# OFFERING A MODEL TO EVALUATE RELATION OF USE OF LAPTOPS, TABLETS AND IPADS TO EFFECTIVE LEARNING BASED UPON MEDIATION OF EDUCATIONAL MOTIVATION THE CASE OF TEACHERS OF SMART HIGH SCHOOLS OF ) (TEHRAN

## Abstract

The present study makes an attempt to evaluate the relation of the use of laptops, tablets, and iPads to effective learning based upon the mediation of educational motivation. The study is a descriptive-correlational research. The population comprises all the teachers of smart high schools of Tehran in the academic year 2011-2012. To choose the sample, the two-step cluster random sampling was employed. The research tools comprise three questionnaires: the researcher-made questionnaire of the use of information and communications technology (use of laptops, tablets and iPads), the researcher-made questionnaire of students' educational motive, and the researcher-made questionnaire of effective learning. Views of some faculty members and specialists have been used to obtain the reliability of the questionnaires. For data analysis, the study employs Pearson correlation coefficient and Structural Equations Modeling. Generally, the findings reveal that use of laptops, tablets and iPads has a significant relation to effective learning in terms of promoting cognitive, affective and psychomotor abilities. The findings also reveal that educational motivation mediates the relation of the use of laptops, tablets and iPads to the development of effective learning. . According to the findings, GFI index equals 0.95, AGFI index equals 0.93, AGFI equals 0.248 and $x^2 = 0.248$ which indicate the model's fitness

*Key words*: laptop, tablet, iPad, effective learning

## Introduction

Educational technologies include all those factors that effectively influence the learning process and, too, facilitates students' learning; technologies such as PCs, laptops, iPads (Kadiyala and Crynes, 2000; Wang and Reeves, 2007). The general role of technology, thus to say, is to improve the overall efficiency of teaching and learning processes. In education, this efficiency has been improved and also can appear in different ways. For instance: 1. Enhancing the quality of learning, or the amount of its mastery, 2. Reducing the time span used by learners in order to reach the desired goals, 3. Imrpoving the teachers' efficiency in terms of the number of learners without reducing the quality of learning, 4. Reducing the costs without affecting the quality of learning, 5. Improving the learner's independency and flexibility of the educational facilities (Ahadian et al., 1380). In other words, there has been paid a lot of attention to the application of modern technologies in classes. Simply put, rapid changes of technology in the process of teaching/learning has led to widespread changes and has been aimed at improving the quality of education in schools. Providing opportunities for students' potentialities and personal interests, new technologies have contributed to the improvement of school system. Studies show that utilizing technologies (e.g. Computer and Web) in classrooms will provide students

with an atmosphere to better learn and feel more satisfied in the classrooms (Shafi'poor Mutlaq & Abbaspoor, 2012). Nowadays, experts and intellectuals around the world have stressed the importance of educational technology in the process of teaching/learning; furthermore, they believe that the proper use and application of the educational technology affect the quality of learning. Instances of such influences, so to speak, are the positive effects on the enhancement of time and quality of learning; developing the sense of inquiry; and gaining necessary skills for life (Yarmohammadian & Shafi'ppor Mutlaq, 1392). Other examples are the positive impacts on the students' efficiency and performance in all educational subjects and students' optimism over their future; the influence of the teacher's role; the ways of dividing students into groups; improving a student-centered atmosphere; increasing teacher/students interactions; continuity in the application of technology; interests of trainees in the process of education; increase in the level of  self-reliance in learning; use of telecommunications facilities in terms of cooperation, participation, friendship, and partnership (Shafi'poor Mutlaq & Yarmohammadian,1390). Educational technology has a potentiality in developing the process of teaching and learning, instances of which are: individualizing education, improving the quality of teaching, dealing with problems of mass education, preparing equal educational opportunities, preparing continuous education, strengthening the role of teacher, emphasis on the human aspect of education (Attaran, 1381). Moreover, using educational technologies in teaching and learning gets a classroom out of monotony, and also makes students active. It, furthermore, leads to the emergence of creativity in learners and thus accelerates the process of learning. Providing a set of various teaching/learning methods, technology, so to speak, prepares students for understanding their areas of interest, hence makes learning a significant matter. Trainers and specialists strongly believe that educational technologies, such as utilities, educational equipments and media, have high capabilities in teaching and learning; and the teacher's role nowadays is far different from the traditional one (Shafi'poor Mutlaq et al. 2011).  Budin (1991) has investigated the probable impacts of Information Technology (IT) on the role of teachers in classrooms.

**Methodology**
David Perkiz (1984) believes that the method of active teaching and participatory learning in smart schools is of great importance; it also increases students' motivations. This way the students' power of thinking and creativity improve. Zamani and Ghassabpoor's (1380) research showed that one of the aims smart schools in Malaysia follow is to make opportunities for improvement of individuals' capabilities and, too, improving the participation of stakeholders in the process of teaching. Arezoo Jahanbakhash in a research entitled "The Role of Information Technology in Teaching Educational Subjects" concluded that ICT could undoubtedly bring changes to the education system so as to have a class an appropriate environment for active participation. Such classes will demand the improvement of teachers and students' skills. Attaran's (1381) investigations in this ground showed that one of the new roles that teachers play in the classrooms is the teaching of learning/teaching skills to students in order to let them make the most out of the allocated time. Afzalnia's (1384) studies, furthermore, showed that new technologies in educational system have brought about certain changes in learning circumstances, such as: change in the role of teachers, 2. Change in the pervasive role, 3. Increase in student/teacher interactions. Shafi'poor Mutlaq (2011) in his studies maintained

that in smart schools it is the students who specify the speed of learning. That is, the time of learning is not confined to the school hours; to this end, whenever students wish they can have their favorite classes on-line or in a boarding system. Assumptions of Constructive Learning Theory have already prepared certain conditions for presence of IT in the teaching/learning process (Beiler & Snowman, 1997). Carrie B Fried (2008), in a research entitled "In-Class Laptop Use and Its Effects on Student Learning" concludes that students who have used laptop in the class could do various class assignments at the same time. The use of laptop, furthermore, had great effects on students and their friends. Weaver and Nilson (2005) in their studies maintained that computers, especially laptops, are standard tools for education and have been used increasingly in the process of teaching/learning. Brown and Petitoo (2003) mention a condition in which students and teachers use laptop pervasively and can connect to the Internet through Wi-Fi. Moreover, they have pointed out the profits of constant access to computers in the educational atmosphere. Previous studies (Candiotti & Clarke, 1998; Hall & Elliot, 2003; McVay, Snyder, & Graetz, 2005; Platt & Bairnsfather, 2000; Schrum, Skeele, & Grant, 2002) have been looking for ways through which they can make use of laptops for effective learning.  Kevin Scott Nicholas' (2006) research concluded that there exists a significant relation between the use of laptop and students' improvement. Various studies (Barak et al., 2006; Hall & Elliot, 2003; Hyden, 2003; Pargas & Weaver, 2005; Weaver & Nilson, 2005) have been done aimed at investigating how class and classroom atmosphere are adapted in order to use laptop. Pourling (2012) and Shillady et al. (2012) in their studies showed that the use of iPad enrich students' learning. Furthermore, some anonymous studies (2012) together with studies of Abilene Christian University (2012) showed that iPads are quite effective in developing learning process and make the learning atmosphere efficient.  On the other hand, studies by Barseghian (2011) and Apple (2011) show that by the use of iPads, there will be prepared multimedia books. However, the use of iPads, depending on the level of student's learning, differ from one student to another. Studies of Beck (2000) and Hancock, Bray, and Nason (2002) show that the technologies used in the educational system affect students' motivation for learning. The results of Bertholt et al., (2002) have shown that the set of factors that students deal with in the process of learning effects their educational motives. Moreover, an approach to the use of ICT in the learning process is based on a student-centered system (Schneckenberg, 2007; Williams, 2009). Brophy and Walker's (2005) studies depicted that the use of Tablets improves learning capabilities of students, and also expands students' practical engagement with learning issues to a point where they can understand. To this end, studies have shown that the use of Tablets is one of the ways through which students enrich and improve their learning experiences. The use of tablet, furthermore, leads to the improvement of associative-learning cooperation and students' self-regulation behaviors (Tront et al, 2009). Catherine T et al. (2012) in their research have shown that taking the advantage of tablet influence the students' learning behavior.

**Research hypotheses**
1. Use of laptops, iPads and tablets has a significant relation to the development of effective learning in terms of improving ccognitive, affective and psychomotor abilities.
2. Educational motivation mediates the relation of the use of laptops, tablets, and iPads to the development of effective learning.

**Methodology**

This study is a descriptive-correlational research. The population comprises all teachers of smart high schools of Tehran in the academic year 2011-2012. To choose the sample, the two-step cluster random sampling was employed. The research tools comprise three questionnaires: the researcher-made questionnaire of use of information and communications technology (use of laptops, tablets and iPads), the researcher-made questionnaire of students' educational motive, and the researcher-made questionnaire of effective learning. Views of faculty members and specialists have been used to obtain the reliability of the questionnaires. Data analysis has been conducted by employing Pearson Correlation Coefficient and Structural Equations Modeling.

Table 1. Reliability coefficient of the research questionnaires

| Items | questionnaire | Number of items | Reliability coefficient |
|---|---|---|---|
| 1 | Questionnaire of the use of ICT | 36 | 0.85 |
| 2 | Questionnaire of students' educational motivation | 12 | 0.94 |
| 3 | Questionnaire of effective learning | 16 | 0.91 |

**Finding of this research**

**The first hypothesis:**

Use of laptops, iPads and tablets has a significant relation to the development of effective learning in terms of improving cognitive, affective and psychomotor abilities.

Table 2. Descriptive and correlational indices between the research variables

| Items | | Mean | Standard deviation | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Development of effective learning | 31.49 | 2.19 | 1 | | | | | | | | | | |
| 2 | Educational motivation | 24.35 | 11.3 | 0.28** | 1 | | | | | | | | | |
| 3 | Use of laptops for improving cognitive abilities | 53.61 | 6.12 | 0.21** | 0.25** | 1 | | | | | | | | |
| 4 | Use of laptops for improving affective abilities | 22.52 | 2.63 | 0.28** | 0.23** | 0.21** | 1 | | | | | | | |
| 5 | Use of laptops for improving psychomotor abilities | 15.29 | 3.42 | 0.25** | 0.17* | 0.42** | 0.31** | 1 | | | | | | |

| No | Research variable | Mean | SD | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | Use of tablets for improving cognitive abilities | 3522 | 273 | 0.29** | 0.26** | 0.32** | 0.30** | 0.23** | 1 | | | | | |
| 7 | Use of tablets for improving affective abilities | 22.15 | 682 | 0.35** | 0.21** | 0.38** | 0.46** | 0.37** | 0.32** | 11 | | | | |
| 8 | Use of tablets for improving psychomotor abilities | 2813 | 748 | 0.28** | 0.18** | 0.19** | 0.38** | 0.33** | 0.24* | 0.26** | 1 | | | |
| 9 | Use of iPads for improving cognitive abilities | 19.23 | 5.62 | 0.17** | 0.13** | 0.27** | 0.26** | 0.18** | 0.34** | 0.35** | 0.33** | 1 | | |
| 10 | Use of iPads for improving affective abilities | 2841 | 8.74 | 0.23** | 0.190** | 0.43** | 0.31** | 0.14** | 0.24** | 0.27** | 0.31** | 0.29** | 1 | |
| 11 | Use of iPads for improving psychomotor abilities | 34.73 | 6.28 | 0.31** | 0.27** | 0.28** | 0.46** | 0.21** | 0.31** | 0.22** | 0.35** | 0.41** | 0.34** | 1 |

*P<0.01  & ** P<0.05

| Items | Research variables | Educational motivation | | | Coherence of the content of the perceived curriculum | | |
|---|---|---|---|---|---|---|---|
| | | Direct impact | Indirect impact | Total impact | Direct impact | Indirect impact | Total impact |
| 1 | Educational motivation | 0 | 0 | 0 | 0.157 | 0 | 0.157 |
| 2 | Use of laptops for improving cognitive abilities | 0.148 | 0 | 0.148 | 0.129 | 0.023 | 0.152 |
| 3 | Use of laptops for improving affective abilities | 0.125 | 0 | 0.125 | 0.131 | 0.019 | 0.15 |
| 4 | Use of laptops for improving psychomotor abilities | 0.103 | 0 | 0.103 | 0.186 | 0.016 | 0.202 |
| 5 | Use of tablets for improving cognitive abilities | 0.131 | 0 | 0.131 | 0.108 | 0.020 | 0.128 |
| 6 | Use of tablets for improving affective abilities | 0.159 | 0 | 0.159 | 0.112 | 0.025 | 0.137 |
| 7 | Use of tablets for improving psychomotor abilities | 0.142 | 0 | 0.142 | 0.124 | 0.022 | 0.146 |
| 8 | Use of iPads for improving cognitive abilities | 0.183 | 0 | 0.183 | 0.117 | 0.028 | 0.145 |
| 9 | Use of iPads for improving affective abilities | 0.177 | 0 | 0.177 | 0.103 | 0.027 | 0.13 |
| 10 | Use of iPads for improving psychomotor abilities | 0.139 | 0 | 0.139 | 0.127 | 0.022 | 0.149 |

According to the above table, the relation between use of laptops for improving cognitive abilities and the development of effective learning abilities (r=0.21), use of laptops for improving affective abilities in terms of improving cognitive (r=0.28), and use of laptops for improving psychomotor abilities (r=0.25) is significant. Besides, the relation between use of tablets for improving cognitive abilities and the development of effective learning abilities (r=0.21), use of tablets for improving affective abilities in terms of improving cognitive (r=0.28), and use of tablets for improving psychomotor abilities (r=0.25) is significant too. There is also a significant relation between use of iPads for improving cognitive abilities and the development of effective learning abilities (r=0.21), use of iPads for improving affective abilities in terms of improving cognitive (r=0.28), and use of iPads for improving psychomotor abilities (r=0.25).

**The second hypothesis:**
3. Educational motivation mediates the relation of the use of laptops, tablets, and iPads to the development of effective learning**.**

Table 3. Direct and indirect impacts of the use of laptops, tablets and iPads on the development of effective learning

According to the above table, the direct impact of the use of laptops for developing cognitive abilities on the development of effective learning is (0.129), the use of laptops for improving affective abilities (0.131), and the use of laptops for improving psychomotor abilities is (0.186).The findings also show that the direct impact of the use of tablets for developing cognitive abilities on the development of effective learning is (0.108), the use of laptops for improving affective abilities

(0.112), and the use of laptops for improving psychomotor abilities is (0.124). Besides, the direct impact of the use of iPads for developing cognitive abilities on the development of effective learning is (0.117), the use of iPads for improving affective abilities (0.103), and the use of iPads for improving psychomotor abilities is (0.127). The above table also shows that the indirect impact of the use of laptops for developing cognitive abilities on the development of effective learning is (0.023), the use of laptops for improving affective abilities (0.019), and the use of laptops for improving psychomotor abilities is (0.016). The direct impact of the use of tablets for developing cognitive abilities on the development of effective learning is (0.020), the use of laptops for improving affective abilities (0.025), and the use of laptops for improving psychomotor abilities is (0.022). Also, the direct impact of the use of iPads for developing cognitive abilities on the development of effective learning is (0.028), the use of iPads for improving affective abilities (0.027), and the use of iPads for improving psychomotor abilities is (0.022).

Use of laptops
- Cognitive abilities
- Affective abilities
- Psychomotor abilities

Use of tablets
- Cognitive abilities
- Affective abilities
- Psychomotor abilities

Use of iPads
- Cognitive abilities
- Affective abilities
- Psychomotor abilities

Educational motivation

Development of effective learning

0.129
0.148
0.131
0.125
0.186
0.103
0.157
0.131
0.159
0.108
0.112
0.142
0.124
0.177
0.139
0.127
0.183
0.117
0.103
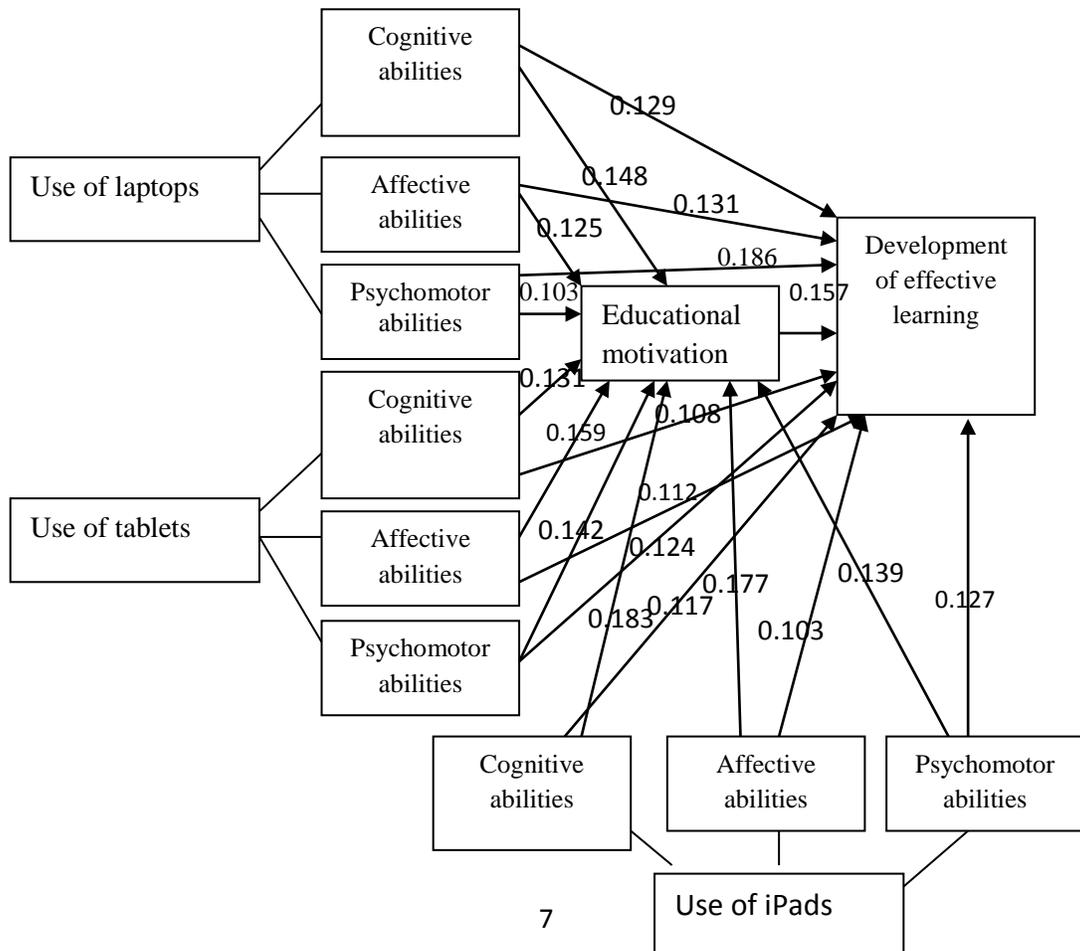
Figure 1. Experimental research model for evaluating the relation of the use of laptops, iPads and tablets to effective learning based upon the mediation of educational motivation

Table 3. Goodness of fit of the experimental research model for evaluating the relation of the use of laptops, iPads and tablets to effective learning based upon the mediation of educational motivation

| Fitness indices | estimate |
|---|---|
| Goodness of Fit Index (GFI) | 0.95 |
| Adjusted Goodness of Fit Index (AGFI) | 0.93 |
| Root Mean Square Residual (RMSEA) | 0.248 |
| Chi Square ($x^2$) | 252.46 |
| Degree of freedom (df) | 29 |

**Discussion and conclusions**

Studies conducted by Perkins (1984) and Budin (1991) show that an active teaching method and involvement is very effective in learning at smart schools and enhances students' motivation. The findings of the present study indicate that the relation of the use of laptops, tablets and iPods for improving cognitive abilitire to the development of effective learning is significant. Therefore, the first hypothesis assuming that the use of laptops, tablets and iPads has a significant relation to the development of effective learning is proven. Puerling (2012) and Shillady et al. (2012) show that the use of iPads enriches students' learning. Anonymous (2011) and Abilene Chritian University (2011) show that iPads are influential in the development of effective learning and make the learning environment efficient. Barseghian (2011) and Apple (2011) maintain that the use of iPads could help provide students and teachers with multimedia books. Catherine et al. (2012) shows that the use of tablets affects students' learning behavior. The research findings also indicate that the indirect impacts of the use of laptops, tablets and iPads for improving cognitive abilities on the development of effective learning are significant. Therefore, the second hypothesis assuming that educational motivation mediates the relation of the use of laptops, tablets and iPads for improving cognitive, affective and psychomotor abilities to the development of effective learning is proven. Beck (2000), Hancock, Bray and Nason (2002) show that the technology used in the learning system affects students' educational motivation. The findings of the research conducted by Berthold et al. (2009) show that the set of factor in which the students are involved in the learning process affect students'

educational motivation. According to the above table, GFI index equals 0.95, AGFI index equals 0.93, AGFI equals 0.248 and $x^2$ equals 252.46 which indicate the model's fitness.

## References

Afazlnia, M. (2005). Designing and Familiarizing with Centers of Syllabus and Learning Sources, Tehran: Samt Publication.

Ahadian, M.; Muhammadi, D.; Ramezani, O. (2001). *Fundamentals of Educational Technology*, Tehran: Ayeezh Publication.

Anonymous,C.(2011).Abilene Christian University, a Christian college in Abilene, Texas.

Apple, (2012). iBooks Textbooks for iPad. The Next Chapter in Learning. Retrieved 20January,2012<<http://events.apple.com.edgesuite.net/1201oihbafvpihboijhpihbasdouhbasv/event/index.html>>

Attaran, M. (2002). Globalization, Information Technology and Education, Tehran: Aftebemehr Cultural and Research Institute.

Barak, M., Lipson, A. & Lerman, S. (2006). Wireless laptops as means for promoting active learning in large lecture halls. Journal of Research on Technology in Education, 38(3), 245-263.

Barseghian, T. (2011c). Learning algebra with the iPad. Mindshift. Retrieved December 30,2011 from <<http://mindshift.kqed.org/2011/01/learning-algebra-with-the-ipad/>>

Beck, J., and Woolf, B. 2000b. High-level Student Modelingwith Machine Learning. Proceedings of the InternationalConference on Intelligent Tutoring Systems, 5: 584– 593.

Berthold, K., & Renkl, A. (2009). Instructional aids to support a conceptual understanding ofmultiple representations. Journal of Educational Psychology, 101(1), 70-87.

Bieler, R. & Snowman, J. (1997). Psychology applied to teaching (8th Ed.). Boston:
Houghton-Mifflin.

Brophy, S., and Walker, G.D. 2005. Case study of the pedagogical impact of the Tablet PCs as a presentation medium in large-scale engineering classrooms. Proceedings of the 2005 American Society for Engineering Education Annual Conference & Exposition. http://search.asee.org/search/

Brown, D. G. & Petitto, K. R. (2003). The status of ubiquitous computing. Educause Review, 38, 25-33. http://net.educause.edu/ir/library/pdf/erm0331.pdf

Budin, Howard.(1999). The Computer Enters the Classroom, Teachers College Record 100(3):656-69.

Candiotti, A. & Clarke, N. (1998). Combining universal access with faculty development and academic facilities. Communications of the ACM, 41(1), 36-42.

CATHERINE T. AMELINK., GLENDA SCALES , JOSEPH G. TRONT.(2012)." Student use of the Tablet PC: Impact on student learning behaviors", Advances in Engineering Education ,WINTER.

Fried, C. B. (2008). In-class laptop use and its effects on student learning. Computers & Education, 50(3), 906-914.

Hall, M., & Elliot, K. M. (2003). DiVusion of technology into the teaching process: strategies to encourage faculty members to embrace the laptop environment. Journal of Education for Business, 79, 301–307.

Hancock, D.R., Bray, M., and Nason, S.A. 2002. Influencing university students' achievement and motivation in a technology course. The Journal of Educational Research, 95: 365–373.

Hyden, P. (2005). Teaching statistics by taking advantage of the laptop's ubiquity. New Directions for Teaching and Learning, 101, 37-42.

Kadiyala, M., & Crynes, B. L. (2002). Where's the proof? A review of the literature on the effectiveness of information technology in education. Retrieved August 27, 2002, from the University of Oklahoma, College of Engineering Web site: fie.engrng.pitt.edu/fie98/papers/1038.pdf

Kevin Scott, Nicholas.(2006).”A laptop-learning initiative: Relationships with student achievement, technology proficiency, and attitude towards technology”, Dissertation, Educational Leadership and School Counseling, University of Southern Mississippi.

McVay, G. J., Snyder, K. D., & Graetz, K. A. (2005). Evolution of a laptop university: a case study. British Journal of Educational Technology,36, 513–524.

Pargas, R. P. & Weaver, K. A. (2005). Laptops in computer science: Creating the "learning studio". New Directions for Teaching and Learning, 101, 43-51.

Perkins, D.N. (1986) Knowledge as design. Hillsdale, N.J.: Lawrence Erlbaum Associates.

Platt, M. W., & Bairnsfather, L. (2000). Compulsory computer purchase in a traditional medical school curriculum. Teaching and Learningin Medicine, 11, 202–206.

Puerling, B. 2012. Teaching in a Digital Age: Smart Tools for Age 3 to Grade 3. St. Paul, MN: Redleaf.

Schneckenberg, D. (2007). eCompetence Development Measures for Faculty in Highe Education - A Comparative International Investigation. PhD Dissertation, University of Duisburg-Essen. Essen: DuePublico University Press.

Schrum, L., Skeele, R., & Grant, M. (2002). One college of education's eVort to infuse technology: a systematic approach to revisioning teaching and learning. Journal of Research on Technology in Education, 35, 256–271.

Shafiepour, F., Abbas pour, J.(2012).” Designing a Model for Developing Students' Needs Skills of High Schools for Using Virtual Learning “, International Journal of Electronics Communication and Computer Engineering Volume 3, Issue 6, ISSN (Online): 2249–071X, ISSN (Print): 2278–4209.

Shafiepour, F., Tadaion, M., Soltan Rezaei, E.(2011).” Designing an Adjusted Model for Evaluating Factors of Efficiency Learning in Smart Schools, International Conference on Educational Technology”, Jakarta. Indonesia.

Shafipoor, F.; Yarmuhammadian, M. (2001). *Offering a Model for Evaluating Factors Effective in Development of Perceived Responsive Curriculum at Smart Schools*, Journal of Research in Curriculum of the Islamic Azad University of Khorasgan (Isfahan), 8th Year, 2th issue, spring and summer.

Shillady, A., & L. S. Muccio, eds. 2012. Spotlight on Young Children and Technology. Washington, DC: NAEYC.

Tront, J.G., Filer, K., Scales, G.R., and Prey, J.C. 2009. Implementing a Tablet PC requirement program. Proceed¬ing of the American Society for Engineering Education Annual Conference & Exposition 2009, Austin, TX, June 14–17, 2009. http://search.asee.org/search/

Yarmuhammadian, M.; Shafipoor, F. (2013). Offering a Model for Evaluating Factors Effective in the Development of Perceived Efficient Communication between Teachers and Students at Smart Schools, Science-Research Journal of Curriculum, Islamic Azad University of Khorasgan, 10th year, 2nd issue, Serial No. (9) 63, spring, pp. 16-26.

Zamani, B.; Ghassabpoor, B. (2001*). How to Use Information Technology at Smart Schoos of The Islamic Country of Malasia and Its Comparison with Smart Schools in Iran,* a set of papers presented at the first national conference on IT in Education.

Wang, S.K., and Reeves, T. 2007. Effects of a web-based learning environment on student motivation in a high school earth science course. Educational Technology Research and Development, 55: 169–192.

Weaver, B. E. & Nilson, L. B. (2005). *Laptops in class: What are they good for? What can you do with them? New Directions for Teaching and Learning,* 101, 3-13.

Williams, J.S. *Embodied multi-modal communication from the perspective of activity theory*, *Educational Studies in Mathematics* 70, no. 2(2009) : 201-210. eScholarID:87739 | DOI:10.1007/s10649-008-9164-y.