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The Degree of Knowledge that Faculty Members in Colleges of Science and Engineering Possess Regarding Ways and Methods of Using Computers and Modern Technology in a Constructivist Learning Environment

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ABSTRACT

This study aims at identifying the degree of knowledge that faculty members in colleges of science and engineering possess regarding ways and methods of using computers and modern technology in a constructivist learning environment, and the impact of their academic expertise on this knowledge. This was achieved through a questionnaire designed according to the principles of the Constructivist Theory. The results indicate that the knowledge of faculty members about the use of computer technology in teaching is only limited to the use of their technical skills in IT and computer. It appears that their familiarity with the representation of knowledge in different ways is high, but they are not familiar with the methods of designing learning situations in an exploratory context through technology, nor are they familiar with employing this technology to develop higher-order thinking skills. Moreover, faculty members do not have the knowledge of how to give students real roles and effective participation; and how to assign them authentic tasks to be implemented in an effective manner. In brief, the study shows that faculty members in science and engineering faculties do not have knowledge of using computer and technology in a constructivist learning environment appropriately.

Key Words: Science and Engineering Teaching; Higher Education; Modern Technology; Constructivist Theory; Professional Development for University Instructors.

INTRODUCTION

Learning and teaching processes in the twenty-first century require the necessity to use modern technology in a way contrary to the traditional pattern which is confined only to increasing students' ability to remember and repeat the facts. The intended use of modern

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technology nowadays aims at developing the skills of collecting, organizing and evaluating information in order to employ them in problem solving and devising practical ideas in a learning environment similar to reality (Jimoyiannis, 2010).

The efficiency of using information technology and computer in all teaching stages, including university, whether in classrooms or in scientific laboratories, is undeniable (Rsaa'i, 2007; Amer, 2004; Dawson, Forster, & Reid, 2006) as well as the importance of technology and computer in developing thinking skills (Lim, 2007) and the possibility of using them effectively in teaching by problem solving approach (Markauskaite, 2007; Hennessy et al., 2005). Furthermore, computer and technology play a great role in helping students understand many scientific phenomena using simulation software. They can also be used for preparing and understanding graphs (Beichner, 1990; Ainsworth, 1999), scientific concepts in science and engineering, and other areas of knowledge (Bernhard, 2001; Hake, 1997). However, all these gains will not be achieved without the knowledge and expertise of university teachers in modern methods of teaching and learning, through which they can employ all kinds of technology in such a way that can result in positive gains for students and makes them build their knowledge by practicing science operations, let alone forming positive attitudes towards the integration of computer and technology in education (Becta, 2004; Davis et al., 2009; Hennessy et al., 2007; Jimoyiannis & Komis, 2007).

Theses pioneer roles for computer and technology in teaching increased the importance and necessity of professional development for faculty members. We realize that universities and higher education institutions spend big amounts of money to provide modern technology and teaching aids, as well as experts and technicians to sustain its operation. This modern technology requires faculty members who are familiar with it and have enough experience in using it efficiently in the process of university teaching, as the educational gains that can be achieved from the use of computers and technology does not rely on the degree of using them, but the importance lies in how use them (Kisla et al., 2009).

This underlines the need to identify the nature of computer, modern technology, literacy and skills used by faculty members in universities, to determine the type of training programs that elevate their performance and raise the level of their abilities to achieve learning excellence for their students. Especially if we know that the use of computer technology in education is characterized by an acceleration of the developments and trends of modern software, which aims to develop the educational process.

The fact that science and engineering are of the most undergraduate majors that require active roles of students in the learning processes, as they include practical aspects closer to reality. It's no secret the close relationship between technology, science and engineering; as technology is the most important tool for the access to new knowledge in science and engineering, and every new knowledge in these sciences is often employed to design new technology or to develop an available one.

Therefore, this study tries to determine the degree of knowledge of faculty members in colleges of science and engineering about methods and systematic use of computers and modern technology in a constructivist learning environment, and how this knowledge affects their academic expertise?

Theoretical Literature

Constructivist Theory in the teaching of science and engineering:

Constructivist theory emphasizes that learning is a process for building knowledge and not merely for transferring it from the teacher and receiving it by students (Ben-Ari, 1998). And, of the most important pillars of constructivist theory and hypothesis stipulates that learning is an active, meaningful, and cumulative constructive process based on reflective

thinking in a practical social environment through the implementation of genuine tasks similar to what the students face in their lives (King-Dow Su, 2008; Simons, 1993). Hence, constructivist theory emphasizes the interactive social context, as an important requirement for learning process, based on the fact that general understanding of the ideas and concepts in human life is a product of social negotiation about the meaning of these ideas and concepts (Jonassen et al., 1993).

Moreover, learning according to constructivist theory inspires students and makes them adopt and develop critical thinking abilities to solve problems that confront them in reality. Constructivist theory also offers wide applications in the educational curricula and modern teaching methods, these applications fall within the strategies of free discovery and problem-solving (Huang, 2002). Science and engineering are the most knowledge fields that we can employ the constructivist theory while teaching them, as they require laboratories, workshops, preparing worksheets, and writing reports; and they are considered from the most studying materials that are attached to the learner's life in all stages. In addition, learning inside the scientific laboratories and engineering workshops takes place in an interactive and communicative environment through a group of tasks executed in a free-exploratory or semi-controlled context in which the role of the university instructor is watching and guiding the learning process functioning properly.

Technology and Designing a Constructivist Learning Environment:

The contribution and the integration of modern technology in education has made significant strides in science and engineering education more than other areas of learning, such as presenting images and graphics, simulation programs, and computer software for scientific experiments in laboratories and workshops, which can be employed effectively in collecting and analyzing information in different ways. Modern technology is also used in the presentation and interpretation of the results of scientific experiments (Gillespie, 2006; Osborne & Hennessy, 2003).

Several studies suggest that computer and modern technology can provide significant opportunities for the design of constructivist learning environment, where the use of modern technology in education is strongly associated with the opportunities of the students' involvement and participation (Kuh and Hu, 2001). Therefore, we can employ modern technology as a means to increase the integration of the learner in the educational situation and giving him active roles in an effective, cooperative, and participatory manner, which helps him to achieve more learning and be more productive.

Despite the fact that modern technology will help greatly in the design of a constructivist learning environment, however, the effectiveness and the role of this environment to achieve learning properly require an understanding by the teacher for his role and his ability to design an exploratory context based on the appropriate learning and pedagogic theories; several studies have reported that this can be achieved through the following (Cunningham, Duffy & Knuth, 1993; Duffy & Cunningham, 1996; Partlow & Gibbs, 2003; Rovai, 2004; Lofstrom & Nevgi, 2008):

1. Constructivism proposes to give great importance to a context of learning that is far from memorization and remembering, and in return, emphasizes the knowledge-building and the implementation of activities similar or identical to experiences in the real world, through discussion between the working groups.
2. Learning environment must be flexible where knowledge is represented in different ways, as students learn in various patterns.
3. Regarding the role of computer and modern technology in the constructivist learning environment, constructivist theory scholars assert that they are not only be used to

merely display the information and knowledge, but must be used as a tool to support experimentation and knowledge-building.

4. Authentic teaching tasks based on the implementation of projects that need to use higher-order thinking skills.
5. The necessity to design learning situations that stem from the ideas and previous knowledge of the students, as well as specifying the type and way of the teacher's intervention in the educational situation.
6. One of the basic characteristics of a constructivist learning environment is cooperative learning, where students work together and help each other, which enhances the trend of social learning. This humane technique that is based on the principles of experience with the activeness and effectiveness it includes will achieve better learning results.
7. Feedback, support and guidance.

The design of a constructivist learning environment involving the use of modern technology requires the building of a network of interactive relations between the components of this environment (content and methodology or pedagogy, methods of communication, technology), as well as defining the roles of both the teacher and the student, and the appropriate evaluation mechanisms. This process needs training and high proficiency and aims at building an interactive social environment in which the learner advances in an exploratory context and authentic learning tasks. All of which occur through the technological medium, as shown in Figure 1.

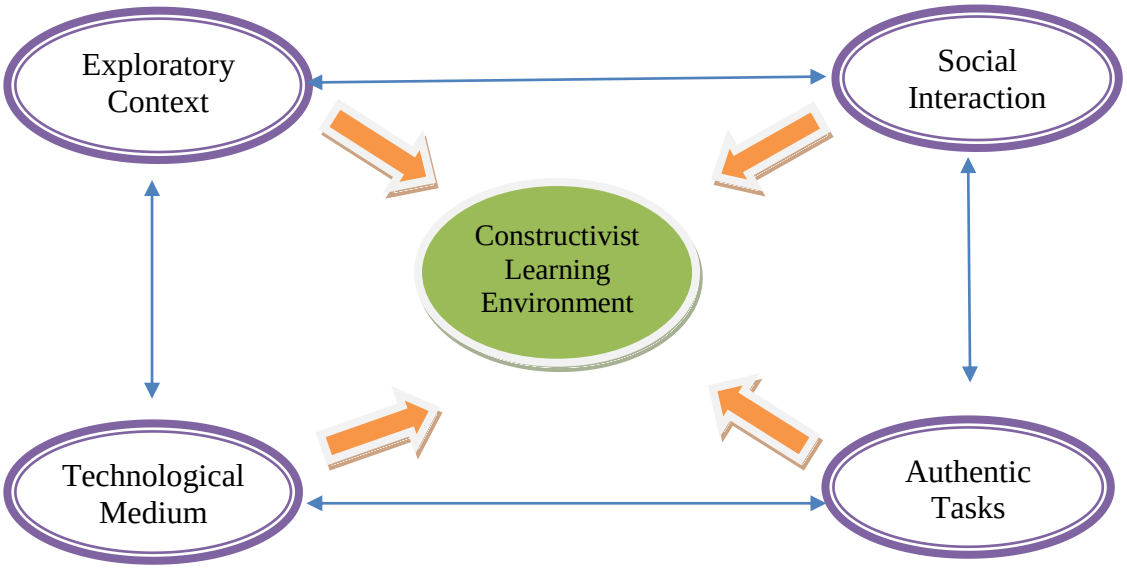

Figure 1. *Constructivist Learning Environment*

METHODOLOGY

a) Study Procedures

This study aimed at determining the degree of knowledge that faculty members in colleges of science and engineering possess regarding methods and systematic use of computers and modern technology in a constructivist learning environment and the extent of which this knowledge is affected by academic expertise. To achieve this goal, a questionnaire was designed to identify the degree of knowledge of faculty members about methods of

employing computer and technology in a constructivist learning environment. This questionnaire was distributed to the faculty members at Al-Hussein Bin Talal University in the south of the Hashemite Kingdom of Jordan.

b) The Study Sample

Most of the faculty members in the faculties of Science and Engineering at Al-Hussein Bin Talal University in Jordan were members of the study sample. What follows is a clarification of the characteristics of this sample according to the variables: college, academic rank, and teaching experience, where table 1 shows the academic ranks and the distribution of members of the study sample.

Table 1. *Academic Ranks of the Members of the Study Sample*

Faculty	Academic Rank	Number	Total
Science	Professor	2	19
	Associate Prof.	4	
	Assistant Prof.	10	
	Lecturer	3	
Engineering	Professor	1	21
	Associate Prof.	2	
	Assistant Prof.	12	
	Lecturer	6	
			40

Table 2 shows the teaching experience of the members of the study sample.

Table 2. *Academic Experience of the Members of the Study Sample*

Experience	Number
Less than 5 years	24
5 – 10 years	12
More than 10 years	4

c) Study Tool

The study tool was designed in its primary form relying on the applications of the constructivist theory in learning through computers and modern technology, and after having reviewed the previous studies, The study tool has been built in accordance with the requirements of the constructivist theory where he presumed that every requirement of the constructivist theory represents an area of study. It was also keen to include different educational situations in the classrooms, the laboratories and workshops. It was also pointed out all uses of technology in teaching science and engineering such as the use the university's website on the internet along with modern computer software in science and engineering, such as, Excel, SPSS, Flash, Java, AutoCAD, Adobe Premiere, and Movie Maker.

Moreover, it was taken into account the different thinking skills (thinking by ways of resolving the problem, convergent thinking and divergent thinking), then the questionnaire was presented to a group of experts in the field of education technology and a group of specialists in methods of teaching science and engineering, after conducting a series of proposed amendments, the questionnaire became comprising twenty articles within six areas as shown in table 3.

Table 3. *Areas of Study Tool*

Area	Number of Articles
Representing Knowledge in Different Ways	5
Realistic and Participatory Roles of the Students	3
High-order thinking Skills	5
Investigative, Exploratory Context	3
Collaborative Learning in a Social Environment	2
Authentic Tasks Executed Creatively	2

The stability of the study tool extracted through applying it on a sample consisting of (14) faculty members in the faculties of science and engineering, then re-applied it two weeks later. The value of the coefficient of stability to the tool was 0.91, which shows a high level of stability. The coefficient of internal consistency for the articles was calculated (Gronbach alpha) $\alpha = 0.83$

The degree of knowledge of a faculty member on each area of the questionnaire in addition to the overall average degree of knowledge was classified into three categories, as shown in table 4.

Table 4. *Knowledge classified categories*

Average	Description
1 – 2.5	Low
2.5 – 3.5	Medium
3.5 - 5	High

FINDINGS

After discussing the study and its objectives with the members of the study sample and coordinating to visit them in the classrooms and educational laboratories in order to monitor the methods of their use of computer and technology, their responses were emptied on the tool of the study (the questionnaire). Then the average of the degree of their knowledge about the ways and methods of designing a constructivist learning environment, the general average, and the average of each area within the categories (low, medium, high) were calculated, as shown in table 5.

Table 5. *Averages, Standard Deviations, and the Degree of the Study Sample Members' Knowledge of Every Area of Using Technology in a Constructivist Learning Environment*

Area	Average	S.D	Description (degree)
Representing Knowledge in Different Ways	3.785	0.766	High
Realistic and Participatory Roles of the Students	3.341	0.842	Medium
High-order Thinking Skills	2.050	0.474	Low
Investigative, Exploratory Context	1.075	0.463	Low
Collaborative Learning in a Social Environment	3.687	0.903	High
Authentic Tasks Executed Creatively	2.712	0.799	Medium
Total	**2.862**	**0.353**	**Medium**

As seen in table 5, the members of the study sample have knowledge of a high degree about the representation of knowledge in different ways, as well as the implementation of collaborative learning in an interactive social environment, while their knowledge was medium regarding giving students realistic roles and effective participation and assigning authentic tasks to them which are to be implemented in an effective manner. Moreover, faculty members in science and engineering faculties showed that they have a low degree of knowledge to achieve learning in an exploratory context that requires higher-order thinking

skills. Figure 2 shows the degree of differences in the knowledge of the members of the study sample about the elements of designing a constructivist learning environment that employs computer and technology.

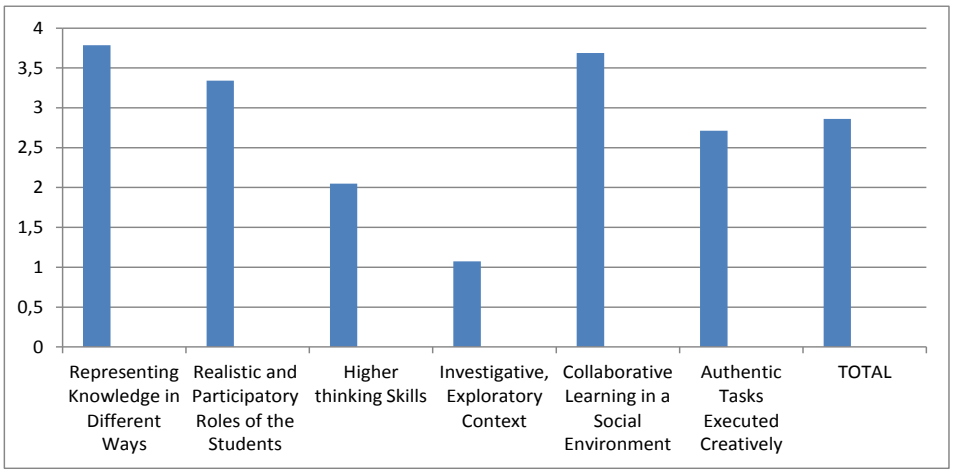

Figure 2. *Averages of the Sample Members' Knowledge of Every Area of Using Technology in a Constructivist Learning Environment*

To identify the impact of teaching experience on the acquisition of ways and methods of using computers and technology in a constructivist learning environment by faculty members, averages and standard deviations were calculated for the degree of knowledge of faculty members based on their experiences as shown in Table 6.

Table 6. *Averages of the Sample Members' Knowledge of Using Technology in a Constructivist Learning Environment Based on Their Experience*

Experience	Number	Average	S.D
Less than 5 years	24	2.845	0.385
5 – 10 years	12	2.862	0.281
More than 10 years	4	2.962	0.423
Total	40	2.862	0.353

To determine whether the differences shown in table 6 between the averages of the sample members' knowledge are statistically significant, the "One Way Anova" test was used as shown in table 7.

Table 7. *Results of the Variance Test (Anova)*

	Sum of squares	Degrees of freedom	Mean square	F	Significance
Between groups	0.047	2	0.023	0.179	0.837
Within groups	4.817	37	0.130		
Total	4.864	39			

It is inferred from the results of the analysis that there were no statistically significant differences in the degree of knowledge of faculty members in colleges of science and engineering about methods of using technology in a constructivist learning environment at F=0.179. In other words, the academic experience did not contribute to the development of the faculty members' knowledge in colleges of science and engineering education about methods of using technology according to the Constructivist Theory.

DISCUSSION and RESULTS

Using technology as a constructivist tool requires changing our understanding of teaching process. So, we should begin to prefer thinking and problem-solving to knowledge retention and memorization (Jonassen et al., 2003). Also, the integration of technology in education is linked to many issues, such as education policy and planning; the nature of the curriculum and pedagogy; equipment and readiness of the institution financially and technically; as well as the teachers' competence.

It is clear from the results of the study that knowledge of faculty members about the use of computer technology in teaching is only limited to the use of their technical skills in IT and computer. It was found that their skills in the representation of knowledge in different ways and patterns were of a high degree because they had received training in common computer skills, such as Microsoft Widows, Word, Power Point, Excel, and the Internet. It appeared that the teachers employed these programs In their service and to achieve their own goals, not to achieve the goals of the students, as many of them use several types of software and display devices to display information, forms, and tables. Meanwhile, the role of students in the course of this is just to watch these presentations without having any roles that make them real participants in the learning process.

Teaching science and engineering requires implementing some aspects of the teaching process in laboratories and workshops, where students are distributed in the form of workgroups to conduct experiments and projects in a collaborative way and in a social context, and to carry out a group of tasks in which computer and technology are used. That's why members of the study sample had big knowledge in collaborative learning skills and group work through authentic tasks and realistic roles for the students.

On the other hand, the study results showed that members of the study sample had little knowledge about designing learning situations that require high-order thinking skills in an exploratory context, using computer and technology. As faculty members reported that they didn't have any training regarding that aspect, and that they got used to teaching in a traditional way based on transferring information directly to the students, without letting them pass through real experience and use high levels of thinking. Faculty members also reported that the only chance students have to think and investigate is through answering the exams' questions or answering the questions at the end of each chapter they study, or through some learning situations they encounter during lectures. Thus, long academic experience didn't help in developing the performance and knowledge of faculty members in modern learning theories, which indicates a lack of interest in universities to raise the competency of their faculty members. It also indicates that there was a default on the part of faculty members in developing their abilities and knowledge in the use of modern and effective methods of teaching, which would improve the standard of their students and complies with the technical developments and information technology.

SUGGESTIONS

In light of these findings, it seems clear that it had become necessary for universities to rehabilitate their faculty members in the field of modern teaching methods and pedagogy, and to focus on making them acquire skills of employing technology not only as a technical tool but also as a cognitive tool. Furthermore, traditional criteria of evaluation are to be modified and developed to include students' competence in group work through projects that simulate the reality of their lives, and giving more space to measure high-order thinking skills and the ability to investigate and to explore through the use of computer and modern technology.

REFERENCES

Amer, M,I,K., (2004). Teaching chemistry through using the computer and the internet. *Fourth Arab Conference – Systemic Approach in teaching and Learning- Egypt, 683-712.*

Ainsworth,S,E., (1999). The functions of multiple representations, *Computers and Education* 33**,** 131–152.

Becta .(2004). A review of the research literature on barriers to the uptake of ICT by teachers, *British Educational Communications and Technology Agency*.

Beichner, R,J.,(1990). The effects of simulations motion presentation and graph generation in a kinematics lab. *J Res Sci Teaching.* 27(8), 803–815.

Ben-Ari, M., (1998). *Constructivism in computer science education*. Acm sigcse bulletin, 30(1), 257-261.

Bernhard, J., (2001). Physics learning and microcomputer based laboratory (MBL) - Learning effects of using MBL as a technological and as a cognitive tool. *Proceedings of ESERA2001, Science Education Research in the Knowledge Based Society, Thessanoliki.*

Cunningham, D., Duffy, T., & Knuth, R., (1993). *Textbook of the future*. In C. McKnight (Ed.), Hypertext: A psychological perspective. London: Ellis Horwood.

Davis,N., Preston, C., & Sahin, I.,(2009). Training teachers to use new technologies impacts multiple ecologies: evidence from a national initiative, *British Journal of Educational Technology.* 40(5), 861–878.

Dawson, V., Forster, p, & Reid, D.,(2006). Information communication technology (ICT) integration a science education unit for pre-service science teachers; students' perceptions of their ICT skills, knowledge and pedagogy, *International Journal of Science and Mathematics Education.* 4, 345–363.

Duffy, T., & Cunningham, D., (1996). *Constructivism: Implications for the design and delivery of instruction*. In D.H. Jonassen (Ed.), Handbook of research for educational telecommunications and technology: A project of the Association for Educational Communications and Technology (170–198). New York: Macmillan.

Gillespie, H., (2006). *Unlocking Learning and teaching with ICT: Identifying and overcoming barriers*. London: David Fulton.

Hake, Richard., (1997). "Interactive engagement methods in introductory mechanics courses". http://www.physics.indiana.edu/~sdi/IEM-2b.pdf

Hennessy,S., Ruthven., K & Brindley,S.,(2005) .Teacher perspectives on integrating ICT into subject teaching: Commitment, constraints, caution, and change, *Journal Curriculum Studies.* 37, 155–192

Hennessy, S., Wishart, J., Whitelock, D., Deaney, R., Brawn, la Velle L., & A. McFarlane *et al.*, (2007). Pedagogical approaches for technology-integrated science teaching, *Computers & Education.* 48(1), 137–152.

Huang, H. (2002). Toward constructivism for adult learners in online learning environments. *British Journal of Educational Technology*. 33(1), 27-37.

Jimoyiannis, A., & Komis,V.,(2007). Examining teachers' beliefs about ICT in education: implications of a teacher preparation programme, *Teacher Development.* 11(2), 149–173.

Jimoyiannis, A. **(**2010**).** Designing and implementing an integrated technological pedagogical science knowledge framework for science teachers professional development *Computers & Education.* 55(3), 1259-1269.

Jonassen, D., Mayes, T., & McAleese, R., (1993). *A manifesto for a constructivist approach to uses of technology in higher education*. In T. Duffy,J. Lowyck, & D. Jonassen

(Eds.),The design of constructivist 15 Designing Environments for Constructivist Learning (231-247). Berlin Heidelberg: Springer-Verlag.

Jonassen, D,H., Howland, J., Moore, J., & Marra, R,M., (2003). *Learning to solve problems with technology: A constructivist perspective*, Prentice Hall

King-Dow Su.(2008). An integrated science course designed with information communication technologies to enhance university students' learning performance *Computers & Education* .51(3), 1365-1374.

Kisla, T., Arikan, Y.D. & F. Sarsar (2009). The investigation of the usage of ICT in university lecturers' courses. *In Procedia Social and Behavioral Sciences* 1, 502-507.

Kuh, G,D., & Hu, S., (2001). The relationships between computer and information technology use, student learning, and other college experiences. *Journal of College Student Development, 42*, 217-232.

Lim, C,P.(2007). Effective integration of ICT in Singapore schools: Pedagogical and policy implications, *Educational Technology Research and Development.* 55, 83–116.

Lofstrom, E., & Nevgi, A.,(2007). University teaching staffs' pedagogical awareness displayed through ICT-facilitated teaching. *Interactive Learning Environments.* 16(2), 101–116.

Markauskaite, L. (2007). Exploring the structure of trainee teachers' ICT literacy: The main components of, and relationships between, general cognitive and technical capabilities, *Education Technology Research Development.* 55, 547–572.

Osborne,J & Hennessy,S.,(2003). *Literature review in science education and the role of ICT Promise, problems and future directions*, Nesta Future Lab, Bristol.

Partlow, K,M., & Gibbs, W,J., (2003). Indicators of constructivist principles in Internet-based courses. *Journal of Computing in Higher Education*. 14, 68–97.

Rsa'i, M,S, Al-Ani, A., & Al-qaderi, S.,(2008). The Effect of Using Computer Multi-Media on University Students' Understanding of the Physics Concepts. *College of Education Magazine*, University of UAE, 25(24), 158-180.

Rovai, A,P., (2004). A constructivist approach to online college learning. *Internet and Higher Education*. 7, 79–93.

Simons, P, R, J., (1993). *Constructive learning: The role of the learner*. In T. M. Duffy, J. Lowyck, D, H., Jonassen, and T. M. Welsh (Eds.), Designing Environments for Constructive Learning (291-313). New York: Springer-Verlag.