Journal of Multidisciplinary Engineering Science and Technology (JMEST)
ISSN: 3159-0040
Vol. 2 Issue 11, November - 2015

Cognitive Load Implications of Social Media in Teaching and Learning

[1,2]Bosede Edwards [1]Baharuddin Aris Nurbiha Shukor
[1]Dept. of Educational Science, Mathematics & Creative Multimedia
Universiti Teknologi Malaysia
Skudai, Johor
[2]Dept. of Chemistry, School of Science
Osun State College of Education
Ilesa. Osun State. Nigeria

***Abstract*—Teaching and learning in the 21st century had taken advantage of technology to foster effective learning through multimedia education, active learning and improved classroom interaction. Social media have particularly helped in the area of content sharing and learner collaborations. Several schools in both developing and developed nations have incorporated social media as informal Learning Management Systems (LMSs). Reports also abound on the positive contributions of these media to teaching and learning. However, the capability of these media to derail learning due to the high cognitive load generated from the extraneous processing induced by their design have not been extensively studied. This paper discusses the place of social media as educational technology in terms of its ability to foster collaborative learning, classroom communication and improved learning. The challenges associated with its use are also discussed from cognitive load standpoint based on the nature of human cognitive architecture (HCA) and information processing. Implications for essential processing, effective processing and extraneous processing are discussed. The implications for teaching and learning are also highlighted.**

Keywords*— *social software; cognitive load; information processing; distraction; multitasking, collaborative learning, extraneous processing

I. INTRODUCTION

Effective learning must be focused on the generation of schemas; that is, single, large, extensive information chunks that are retrievable for use at any time and requiring no further processing [1], [2]. Effective teaching and learning techniques should therefore foster and support creation of schemas. Various techniques are constantly being explored in teaching and learning to achieve improved effectiveness. The common thread in these techniques being collaboration or team work, which, according to Educational Broadcasting Corporation (EBC), can help learners create meaningful learning experiences [3].

Students are able to engage in paced learning, individual differences are supported, and in many cases, personal as well as group credit accrues. Various methods are leveraged to foster collaborative learning; face-to-face and remote connections are possible depending on the learners and the learning situations as well as the resources available. In recent times, as the use of media and gadgets become commonplace, great advantage is being taken of the affordances of new media and gadgets for educational purposes. As a result, technology is continually invading the 21st century classroom. These changes, according to the submission of Higher Education Funding Council for England (HEFCE), are due to the fact that technology enhances learning and learners are enthusiastic about technology in education [4].

The Technology-Enhanced Learning (TEL) research of the United Kingdom also identified some benefits of technology in education to include its ability to support the learning of abstract concepts through the provision of visual systems that the learner can relate with. It can also enhance the productivity of both teachers and students through the use of software which cuts down the required effort, time and cost for some tasks [5]. Other technologies (e.g. artificial intelligence systems) have the ability to anticipate and meet user-needs.

II. TECHNOLOGY IN EDUCATION

A major stride of technology in education in the form of media is the use of social software. Classrooms across the world now employ these software that were originally meant for non-academic communication. The result has been found to be quite positive. These media offer a platform for learner-focused education by promoting social interaction and collaborative learning. They stimulate 'proactive and reactive participation' [6] in addition to providing a platform for content sharing. Facebook is particularly outstanding in its classroom invasion due to its design which affords a lot of applications for academic transactions.

Some of the factors that make Facebook a unique educational tool were identified by [6]

through comparison with a conventional LMS. They identified among other elements, the factors of student-focused ownership, creation, organization, management and sharing of content as well as synchronous interaction. They reported on several studies of Facebook as an academic tool and identified the advent of Facebook 'groups' as a major welcome development that was to redefine teacher-student communication.

III. FOCUS OF STUDY

The use of social software in education when viewed from its support for collaborative learning is tremendous. However, technology in education is not without its negative consequences. According to [7], the design of multimedia instruction uses two main approaches: the technology-centered and the learner-centered approaches. The focus of the learner-centered approach is the nature of human cognitive system. The three possible learning outcomes according to Mayer include: no learning (indicated by poor retention and poor transfer of learning), rote learning (typified by good retention but poor transfer) and meaningful learning (characterized by excellent retention as well as transfer). This is however dependent on the learner's cognitive activity during learning. One of the key issues of multimedia learning therefore focuses on the cognitive load implications.

Cognitive load refers to the mental demand placed on the information processing system for learning based on the nature, type and design of the learning material. Hence, this paper is focused on the assessment of the implications of social software in Education from cognitive load perspectives. It will highlight the implications for teaching and learning, retention and transfer as the ultimate goal of instruction. It will also make recommendations for addressing the identified challenges.

IV. SOCIAL MEDIA EDUCATION: POSITIVES

The use of social software in education affords several opportunities and advantages. Applications for in-class use as well as for out-of-class communication are extensive and have been explored by many teachers in institutions across the world. Some of the key affordances are discussed.

A. Collaborative Learning and Classroom Communication

Collaborative learning is greatly enhanced through the use of social software. Classroom communication and the sharing of content (graphics, video, animations, documents), links and many other educational materials are possible. Groups within a large class group can also collaborate separately and carry on private discussion among the few members. Such discussion can be labelled for easy reference or for a revisit by members.

Through Facebook groups, classroom communication is extended beyond the classroom. Sharing of content including documents and various multimedia materials are possible and out-of-class 'live' interactions are enabled by the asynchronous capabilities afforded by the platform. These groups afford various modes of connection and participants in a course or programme can learn together 'alone' in their course group without interferences from 'outside' the class. The teacher is also able to provide guidance, corrections and share useful materials with the learners. These software can be great assets in distance education settings.

B. Fostering Improved Learning

According to [8], various factors that support improved education include factors of collaborative learning (Fig 1). They submit that the identification of a clear purpose for the learning as well as the use of repetition is important for effective learning but also identified the creation of stories, break-times, enjoyment as well as the use of visuals among other things as important factors. These techniques work by supporting encoding of information which is fundamental to retention and learning. The techniques also underscore the importance of engagement and motivation in learning as factors that foster transfer and storage and the creation of schemas (Fig 1).

V. SOCIAL MEDIA IN EDUCATION: NEGATIVES

One of the key challenges of technology in education is multitasking or engagement with multiple media or gadgets. With the proliferation of media and gadgets came the need for individuals to attempt to do many things at the same time. This is necessarily a challenge to learning where there is an overriding need for focus or learner engagement.

A. Multitasking and Distraction

According to [9], 72 hours of video content alone goes online on YouTube every minute. This amounts to 12-year content per week, putting the normal person under the constant pressure to meet up with so much information. Hence, the need to continually multitask. This situation is described by [9] as the 'fear of missing out' or 'FOMO'. The effective 21st century person is thus often found trying to 'meet up' by multitasking. This is also carried on into the classroom. Multitasking is defined by [10] as the 'simultaneous execution of two or more processing activities'. It is a parallel processing function which [11] believe the members of the 'net' generation are enabled for by virtue of their relationship with technology.

However, many researchers [12],[13],[14],[15] opined humans are incapable of multitasking.

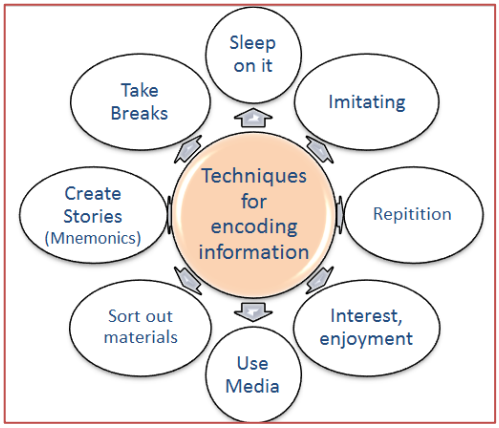

Fig 1. Techniques for Improving Education

This is in spite of the fact that supporters of multitasking believe it is the 'way to go' in the age of information and it is promoted by the business world and touted as the selling point for new tools, gadgets and media. Invariably, humans are expected to function the way these gadgets and tools would. There is however no denying the fact that multitasking constitutes a great source of distraction. [16] in his article, reported on a Havard study of distracted driving in America which identifies 2,600 annual deaths and 330,000 moderate and severe injury cases resulting from cell-phone distractions during driving alone. There is therefore reason to expect 'danger' to learning as well. Research actually attests to the detrimental effect of multitasking on the brain and personality [17] as well as the fact that 'distractions make learning harder' [18]

VI. SOCIAL MEDIA IN EDUCATION AND THE COGNITIVE LOAD EFFECTS

Information processing in the human memory system is influenced by the design of the HCA. This is because of the limitations of the working memory responsible for information processing. Cognitive resources are allocated in the HCA for the handling of cognitive load which have three components as identified. When social software is being used, the learner is exposed to multiple processing and distractions from sources including posts and comments, chats, uploads (multimedia, web links, etc.), notifications on the activities of other connected users and many other factors inherent in the design of the social software. The implications of social media in education viewed from cognitive load perspective are therefore discussed from information processing standpoints.

A. The Human Cognitive Architecture (HCA) and Information Processing

The HCA describes the nature, design and properties of the human memory system [19]. It describes the manner in which information is processed by humans as well as the limitations of the human memory system. The HCA provides a layout of the memory system as a 3-part structure (Fig. 2) composed of an external or physical sensory memory, a working memory that constitutes the seat of information processing [20], [21], [22] and a long term memory that is responsible for storage of processed information [23], [24].

The key significance of the HCA in education lies in the capacity of the working memory [20], [21], [22]. While the long term memory is unlimited in its capacity, the working memory is quite limited; able to process only a very small amount of information at a given time. As a result of this, when there is information overload, the processing demand may exceed the capacity of the working memory and the processing become ineffective, resulting in consequent loss of material.

Ref [7] identified the implications of cognitive load for essential processing, effective processing and extraneous processing. He discussed the need to employ cognitive load principles in the use of media and technology in education and provided insights on the means by which this might be achieved.

B. Cognitive Load and Information Processing

According to cognitive load theory [19], [20], [21], every learning material imposes a mental demand or cognitive load on the working memory. Total cognitive load (CL_t) have three components [23], [25] that are summative in nature. These are the intrinsic load (CL_{int}), the extraneous load (CL_{ext}) and the germane load (CL_{ger}). The three components are related such that,

$$CL_{int} + CL_{ext} + CL_{ger} = CL_t$$

This total capacity (CL_t) cannot be exceeded; hence an increase in one component can only cause a decrease in others or vice versa. The intrinsic load or CL_{int} is a property of the learning material and cannot be manipulated. CL_{ext} and CL_{ger} can however be manipulated. Though both CL_{ext} and CL_{ger} are functions of instructional design/presentation, CL_{ext} is undesirable because it constitutes a waste of cognitive resources and does not contribute to learning. It is occasioned by bad presentation of instruction, unnecessary materials or activities that are unrelated to or distracting from the learning tasks; this include multitasks and distractions.

1) Implications for essential processing

The learning material constitutes the intrinsic load. This load represents the mental demand inherent in and native to the learning material. It is the cognitive resource required to process the learning material. It is 'unalterable' and can only be managed in such a way that the learner is supported to achieve effective processing.

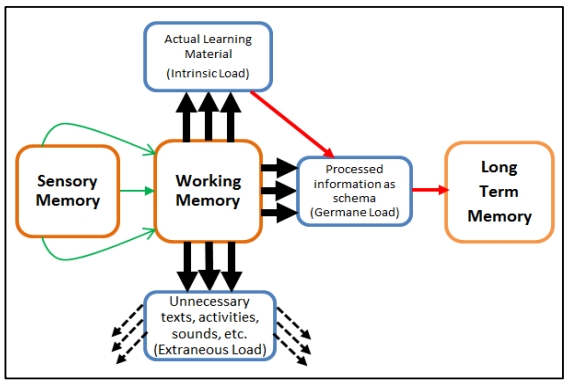

Fig. 2. Cognitive Load & Resource Allocation in the HCA

Mayer suggested the use of paced presentation for addressing this; that is, presentation of instruction in small sequential parts rather than as a whole chunk of heavy material. This will assist the learner in mastering content in a stepwise manner such that cognitive resources can be allocated according to the need of each part.

2) Implications for effective processing

Effective cognitive load or germane load (CL_{ger}) contributes positively to learning. It is invested in effective transfer and storage of fully processed materials. In other words, it is required for the formation of schemas. This refers to chunks of learnt materials that have been automated and needs no more processing but available for use whenever needed. Good instruction is therefore one that maximizes CL_{ger}. Cognitive load devoted to effective processing is cognitive resource effectively employed.

3) Implications for extraneous processing

When multitasking is viewed within the context of cognitive load theory, it can be understood that having to handle many tasks simultaneously demands a correspondingly huge working memory capacity that can easily become unaffordable for the memory system. This is extraneous processing and can result in ineffective learning. Materials capable of causing extraneous processing include unnecessary texts, graphics, sounds and other similar cognitive activities. They constitute the extraneous load, causing unnecessary processing, transfer losses and poor storage (reduced germane load) and a defeat of the ultimate goal of instruction.

Allocation of cognitive resources in the HCA is depicted in Fig 2. The green arrows depict information received in the sensory memory while the thick arrows represent cognitive resources allocated to intrinsic, germane and extraneous loads in the Working Memory. The red arrows represent fully processed information as schema passed into the long term memory for storage while the long broken arrows symbolize wasted cognitive resources devoted to extraneous processing which makes no contribution to learning but rather defeats transfer and storage.

4) Implications for Teaching and Learning

The implications of social software in education from cognitive load viewpoint can be summarized based on the operations of working memory and long term memory. When social media is employed in education, the design of the interface could constitute a source of multitasking and distraction to the learner. This imposes cognitive load on the working memory system as the extraneous processing competes for the consumption of cognitive resources. This can impose additional threat on concentration and engagement with learning, resulting in ineffective learning.

It is possible that extraneous processing may override the learning materials in the competition for cognitive resources due to the fact that they are less demanding on attention, more engaging and more motivating. This can jeopardize the entire learning process. Furthermore, the demands placed by this extraneous processing in addition to those legitimately placed by essential processing of actual learning material may exceed the working memory capacity. Failure of processing in the working memory will result in ineffective transfer and consequent ineffective storage, thereby jeopardizing the formation of schema and a compromise of the goal of education.

VII. CONCLUSION

Social software in education have great benefits as effective platforms for multimedia education, content sharing and collaborations. They can provide cost-effective platforms for collaborative and peer learning and academic communications at various levels and modes of education. The fact that they are designed primarily for social rather than academic communication must however not be lost on especially learners, teachers and designers of instruction. Efforts at using these software should be with cognizance to the cognitive load implications of their employment to achieve effectiveness. Instructional design employing social media should focus at minimizing cognitive load. Learners should understand the dangers of distractions during learning while teachers should take into account these factors during instructional presentation.

VIII. RECOMMENDATION

The use of social software should leverage on cognitive load principles as presented in the cognitive load theory. Principles that foster essential processing, effective processing and those that reduce extraneous processing should be employed for use with social software for education. Instructional methods that leverage on the increase of learner motivation and engagement with learning materials should also be employed

REFERENCES

[1] Recker, M. “Overview of Lev Vygotsky's Theory. Learning and Communication Theories in Instructional Technology”, 1996 Utah State Univ.
[2] McLeod, S. A. Jean Piaget. 2009 [Online] http://www.simplypsychology.org/piaget.html
[3] Educational Broadcasting Corporation, EBC. “Cooperative and collaborative learning”. Concept to Classroom Workshop. 2004.
[4] HEFCE (Higher Education Funding Council for England). Effective Practice in a Digital Age: A guide to technology-enhanced learning and teaching. JISC Innovation Group, 2009. University of Bristol.
[5] Technology-Enhanced Learning. “Does technology enhance learning? Some findings from UK’s Technology Enhanced Learning (TEL) Research Programme”, 2011. London: Knowledge Lab
[6] Meishar-Tal, H., Kurtz, G. and Pieterse E. Facebook Groups as LMS: A Case Study. The International Review of Research in Open and Distance Learning, 13, 2012 (4) 33-48
[7] Mayer, R. Multimedia Learning 2nd Ed., Cambridge, Cambridge University Press, 2009
[8] Ludescher, F., Rahbek, K., Jensen, I., Kumpulainen, K., Jackson, K. and Madrid D., et al. Brain-friendly Learning. Teachers Manual. Brain-friendly Accelerated Language Learning (BALL) Project of the Pädagogische Akademie Feldkirch (Austria), Jelling Seminarium (Denmark), University of Lapland (Finland), Universidad de Granada (Spain) and Kölcsey Ferenc Reformatus Tanitoképzö Föiskola in Debrecen (Hungary). [Online] http://www2.vobs.at/ball-online/main_menu.htm
[9] Nurun. Multitasking: Focus and Dispersion in the Age of FOMO. Our Thinking: Emerging Behaviour. 2013. [Online] http://www.nurun.com/en/our-thinking/emerging-behavior/multitasking-focus-and-dispersion-in-the-age-of-fomo/
[10] Kirschner, P. and Karpinski, A. (2010). “Facebook and academic performance”. Computers in Human Behavior, 26, (6), pp1237-1245, 2010.
[11] Prensky, M. Digital game-based learning. Computers in Entertainment (CIE), 1(1), 2003, pp21-21
[12] Bullen, M., Morgan, T. and Qayyum, A. Digital Learners in Higher Education: Looking Beyond Stereotypes. In T. Bastiaens & M. Ebner (Eds.), Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2011, pp678-687. Chesapeake, VA: AACE.
[13] Kennedy, G., Dalgarno, B., Gray, K., Judd, T., Waycott, J., Bennett, S., Maton, K., Krause, K., Bishop, A., Chang, R. & Churchward, A. The net generation are not big users of Web 2.0 technologies: Preliminary findings. In R. Atkinson, C. Mcbeath, A. Soong Swee Kit & C. Cheers (Eds.) Proceedings of ASCILITE Singapore: ICT: Providing Choices for Learners and Learning. 2007, pp517-525. Australia: ASCILITE.
[14] Kennedy, G., Judd, T., Churchward, A., Gray, K., and Krause, K. First year students’ experience with technology: Are they really digital natives? Australasian Journal of Educational Technology 24(1), 2008, pp108-122
[15] Kvavik, R. Convenience, communications, and control: How students use technology. In D. Oblinger & J. Oblinger (Eds.), Educating the Net Generation: 7.1-7.20. 2005. EDUCAUSE. http://www.educause.edu/educatingthenetgen/ (accessed November 19, 2009)
[16] Richtel, M. Driven to distraction: Drivers and legislators dismiss cellphone risks. The New York Times. 2009. [Online] http://www.nytimes.com/2009/07/19/technology/19distracted.html?_r=0
[17] Wallis, C. The impacts of media multitasking on children’s learning and development: Report from a research seminar, New York, NY. The Joan Ganz Cooney Center at Sesame Workshop, 2010.
[18] Stevenson, P. Distractions make learning harder. CBS News. July 24, 5:27pm, 2006
[19] Sweller, J. Cognitive load during problem solving: Effects on learning. Cognitive Science, 12, 1988, pp257-285
[20] Paas F., Ayres P. and Pachman M. Assessment of Cognitive Load in Multimedia Learning: Theory, Methods and Applications In Robinson D. and Schraw G. (Eds). Recent Innovations in Educational Technology that Facilitate Student Learning. 2008. USA. Information Age.
[21] Paas, F., Renkl, A., & Sweller, J. Cognitive load theory: Instructional implications of the interaction between information structures and cognitive architecture. Instructional Science, 2004a, pp32, 1-8.
[22] Paas, F., Renkl, A. and Sweller, J. (eds.). Cognitive Load Theory. Instructional Science 32, 2004b (1–2; special issue)
[23] Mayer, R. E., & Moreno, R. Nine ways to reduce cognitive load in multimedia learning. Educational psychologist, 38(1), 2003, pp43-52.
[24] Kirsh D. (2000). A Few Thoughts on Cognitive Overload. Intellectica, 1, 30, 2000, pp. 19-51
[25] De Jong, T. Cognitive load theory, educational research, and instructional design: some food for thought. Instructional Science, 38(2), 2010, pp105-134.