Persuasive Technologies for Efficient Adaptable Self-Education

Kids Smart Mobile School Project

Saad Abdessettar
École de Technologie Supérieure (ÉTS)
Montreal, Canada
e-mail: saad.abdessettar.1@etsmtl.ca

Mickaël Gardoni
École de Technologie Supérieure (ÉTS) / INSA
Montreal, Canada / Strasbourg, France
e-mail: mickael.gardoni@etsmtl.ca

Richard Hotte
Dept.: LICEF research center at Téluq University
Montreal, Canada
e-mail: richard.hotte@teluq.ca

Bessam Abdulrazak,
University of Sherbrooke
Sherbrooke, Canada
e-mail: bessam.abdulrazak@usherbrooke.ca

Abstract—**Persuasive Technologies could revolutionize the way education is delivered. It could enable serving kids who would probably never have the chance to even see a school. Millions of children still do not have access to school or teachers, especially in poor and developing countries. Thus, our research project aims at offering a persuasive mobile self-learning system that can be an alternative to standard school. We present in this paper the (KSMS) project. We focus on our vision of embedding persuasive technologies to enhance kids' education quality and efficiency, in a self-learning context.**

Keywords-Persuasive technology, Persuasive learning, Mobile learning, Pupil Perseverance, Pupil Motivation, Pupil Engagement

I. INTRODUCTION

Information and Communication Technologies (ICT) have changed our way of performing tasks in diverse domains such as economy, health, and higher education. This change affects even the way we live [1]. Still, the effectiveness of the ICT is not maximal due to the lack of efficient Human Machine Interaction (HMI) design. Several studies have emerged in the persuasive technologies science to address limitations of the HMI design. These studies resulted in numerous findings, constructs, methods and models, addressing problems related to persuasion and behavior or attitude changes. Persuasive technologies have a potential to revolutionize the Education [2-6]. Thus, we target in our *Kids Smart Mobile School* (KSMS) project, in collaboration with our industrial partner DATAWIND Inc. [36], to propose a low-cost solution for school access problems using mobile and persuasive technologies. The first target population of KSMS is the rural area in India.

In the rest of the paper is structured as follows. In Section II, we discuss the background of our research and our research project context. In Section III, we define our research question and originality. Section IV presents a summarized review of research studies and findings addressing the two main issues related to education (i.e., motivation and engagement) in primary and secondary school. Next, I Section V, we present an overview of relevant works in persuasive technologies for education, and then conclude the paper with a summarizing synthesis and a discussion of future perspectives.

II. BACKGROUND

Adapting and using ICT for education is a current problem, particularly in developing countries. In Africa, for example, there have been numerous initiatives that target ICT for education. The list includes: use of tablets in colleges in Niger as a tool/medium for education, use of mobile phones in continuing training of primary teachers in Madagascar, etc. Unfortunately, there are still children in the world without access to school (primary and secondary). This situation is due to various reasons such as economy, social behavior, family structure, geographic condition, racial discrimination, and gender disparity [7]. Ardt et al. [7] highlight that gender disparities are critical in Bangladesh. They discussed that three million children between six and ten years (5% of children age of primary school) have never attended school. Ardt et al. [7] conclude that this situation is because those children are poor, from remote rural areas, without homes or, even from minority tribes. Kim et al. and Kim, P.H. [8, 9] discussed similar situations among indigenous of South America, seasonal or itinerant workers. They indicate that, among the underserved population in Latin America, a large number of the indigenous children are the poorest ones who hardly have access to formal school. Similarly, Achoka et al.[10] conclude that the failure in the access of young Kenyan children to primary education is due to poverty, inequality in gender and regional disparities.

Nowadays, around 124 million children and teenagers, between the ages of 6 and 15 years, have either never started school or have dropped out, according to UNESCO Institute

of Statistics (UIS) [11]. The UIS discusses in a recent report that the main problem is (directly or indirectly) the lack of school access in rural and/or urban regions [11]. The UIS report also concludes that we can no longer rely only on 'usual' strategies based on more teachers, classrooms and textbooks. Thus, our KSMS project is an attempt to provide innovative education approaches. KSMS was defined in partnership between LICEF research center and his industrial partner DATAWIND. In the next section, we present a relevant state of the art of research studies related to the KSMS project.

III. RELEVANT WORKS

There exist a number of relevant research studies that focus on technological learning system to compensate the absence of school or teacher. Kam et al. [12] studied designing E-Learning Games for Rural Children in India. Kam et al. project's challenge was to design e-learning games that are both educational and pleasurable for their target learners. These children have limited familiarity with technology. Kam et al. [12] proposed the "receptive-practice-activation cycle" to be used as the conceptual model for designs. Another challenge was to design a balanced solution between fun and self-learning for rural children. Thus, those challenges gave high consideration to local environment and contextual information of the target learners.

EuroPLOT is another relevant project to compensate for the absence of school or teacher [13]. The project's team has developed Persuasive Learning and Technologies (PLOTs) and has evaluated them in four real-world case studies. The project covers different teaching scenarios of university education, adult learning in industry, informal learning at a museum, literature studies, and language learning. EuroPLOT explores to what extent persuasive learning objects and technologies could militate (simulate and alleviate) the functions of a persuasive teacher. The framework was designed based on Fogg's definition of CAPTOLOGY [14], and integrated the RAMP model (Relatedness, Autonomy, Mastery and Purpose) proposed by Marczewski [15] to enable engagement in the learning process. The learning diffusion strategies adopted in the EUROPLOT had diverse challenges. Indeed, the researchers and designers involved in the project had the challenge to deliver the teacher with the text, but at the same time to invest this teacher presence in the text with stronger persuasive power for learning.

Similar projects aiming at diffusing learning throughout technology and gaming environment have been undertaken. Plass et al. [16] present a research study that aims at designing a game (i.e., FactorReactor) to help practicing and automating arithmetic skills. The goal is to increase arithmetic fluency in middle-school-age students. Plass et al. argue that competitiveness increases in-game learning, whereas collaboration decreases performance during the experimental play session. They discuss that competition and collaboration elicit greater situational interest and enjoyment, and invoke a stronger mastery goal orientation. They conclude that, collaboration results in stronger intention and motivation to play the game again and to recommend it to others.

Similarly, Lerkkanen et al. [17] examined the extent to which teaching practices observed in kindergarten classrooms predict children's interest in reading and mathematics. They conclude that girls are more motivated than boys in reading. On the other hand, boys perform better than girls in tasks involving number sequences. Lerkkanen et al. [17] argue that for the observed teaching practices, the more child-centered and the less teacher-directed they are, the higher reading motivation is among children. Similarly, Hirvonen et al. [18] examined the developmental dynamics of task-avoidant behavior and math performance from kindergarten to Grade 4. They studied math performance and task-avoidant behavior development in tandem. Hirvonen et al. [18] argue that an increase in task-avoidant behavior is related to less improvement in math performance, and high initial level of task-avoidant behavior predicted less improvement and slower improvement in math later on.

To conclude, there is yet no research study that focuses on a technological learning system to compensate for the absence of school or teacher. Few existing studies focus on either complementing existing learning provided by standard schools, or on bringing new alternative learning (distant or hybrid) that always include teacher or tutor interaction with final learners. In the next section, we present our research project and research question, and then discuss our vision of persuasive technologies in KSMS.

IV. KSMS PROJECT

KSMS's main goal is to create a learning system on mobile devices that will be adapted for individual self-learning. KSMS project targets particularly children in developing countries without access to teachers or school. Three main objectives are defined for KSMS project:

I.   To provide autonomous learning for part of the elementary and/or secondary curriculum, with content definition and learning strategies adapted to a mobile device apps environment.

II.   To design an educational game application based on serious game architecture to support learning contents.

III.   To integrate persuasive design and HCI multimodal interaction design in the learning process. The main goal is to make the system more adaptive and more context-aware. This will allow guiding and impacting the learner's behavior, by helping him/her to control

his/her own learning and to be continuously motivated to learn.

In this paper, we mainly focus on the third objective. More precisely, we intend to answer the following research questions: (i) How persuasive technologies can help stimulate pupil motivation and perseverance? (ii) At what extent should the targeted system consider contextual persuasion in order to ensure a learner centered strategy and an efficient self-determined education?

The KSMS project originality comes from the fact that the system is fully automated and will represent a unique source of learning for the target population. In other words, the final system will not be a complement to an existing learning system, such as school, classroom, learning resource or teacher. Instead, KSMS aims at providing all those components in an integrated architecture that can ensure the efficiency and the effectiveness of learning for the target population that is supposed to have limited or no access to teacher or school.

The third objective of KSMS project, which is the focus of this paper, is expected to compensate the absence of the school and the teacher. By persuasive learning, we refer to learning that is designed using persuasive technologies to impact the learner's engagement and ability to control his own learning. KSMS project is designed to integrate persuasive system design models and methods with the latest findings in education science field related to engagement and perseverance. Thus, the target solution is designed considering the autonomous fact of the learning provided, and also the challenge to ensure an equivalent quality of learning to Indian government standard as defined by the Central Board of Secondary Education in its international version.

We discuss next some definitions of motivation, its classes, and what factors can help to monitor and manage motivation and engagement in learning.

V. LEARNING MOTIVATION

Motivation refers to "the choices people make as to what experiences or goals they will approach or avoid, and the degree of effort they will exert in that respect" [19]. Motivation is viewed as highly unpredictable and changeable, being subject to divers influences [20]. In education, there is a consensus that motivational messages impact student motivation level and have a positive influence on their class performance

The term "*Motivation to learn*" is defined by Marshall, H. [21] as the meaningfulness, value, and benefits of academic tasks to the learner regardless of whether or not they are intrinsically interesting. According to Brophy, J. [22], motivation to learn is a competence acquired through general experience, but stimulated most directly through modeling, communication of expectations, and direct

instruction or socialization by significant others (especially parents and teachers).

Motivation can be Intrinsic or extrinsic. ***Extrinsic motivation*** is doing or not doing something because of external benefits or consequences (i.e., reward or punishment) [23]. An "***Extrinsically***" motivated student performs "*in order to*" obtain rewards or avoid punishments external to the activity itself," such as grades, stickers, or teacher approval [24]. They also perform because of pressure, reward, incentive, among other external reasons [25].

Intrinsic motivation is basically self-motivation [26]. This internal motivation involves values [27] and is frequently linked with achievement [28]. A student who is "***Intrinsically***" motivated undertakes an activity "for its own sake, for the enjoyment it provides, the learning it permits, or the feelings of accomplishment it evokes" [29].

Condry, J. et al. [30] discuss that, when students were confronted with complex intellectual tasks, those with an intrinsic orientation used more logical information-gathering and decision-making strategies than did students who were extrinsically oriented. Students with an intrinsic orientation also tend to prefer tasks that are moderately challenging, whereas extrinsically oriented students gravitate toward tasks that are low in degree of difficulty. Extrinsically oriented students are inclined to put forth the minimal amount of effort necessary to get the maximal reward [24].

Numerous researches have been undertaken in order to monitor and manage student motivation. Keller, J.M. [31] Introduced the ARCS model as a method for improving the motivational appeal of instructional materials and is based on four dimensions of motivation. These dimensions were derived from a synthesis of research on human motivation and are known as ARCS: Attention (A), Relevance (R), Confidence (C), and Satisfaction (S). ARCS model focuses on using motivational messages that are intended to enhance faculty-student interaction, which leads to enhancing student motivation [32]. Ciampa, K. [24] argues that the list of elements that make an activity both intrinsically and extrinsically motivating for a learner include: challenge, curiosity (cognitive & sensitive), control, cooperation, competition and recognition.

Moreover, Bobis, J., et al. [33] propose a model for mathematics instruction to enhance student motivation and engagement. Part of their research questions were: What teaching strategies might motivate middle-grades students to engage more in mathematics? Bobis et al. proposed an upgraded version of Martin, A.'s motivation wheel framework [34], by conceptualizing the wheel into adaptive, impeding, and maladaptive dimensions. Their framework allows educators to identify a set of common factors. Those factors underpin in particular student's motivation and engagement. The motivation wheel also allows to identify what aspects need to be targeted for intervention. From another perspective, Fogg [14] introduced principal motivators for designing behavior change in the Fogg

Behavior Model (FBM): (1) Pleasure vs. Pain, (2) Hope vs. Fear, and (3) Social Acceptance vs. Rejection.

After discussing motivation in this section, we present next relevant research studies to KSMS and persuasive education.

VI.   PERSUASIVE TECHNOLOGIES FOR EDUCATION

We argue that persuasive technologies and persuasive design can be efficiently integrated in self-learning systems. We believe that persuasive technologies have to be considered in all aspects of the target learning system. Therefore, we propose to integrate persuasive design and persuasive technologies in a framework of three layers. Following is a description of the framework and the guidelines we adopted on each layer (Figure 1):

1) Learning Structure: in this layer we consider the ease of use for the KSMS proposed system, as well as the ease of registration and subscription to all proposed pedagogical activities. We also take into consideration the impact of celebration, and the success/failure perception to ensure an efficient motivating roadmap for the proposed learning progress structure. Thus, the learning progress will be designed to consider small achievable goals. To those goals, specific behaviors are defined as target behavior for the persuasive strategies or component to integrate or include in the solution. The challenge is then to guide and help the final user – the learner, to continuously feel successful by achieving a sequence of small goals that lead to the defined target one.

2) Learning Medium & Infrastructure: at this layer, we are adapting the learning scenario, content and medium to learner context information gathered throughout used devices. The main design driver at this layer is ensuring reduction and facilitating the interaction with KSMS. In this layer, we integrate the ARCS model to ensure user engagement in using the KSMS learning system, and also in keeping focused on the learning goals to progress in his/her learning. We also enhance the context awareness in order to propose content and learning scenarios that match more the real world of the learner. Some technical constraints and limitations make the social learning difficult to occur. In fact, the bandwidth is limited in the provided mobile network using 2G technology. We adapted the solution to use data collected by devices to create virtual classroom or learning groups that are formed by neighbor users. We believe that throughout those learning groups we can stimulate social learning and provide the learner to interact with peers and even act as a teacher when helping other.

3) Learning Content & Scenarios: at this layer, we propose an integration of persuasive technologies in the content and in the way the learner will receive the content. Our analysis of the content leads us to consider target learning skills as target behaviors. Thus, the main goal is to make the final user (in our case, the learner) exercise those target behavior according to their needed frequency. A high consideration is given to the learner context and to the real world learning mapping opportunities, in order to make the KSMS's learning experience more relevant and then more efficient. In fact, the Geographical Positioning System (GPS)'s data is for instance, a great source of context understanding. We propose to use the GPS data to retrieve information about the environment (sunny, raining, culture, known products, etc.), and then map it in the content so we can give examples of raining vocabulary when it is raining, for example. Other sensors and technologies are considered, especially the Bluetooth and ad-hoc Wi-Fi, to stimulate social learning even when there is no Internet connection. Moreover, when a kid is well performing in a task, he will be prompted to share his knowledge with neighbor kids having problems to perform that task. In this way, the intent will be not only stimulating the teacher role (and by the way this is a way to replace the ordinary teacher), but we also give the first well performing pupil to identify and control his own learning.

We base our persuasive design mainly on FBM. We consider different classes of behaviors regarding the three layers. To build strategies for bringing the learner to target behavior, we monitor his ability, motivation and trigger. This principle is applied either for behaviors related to the use of KSMS, to the learning engagement and perseverance or to the target skills defined in the target curriculum. We then use Behavior Wizard methodology to implement the persuasion strategy [35], by defining the behavior state transition and mapping it to the proposed grid. Fogg, B. and Hreha, J. [35] proposed fifteen cells in his BehaviorWizard: five columns for behaviors types (New behavior, Familiar behavior, increasing behavior, decreasing behavior and stop behavior), and 3 rows for behavior frequency (DOT: one time, SNAP: period of time, PATH: from now on). We use the BehaviorWizard to design the transition path of behaviors after breaking them down into a combination of small and more specific ones.

In this section, we presented an overview of the persuasive design integration to KSMS persuasive learning system. A synthesis of guidelines and fundamentals adopted in designing persuasive technologies that will be embedded in the target mobile learning system KSMS.

VII.   CONCLUSION AND FUTURE WORK

ICT and persuasive technologies can contribute significantly to resolve the school's access problem. We presented throughout this paper our vision on delivering education to where there is no access to school and teachers, taking advantage of persuasive technologies. This activity is part of the KSMS project presented in the paper. We also discussed the persuasive design framework and guidelines we adopted for KSMS. We are working on tuning the framework and finalizing the implementation of the defined

solution before evaluating the results with the industrial partner in real settings. DATAWIND has partnered with the Indian government, as well as other countries, to begin providing its low-cost tablets to an estimated number of 220 million kids, especially those suffering from a school access problem.

REFERENCES

[1] Fogg, B.J., Persuasive technology: using computers to change what we think and do. Ubiquity, 2002. 2002(December): pp. 2.

[2] Behringer, R. and Øhrstrøm, P., Persuasive Design in Teaching and Learning. International Journal of Conceptual Structures and Smart Applications, 2013. 1(2): pp. 1-5.

[3] Gram-Hansen, S.B., D. 3.3 PLOT Persuasive Learning Design Framework: Persuasive Learning Designs. 2012.

[4] Winther-Nielsen, N., PLOTLearner's Persuasive Achievement: Force, Flow and Context in Technology for Language Learning from the Hebrew Bible. HIPHIL Novum, 2014. 1(2): pp. 78-94.

[5] Nakajima, T. and Lehdonvirta, V., Designing motivation using persuasive ambient mirrors. Personal and Ubiquitous Computing, 2013. 17(1): pp. 107-126.

[6] Lucero, A., et al., Persuasive technologies in education: Improving motivation to read and write for children. Lecture notes in computer science, 2006: pp. 142.

[7] Ardt, K., et al., Report on primary education in bangladesh: Challenges and successes. Bangladesh Bureau of Education Information and Statistics (BANBEIS)/Bangladesh Ministry of Women and Children Affairs (MWCA), 2005.

[8] Kim, P., Miranda, T. and Olaciregui, C., Pocket school: Exploring mobile technology as a sustainable literacy education option for underserved indigenous children in Latin America. International Journal of Educational Development, 2008. 28(4): pp. 435-445.

[9] Kim, P.H., Action research approach on mobile learning design for the underserved. Educational Technology Research and Development, 2009. 57(3): pp. 415-435.

[10] Achoka, J.S.K., Odebero Sephen O., Naiyo Julius K., and Mualuko N., Access to basic education in Kenya : inherent concerns. Educational Research and Reviews, 2007. 2(10): pp. 275-284.

[11] UIS, U.a., A growing number of children and adolescents are out of school as aid fails to meet the mark. POLICY PAPER 22 / FACT SHEET 31, 2015. :

http://www.uis.unesco.org/Education/Documents/oosci-global-report-en.pdf. (last accessed March 2016)

[12] Kam, M., et al. Designing e-learning games for rural children in India: a format for balancing learning with fun. in Proceedings of the 7th ACM conference on Designing interactive systems. 2008. ACM.

[13] Behringer, R. and Sinclair, G., IWEPLET 2013 Proceedings. EuroPLOT Retrieved December, 2013. 8: pp. 2013.

[14] Fogg, B.J. A behavior model for persuasive design. in Proceedings of the 4th international Conference on Persuasive Technology. 2009. ACM.

[15] Marczewski, A., The Intrinsic Motivation RAMP. 2013.

[16] Plass, J.L., et al., The impact of individual, competitive, and collaborative mathematics game play on learning, performance, and motivation. Journal of Educational Psychology, 2013. 105(4): pp. 1050.

[17] Lerkkanen, M.-K., et al., The role of teaching practices in the development of children's interest in reading and mathematics in kindergarten. Contemporary Educational Psychology, 2012. 37(4): pp. 266-279.

[18] Hirvonen, R., et al., The developmental dynamics of task-avoidant behavior and math performance in kindergarten and elementary school. Learning and Individual Differences, 2012. 22(6): pp. 715-723.

[19] Keller, J.M., The use of the ARCS model of motivation in teacher training. Aspects of educational technology, 1984. 17: pp. 140-145.

[20] Keller, J.M. and Kopp, T.W., An application of the ARCS Model of Motivational Design. 1987.

[21] Marshall, H., Motivational strategies of three fifth-grade teachers. The Elementary School Journal, 1987.

[22] Brophy, J., Socializing students' motivation to learn. Advances in motivation and achievement, 1987. 5: pp. 181-210.

[23] Ryan, R.M. and Deci, E.L., Self-regulation and the problem of human autonomy: does psychology need choice, self-determination, and will? Journal of personality, 2006. 74(6): pp. 1557-1586.

[24] Ciampa, K., Learning in a mobile age: an investigation of student motivation. Journal of Computer Assisted Learning, 2014. 30(1): pp. 82-96.

[25] Konheim-Kalkstein, Y.L. and Van den Broek, P., The effect of incentives on cognitive processing of text. Discourse Processes, 2008. 45(2): pp. 180-194.

[26] Deci, E.L., et al., Motivation and education: The self-determination perspective. Educational psychologist, 1991. 26(3-4): pp. 325-346.

[27] Sanacore, J., Turning reluctant learners into inspired learners. The Clearing House: A Journal of Educational Strategies, Issues and Ideas, 2008. 82(1): pp. 40-44.

[28] Spittle, M., K. Jackson, and Casey, M., Applying self-determination theory to understand the motivation for

becoming a physical education teacher. Teaching and Teacher Education, 2009. 25(1): pp. 190-197.

[29] Lepper, M.R., Motivational considerations in the study of instruction. Cognition and instruction, 1988. 5(4): pp. 289-309.

[30] Condry, J. and Chambers, J., Intrinsic Motivation and the Process of Learning. In the Hidden Costs of Reward, edited by MR Lepper and D. Greene. 61-84. 1978, Hillsdale, New Jersey: Lawrence Erlbaum Associates, Inc.

[31] Keller, J.M., Using the ARCS motivational process in computer-based instruction and distance education. New directions for teaching and learning, 1999. 1999(78): pp. 37-47.

[32] Robb, C.A. and Sutton, J., The Importance of Social Presence and Motivation in Distance Learning. Journal of Technology, Management & Applied Engineering, 2014. 31(1-3): pp. 1-10.

[33] Bobis, J., et al., A model for mathematics instruction to enhance student motivation and engagement. Motivation and disposition: pathways to learning mathematics, 73rd yearbook. Reston: National Council of Teachers of Mathematics (NCTM), 2011.

[34] Martin, A., Building classroom success: Eliminating academic fear and failure. 2010: A&C Black.

[35] Fogg, B. and Hreha, J., Behavior wizard: a method for matching target behaviors with solutions, in Persuasive technology. 2010, Springer. pp. 117-131.
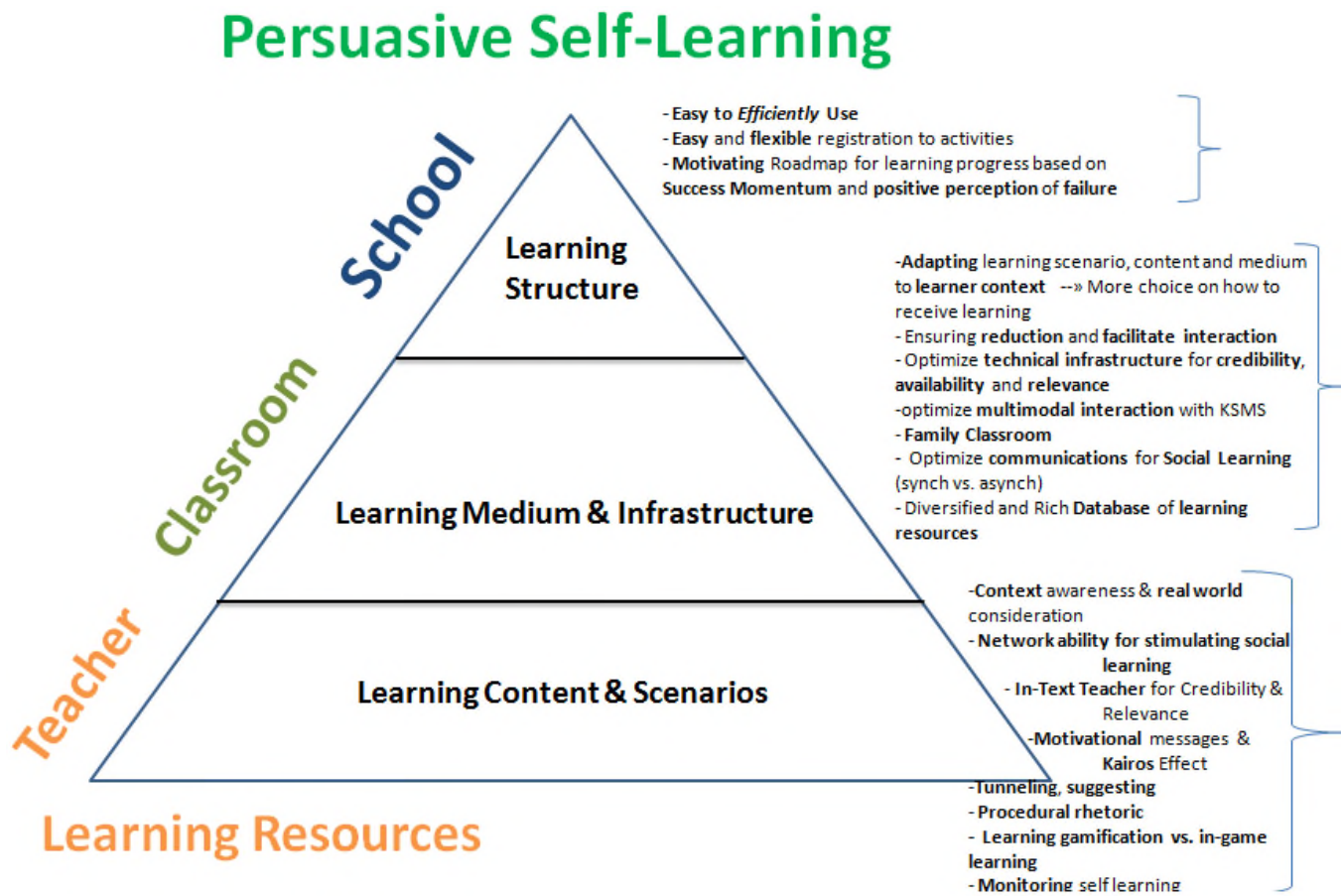
[36] www.Datawind.com (last accessed April 2016)

Figure 1.   Implementing persuasive technologies in KSMS