the quality of the answers to the open questions: trivial explanation of the picture - explanation invocating the correct Darwinian concept - explanation contextualizing the correct Darwinian concept in the overarching evolution theory. The treatment group ($X = 4.5$, $SD = 1.6$) did not perform differently from the control group either ($X = 3.7$, $SD = 1.7$), $t(38) = 1.54$, $p = .13$, $d = .05$.

4.3 Time on task

Total time on task (Fig. 6) was descriptively higher in the group prompted to reflect ($M = 52$ min, $SD = 9$ min) than in the group without prompting ($M = 26$ min, $SD = 12$ min), and the difference was significant, $t(38) = 7.46$, $p < .0001$, $d = 2.45$.

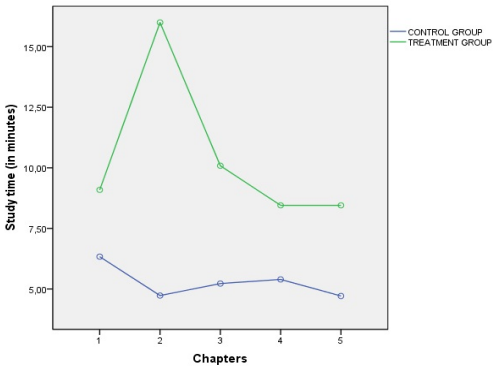

Fig. 6. Average time (in minutes) per chapter for the control and the treatment group

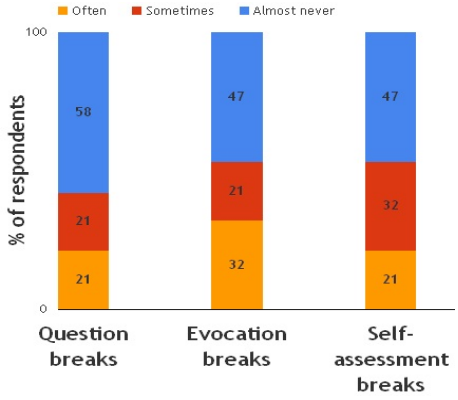

Fig. 7. Familiarity level with the reflective breaks prior to the experiment

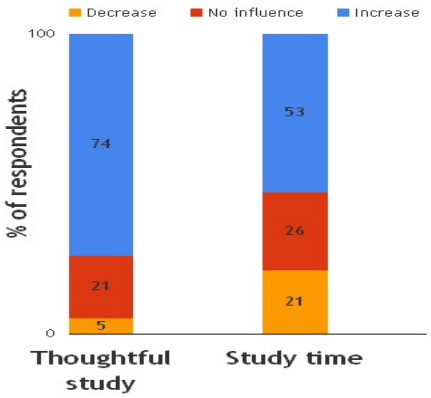

Fig. 8. Perceived contribution of the reflective breaks to study quality and time.

4.4 Feedback from learners

73% of the treatment group claimed that their learning experience in the course differed from usual against 61% in the control group (relative percentages). Results showed that each of the 3 reflective breaks was foreign to about half of the sample (Fig. 7). 16% of the respondents answered almost never for the 3 reflective techniques.

4.5 Perceived effect on time and mindfulness

The reflective breaks were rated by the students (Fig. 8)) on a 3-point Likert-type scale for their contribution to their study result and study time (1 = decreased the quality of my study/my study time, 2 = did not affect the quality of my study/my study time, 3 = increased the quality of my study time).

4.6 Follow-up questionnaire

The treatment group recommended more cheerfully (Mdn = 68/100) the use of the reflective break n1 (questions) than the control group (Mdn = 50/100). This is the only significant difference, U = 63, p = .03, r = .32 emerging from the 29 answers received. However, results showed a tendency for the treatment group to advise the 2 other practiced reflection breaks (evocation and self-assessment breaks) with a higher intensity. The 3 other strategies sustaining a thoughtful learning that were also suggested in the questionnaire (writing the keywords of the page, summarizing the page, taking enough time to understand in detail) were summed up and returned a slightly higher intensity of recommendation.

5 Discussions

In this study, we observed that physiological measurements differ between the conditions both at the global level of the course and when reading/reflection periods are contrasted. However, interpretation of these differences is difficult. It is not clear whether reflection is assimilated to some form of mediation, which can slow down some body activities. Or on the contrary, reflection reverberates as a form of stress [34] because of its compulsory (this is an assignment) or/ and perhaps unfamiliar character, which has effects on some physiological signals. Answering these questions goes beyond the scope of this study. It would require further interdisciplinary discussions combining pedagogical and psychophysiological expertise. However, the observed variations indeed bring extra information to the study of reflection in formal learning. So far, reflective activity attached to this context has usually been inferred from performance changes or claims of students (scales, open questions) or think-aloud protocols [35].

What we have learned here is that biofeedback measurements can be another dimension to the study of the phenomenon of reflection and learning. The findings of this study suggest that the cognitive states associated to different

learning activities may be detected and recognized from physiological parameters. For instance, the externally-imposed reflection remits seems to trigger internal answers traceable in physiological data. But, the findings related to the physiological measures in this paper must nevertheless be taken with prudence for the following reasons:

- a) they bear on four students only,
- b) 2 students covered both version of the course. Familiarity/boredom effects might have biased the results,
- c) the huge amount of sampled observations can partly cause the significance.

This study has demonstrated a physiological method that can be used to study the effects of reflection on learning. It calls for further investigation into the relationships between reflection and learning performance through physiological measures that would be carried out with larger samples and with contrasted audiences of low and high performers in order to confront the way they study and practice reflection to their respective physiological coherence.

6 Conclusion

This study explored the potentials of the reflective breaks. Reflective break means to induce regular mental tingling for evaluating ones own learning, nurturing internal feedback [36] and maintaining active commitment to the tasks at hand. The study reveals that physiological signals can be used as appropriate indicators to detect the actual changes of cognitive states while introducing reflection breaks during learning. The pattern of findings suggests that the benefit of a one-hour hand-on session with these reflective strategies is not to be found in an enhanced cognitive performance but in an increased awareness of and an intensified presence to the learning process itself. The study also points out the future challenges faced by researchers while studying reflective break with physiological signals.

References

1. Ertmer, P., & Newby, T. (1996). The expert learner: strategic, self-regulated, and reflective. Instructional Science, 24, 1-24.
2. Sternberg, R. J. (1998). Metacognition, abilities, and developing expertise: What makes an expert student? Instructional Science, 26(1), 127-140.
3. Schn, D. (1983). The Reflective Practitioner: How professionals think in action. London: Temple Smith.
4. Vicente, K.J., Thornton, D.C.& Moray, N. (1987). Spectral Analysis of Sinus Arrhythmia: A Measure of Mental Effort. Human Factors, 29(2): p. 171-182.
5. Wilson, G.M. (2001). Psychophysiological Indicators of the Impact of Media Quality on Users. In Proceedings of CHI 2001 Doctoral Consortium. Seattle, WA, USA.: ACM Press. p. 95-96.
6. Ekman, P., Levenson, R.W.& Friesen, W.V. (1983).Autonomic Nervous System Activity Distinguishes among Emotions. Science, 221(4616): p. 1208-1210.

7. Dewey, J. 1966. Democracy and Education: an introduction to the philosophy of education. Free Press, New York.
8. Di Vesta, F. J., & Smith, D. A. (1979). The pausing principle: Increasing the efficiency of memory for ongoing events. Contemporary Educational Psychology, 4(3), 288-296.
9. Ruhl, K. L., Hughes, C. A., & Schloss, P. J. (1987). Using the Pause Procedure to Enhance Lecture Recall. Teacher Education and Special Education: The Journal of the Teacher Education Division of the Council for Exceptional Children, 10(1), 14-18.
10. Simpson, W. (2004). The pause method in undergraduate auditing: An analysis of student assessments and relative effectiveness. In J. Ketz (Ed.), Advances in Accounting Education Teaching and Curriculum Innovations (Vol. 6, pp. 69-85): Emerald Group Publishing Limited.
11. Boud, D., Keogh, R., & Walker, D. (1985). Reflection, Turning Experience into Learning. London: Kogan Page.
12. Le Cornu, A. (2009). Meaning, Internalization, and Externalization. Adult Education Quarterly, 59(4), 279-297.
13. Moon, J. (1999). Reflection in Learning and Professional Development. London: Kogan Page.
14. EuropeanCommission. (2006). Proposal for a recommendation of the European Parliament and of the Council on key competences for lifelong learning. COM(2005)548 final. Brussels.
15. Romainville, M. (2007). Conscience, mtacognition, apprentissage : le cas des comptences mthodologiques [Consciousness, meta-cognition, learning: the case of the methodological skills]. In F. Pons & P.-A. Doudin (Eds.), La conscience chez l'enfant et chez l'lve [Consciousness in the child and in the student] (pp. 108-130). Qubec: Presses de l'Universit du Qubec.
16. Rychen, D. S., & Salganik, L. H. (2003). Key Competencies for a Successful Life and a Well-Functioning Society: Hogrefe Publishing
17. Claxton, G. (2006). Expanding the Capacity to Learn: A new end for education? University of Bristol. Claxton, G. (2006), Expanding the capacity to learn: a new end for education?, keynote speech, British Educational Research Association Annual Conference, University of Warwick, 6-9 September 2005.
18. Csap, B. (1999). Improving thinking through the content of teaching. In H. Hamers, J. van Luit & B. Csap (Eds.), Teaching and learning thinking skills (pp. 37-62). Lisse: Swets and Zeitlinger.
19. Jaschnik. (2011). Can students learn to learn. Inside Higher ED Retrieved June 1, 2012, from http://www.insidehighered.com/news/2011/01/31/colleges_try_to_use_metacognition_to_improve_student_learning
20. Joseph, N. (2003). Metacognitive awareness: investigating theory and practice Academic Exchange Quarterly Retrieved June 1, 2012, from http://findarticles.com/p/articles/mi_hb3325/is_4_7/ai_n29059143/
21. Verpoorten, D., Westera, W., & Specht, M. (2011). Reflection Amplifiers in Online Courses: A Classification Framework. Journal of Interactive Learning Research, 22(2), 167-190.
22. Logtenberg, A., van Boxtel, C.,& van Hout-Wolters, B. (2011). Stimulating Situational Interest and Student Questioning through Three Types of Historical Introductory Texts. European Journal of Psychology of Education, 26(2), 179-198.
23. Marbach-Ad, G., & Sokolove, P. G. (2000). Can undergraduate biology students learn to ask higher level questions? Journal of Research in Science Teaching, 37(8), 854-870.

24. Brown-Frossard, R. (2012). Memorization Isnt A Lot Of Hocus Pocus. The International TEYL (Teaching English to Young Learners) Journal Retrieved June 1, 2012, from http://www.teyl.org/article14.html
25. de La Garanderie, A. (1989). Dfense et illustration de l'introspection [Defense and illustration of introspection]: Le Centurion.
26. Pedrosa de Jesus, H.,& Moreira, A. C. (2009). The role of students questions in aligning teaching, learning and assessment: a case study from undergraduate sciences. Assessment & Evaluation in Higher Education, 34(2), 193-208.
27. Seel, N. M. (2001). Epistemology, situated cognition, and mental models: Like a bridge over troubled water. Instructional Science, 29(4), 403-427.
28. Vermersch, P. (2009). Describing the Practice of Introspection. Journal of Consciousness Studies, 16(10-12), 20-57.
29. Taras, M. (2002). Using Assessment for Learning and Learning from Assessment. Assessment & Evaluation in Higher Education, 27(6), 501-510.
30. Eshuis, J. H., & Goltstein, G. P. H. (2007). Seks en de evolutie. Retrieved 18-02, 2011, from http://www.ou.nl/eCache/DEF/2/22/850.html
31. Flesch, R. (1948). A new readability yardstick. The Journal of applied psychology, 32(3), 221-233.
32. McAlpine, M. (2002). A summary of methods of Item analysis. Bluepaper Number 2, University of Glasgow. ISBN 1-904020-02-X.
33. Thompson, C. (2009). Metacognitive Strategies of Teaching and Learning in Introductory Psychology Classes. Paper presented at the 3rd National Conference on Innovations in the Scholarship of Teaching and Learning at Liberal Arts Colleges.
34. McCraty, R., Atkinson, M., Tomasino, D., Goelitz, J., & Mayrovitz, H. (1999). The impact of an emotional self-management skills course on psychosocial functioning and autonomic recovery to stress in middle school children. Integrative Physiological and Behavioral Science, 34(4), 246-268.
35. Veenman, M., Van Hout-Wolters, B., & Afflerbach, P. (2006). Metacognition and learning: conceptual and methodological considerations. Metacognition and Learning, 1(1), 3-14.
36. Butler, D. L., & Winne, P. H. (1995). Feedback and self-regulated learning: A theoretical synthesis. Review of Educational Research Review, 65(245281).