journal of
Adolescent and Youth Psychological Studies
www.jayps.iranmehr.ac.ir

Summer and Fall 2022, Volume 3, Issue 2, 88-95

Determining the comparison of the effectiveness of traditional education and combined education based on the theory of cognitive load in high school female students of district one of Kerman

Farzaneh. Shiralinejad[1], Masoud. Ghasemi*[2], Susan. Emamipour[3]

1. *PhD Student, Department of Psychology, Central Tehran Branch, Islamic Azad University, Tehran, Iran*
2. *Assistant Professor, Depratment of Psychology, Central Tehran Branch, Islamic Azad University, Tehran, Iran*
3. *Associate Professor, Depratment of Psychology, Central Tehran Branch, Islamic Azad University, Tehran, Iran*

ARTICLE INFORMATION

Article type
Original research
Pages: 88-95

Corresponding Author's Info
Email:
ghassemi64@yahoo.com

Article history:
Received: 2022/07/17
Revised: 2022/09/27
Accepted: 2022/10/24
Published online: 2022/11/03

Keywords:
traditional education, combined education (electroscientific), cognitive load, students.

ABSTRACT

Background and Aim: communication technology has had a tremendous impact on teaching-learning opportunities in various educational situations, including education; Therefore, the aim of the current research is to investigate the comparison of determining the effectiveness of traditional and combined education based on the theory of cognitive load in high school female students. **Methods:** This research is included in the group of experimental researches in which immediate and delayed pre-test-post-test design was used along with the control group. The statistical population of this research is made up of all the students of girls' schools of the second period of secondary school in one district of Kerman city, with a volume of 7200. According to the size of the population, the sample of this research consists of 45 female students in the age group of 18 years who were selected by multi-stage cluster sampling method and within each cluster, in a simple random manner. And a combination was designed and then implemented on the students of the experimental groups, each group of which was 15 people. In order to evaluate the effectiveness of these two educational methods, the dependent variable of cognitive load was measured in the area of internal and external cognitive load. The instrument for measuring these variables was the Pass and Van Merenboer (1994) questionnaire. Data analysis was done in quantitative and qualitative sections. **Results:** The results of the research showed that the level of satisfaction of the learners from the combined approach is significantly higher than the traditional group (P=0.01 <0.05 and F=1.36). The comprehensive students present in the course also expressed more satisfaction with blended learning compared to the traditional approach. In the field of learning, the results show that the learning rate of the students who participated in the combined training course is higher than other courses (p=0.01 < 0.05). **Conclusion:** Therefore, the education of students should be done in a multimedia way and technologies It should be updated, and in it, special attention should be paid to the principles of processing and cognitive load effects in order to reduce the external cognitive load, maintain the desired cognitive load and manage the internal cognitive load, as well as pay special attention to the lessons of the learners in order to maximize the efficiency of the students in terms of academic progress.

How to Cite This Article:
Shiralinejad, F., Ghasemi, M., & Emamipour, S. (2022). Determining the comparison of the effectiveness of traditional education and combined education based on the theory of cognitive load in high school female students of district one of Kerman. *Jayps*, 3(2): 88-95.

Introduction

With the expansion of new information technologies and educational technology of communication with others, access to information and, in general, all aspects of life have undergone a vast transformation, and the computer has become an integral part of our society. In this regard, the teaching and learning course has not been an exception to this rule. The development of information and technology has caused the educational system to move from its traditional process to multimedia and hybrid. Therefore, the traditional approaches to learning have changed with the advent of the multimedia educational system, which in turn has caused educators and educational institutions to design the desired methods of learning and teaching learners in the shortest time, the materials and contents they want to a wide number of addressees, pupils, students and all learners in the matter of education in any direction and field (Kian, Abedini, and Zandavanian, 2017).

Hybrid, virtual education is a thoughtful combination of virtual and face-to-face learning experiences and teachings. It provides diverse conditions through face-to-face and virtual oral and written communication in a way that both covers the shortcomings of the traditional education system and presents the strengths of the new approach by responding to the learner's needs by consciously choosing face-to-face methods and combining them with electronic tools (Belens, Vote, & De Wawer, 2018). Along with these issues, among the topics that educational designers should consider in designing lessons and materials, the theory of cognitive load aims to present materials that align with learners' cognitive capacity. In such a way that the design and presentation of lessons are compatible with human learning processes in the educational system, the use of cognitive load theory is an example of this effort in the design of the educational process and is based on the assumption that communication channels have a limited capacity to transmit content and provide information. Cognitive load theory has been developed based on our knowledge and awareness of human cognitive architecture (Abdi & Rostami, 2016).

Today, due to the vast transformation that has occurred in education in the world, unfortunately, traditional and common methods of education are still used in most Iranian schools, methods that are teacher-centered and student-centered, and grades are the criteria for identifying weak and strong students. Using computers in various subjects can be considered a stimulus for learning. The use of new educational technologies at the school level has increased students' interest and motivation to learn and are involved in learning, which leads to faster and better learning (Gholami Chekhand, 2015). Theories about multimedia learning can be placed at different levels. At a basic level, psychological theories describe memory systems and cognitive processes that explain how different types of information are processed and how different types of learning occur. Cognitive load theory is one of the topics developed in educational psychology based on the information processing point of view to support the process of active data processing in working memory. In fact, the main effort of educational designers should be to design lessons in a way that is compatible with human learning processes. The use of cognitive load theory is an example of this effort in educational design. Pass et al. first presented the cognitive concept at the University of NSW in 1950. This theory states that human cognitive capacity is limited, and we can process a limited number of information units simultaneously (Zanganeh, Ponaki, and Haghdoost, 2014).

Blended instruction is a combination of the strengths of traditional and electronic education methods. It includes all analytical and general issues simultaneously, and its supporters believe that blended instruction provides more satisfactory results than traditional and electronic learning. It also causes students to learn this integrated method differently and better than in a traditional classroom (Javadi & Bagchesara, 2016). Therefore, based on the studies, using only electronic education in schools is impossible. Besides, Traditional methods and teacher-centered teaching have been criticized for years for creating superficial and ephemeral learning. Thus, the new paradigm of combined education with unique features is replacing. It is obvious that considering the advantages of traditional education methods and using this method alongside modern methods while completing the disadvantages will provide the possibility of realizing deep and active learning (Kaplan & Haenlein, 2016). The need to use the

proper method in education is so essential that educational science practitioners emphasize the importance of using suitable methods in this process. Therefore, to increase the efficiency and activate the students in the relevant course, which increases their skills in creativity and innovation, applying the principles of cognitive load theory effectively creates a variety of educational programs that lead to their academic progress in all fields. So that the relevant training leads to the creation and increase of desirable cognitive load and the reduction of undesirable cognitive load in students' learning (Norouzi & Razavi, 2015). According to the discussed issues, the current research's main question is whether traditional, combined (electro-traditional) educational methods have a different effect on the attention to the role of cognitive load in students.

Method

According to the objectives, the current research examines and compares the effectiveness of two approaches of traditional and combined (electro-traditional) education on cognitive load theory. This research design is an experiment of immediate and delayed pre-test-post-test with a control group. In this design, the dependent variable (cognitive load), before and after the implementation of the intervention by independent variables (traditional training and combined training (electro-traditional), is measured in the experimental groups, and its results are compared with the control group. The statistical population of the intended research includes all the girls' school students in the second year of high school in the first district of Kerman city with a volume of 7200 people. The statistical sample size was considered to be 45 people according to the size of the population and the research method. To conduct the screening study, the participants were selected using a multi-stage cluster sampling method, and within each cluster, they were selected randomly.

Tools

1. Paas and Van Merriënboer Cognitive Load Scale (1994): This scale has 4 items with a nine-point Likert scale (from very low mental effort to very high mental effort). Each material has a value load between 1 and 9 cognitive loads with questions such as: "How difficult was it for you to understand and understand the presented material", measuring the cognitive load. The reliability of this scale was reported in the study of Pass (1992) and Pass van Merriënboer (1994); the Cronbach's alpha of this scale was 0.90 and 0.82, respectively. In Mahboubi et al.'s study (2013), the homogeneity of the cognitive scale through Cronbach's alpha was 0.86. The test-retest reliability is reported as 0.86. In the present study, the reliability of this questionnaire was obtained using Cronbach's alpha of 0.80 and the retest reliability of 79%.

2. The traditional teaching: It was conducted in the usual and face-to-face manner. The tools used in traditional education were: ordinary whiteboards and markers. The traditional teaching method was such that the teacher had the main role in the teaching process and presenting the material to the students. In fact, the same common method the teacher teaches them is by lecturing and writing on the whiteboard and explaining the relevant materials based on the cognitive effects and theory. The learners, often as listeners of educational materials, are taught in a traditional classroom environment face to face. The students were trained verbally and visually by listening, seeing, and interacting with the respective teacher. After the teacher's teaching, they answered his questions and did their homework, but they did not participate much in the teaching and learning process.

3. Combined teaching (electro-traditional): It is a combination of traditional and electronic methods. In this method, both the sessions for the presentation of educational content and the way of presenting the content are held in a combination of the traditional and common method and the face-to-face, and virtual online and offline e-learning method based on the theory of cognitive load. In the combined teaching method, topics were divided among the students with the coordination of the respective teacher, and the students carried out the teaching process cooperatively with the teacher's help. In combined education, unlike the traditional method, the teacher was not only a theologian, but the students had the main role in the teaching process, and the teacher here acted as a guide and provided supplementary explanations when necessary, pointing out the learners' faults and Completing incomplete issues paid. The way of presenting the material was also like this, the students who were in charge of teaching were asked before the class to briefly review the course material using electronic tools such as the Internet, PowerPoint, through a smart board with a pointer, projector (devices audio and visual aid), slides and Word, prepare the desired topic for the lecture, which will be 5 regular class sessions of face-to-face and face-to-face meetings between the teacher and the students,

teaching and transferring the content with the participation and cooperation of the learners and the relevant teacher and 5 other sessions, the students who taught, in the face-to-face electronic way by placing the materials on the smart board or electronic education in a virtual form at the same time; For your classmates who were present in the Shad system, LMS, or class groups at the same time, or offline for students who were not present in the mentioned systems or class groups during the scheduled class time, educational content using multimedia tools in the form of PowerPoint or they presented a video clip with special effects, and asked the rest of the students to do their homework in line with the desired topic.

Results

The results show that in the pre-test phase, the averages and standard deviations of the cognitive load variable of students in both groups are almost the same. However, in the post-test phase and follow-up after the implementation of the independent variable, there is a big difference between the groups. In addition, the findings show that the skewness and kurtosis are between ±2, indicating the variables' favorable condition for performing parametric tests. Considering that the current research design is of repeated measurement type, the repeated measurement variance analysis method was used for data analysis. The results showed that in the variable of cognitive load (P = 0.14 < 0.05, F = 1.36, and M-Box = 27.17), the significance level of Box's test is higher than 0.05. Therefore, the assumption of homogeneity of variance-covariance matrices has been observed. Moreover, in examining the assumption of homogeneity, the calculated error variances of Levin's test are not less than 0.05 for any of the investigated steps. Levine's test calculated for the cognitive variable in the pre-test stage (P = 0.72 < 0.05, 56 and 3F = 0.43), the post-test stage (p = 0.71 < 0.05, 0.46 56 and 3F), and the follow-up phase (P = 0.58 < 0.05, 56 and 3F = 0.65), was obtained.

The results show that the effect of measurement time on the behaviors related to cognitive load is significant, the product of Pillay and Wilks' Lambda, Hotelling, and the largest root test (F = 338.16, F2, 55, P =0.01), is significant. In the interaction between time and group, Pillai's test (F = 14.49, F6, 112, P = 0.01), Lambaday-Wilks (F = 33.23, F6, 112, F6, 112, P = 0.01), Hotelling (18 F = 0.01, P = 0.01, F = 112), and the largest root (F = 128.96, F6, 112, P = 0.01) was obtained. Therefore, according to the size of F and the level of significance, it can be said that this model is effective over time and the interaction of time and group on the behavior related to cognitive load, and the cognitive load of students is affected by the intervening variable. Therefore, each of the hypotheses will be investigated further. The results show that there is a significant difference between the two groups of traditional education and control in the two stages of cognitive load measurement (F = 114.33, F1,56,P = 0.01). So the average scores of the traditional group, combined in post-test and follow-up stages, are significantly higher in cognitive load variable than the control group

Conclusion

The present study aimed to determine the effectiveness of traditional and combined education based on the cognitive load theory in female students in the second secondary school stage. Therefore, no training without proper training design leads to effective learning. On the other hand, one of the requirements of educational multimedia design is to pay attention to the effects of cognitive load and their application in the teaching-learning process. The cognitive load theory can be used in a wide range of learning environments, especially multimedia educational environments, because it relates the design of educational materials to the principles of processing and the effects of cognitive load and reduces the cognitive load in learners and increases their academic progress. Mayer, 2009). The research results on participation and interaction in the education process in these methods show that each person's learning approach is the method of processing received information, and each person determines how to react to it. Knowing how to process information and evaluate learning styles helps learners to step in line with the goals of education and strive for learning at a broader level. According to the findings of Musa Ramezani, Kanani, and Valai (2012), four dimensions have been identified in the study of learning style; The first dimension is related to cognitive processes and is related to the connection of the information process to the learner, such as: understanding, thinking, problem-solving, memorizing and transferring it to others, deep processing of information and their practical application, which are collected in the form of educational multimedia includes. Based on the results from the statistical findings in the current research, in the traditional

education classroom, students are considered passive receivers of information, but this does not mean that the traditional method lacks any value. The traditional teaching method is useful for recalling information, but more is needed for higher cognitive skills and solving complex problems. One of the advantages of this method is that it gives a person the ability to learn a large amount of information quickly and helps a lot in absorbing, reproducing knowledge, and applying it in similar situations. However, at the same time, it causes a large amount of data to enter the memory. The retention power of the learner's mind increases and increases the external cognitive load to a great extent.

These results are in agreement with the findings of Sarikhani and Zare (2015), Mozhe Avar (2016), Belens, Vote and De Waver (2018), Kyun, Kalyuga, and Sweller (2013), Nowrozi and Razavi (2015), Ajam, Jafarabadi, Mahram and Ahanchian. (2012) and Owens and Sweller (2008), it is consistent. It can be concluded that the combined teaching method allows learners to learn the material in depth in a short time and interactively according to their characteristics by processing the information properly in the perceptual and cognitive systems. Moreover, by deeply processing the relationship between what they have learned and their performance, they can apply what they have learned in their practical life according to their daily needs. Students who participated and trained in combined courses perform much better, and their average grades are higher. In addition, this learning style leads to correcting the input information of the learners and causes the teacher to convey the information to the students in a way that has the least amount of undesirable cognitive load while dealing with different learners while doing class assignments and teaching different subjects. Education should be provided to all learners with a favorable and effective cognitive load. Because it causes the learners to build their knowledge actively, and by combining the information with the knowledge they have already acquired, they reach a better and more practical understanding of the material they are learning. According to the analysis of the obtained statistical results, all the above findings are consistent with the studies of Blens, Vote, and De Waver (2018), Ebrahimabadi (2018), and Mehboubi, Zare, Fardanesh, and Feizi (2011). It confirms them. In sum, According to cognitive load theory, since many traditional teaching techniques do not take into account the limitations of the human cognitive structure accurately and correctly, they cannot integrate the structure and function of the human cognitive system with the principles of educational planning. (Schnotz and Kerchner, 2007). The main premise of cognitive load theory is an educational design based on the characteristics of human cognitive structure. This article shows that education should take into account the limitations of working memory and emphasizes the necessity of this article that educational techniques should be designed in line with the practical principles of the cognitive system (Pas et al., 2010). Based on the results of recent studies, education based on the cognitive load theory should increase the learning results and minimize the perceptual and cognitive load. In this way, the design of educational environments based on the effects of cognitive load, which is optimized based on active learning, causes students to understand the value of learning and trust their abilities to conclude that they can learn and progress with acceptable effort (Zanganeh, 2015). In explaining these findings, it can be said that according to the hybrid education approach, many traditional and electronic education techniques alone do not pay attention to the process of applied education accurately and correctly and cannot integrate the structure and function of the cognitive system of learners with the principles of planning multimedia education (Omrani Saravi & Hemmati, 2017).

This article shows that education should take into account the limitations of each of the usual educational methods and emphasizes the necessity of this article that educational techniques should be in line with the practical principles of a multimedia system that considers all the necessary implications for the best performance of learners (Sweller, 2010).

Conflict of Interest

According to the authors, this article has no financial sponsor or conflict of interest.

References

Abdi, A., & Rostami, M. (2018). The Effect of Instruction Based on Cognitive Load theory on Academic Achievement, Perceived Cognitive Load and Motivation to Learning in Science Courses. Journal of Instruction and Evaluation, 10(40), 43-67.

Amirteymoori, M., & Zare, M. (2015). Cognitive load and multimedia education. Tehran: Allameh Tabatabaei Publication.

Ayres, P., & Paas, F. (2012). Cognitive load theory: New directions andchallenges. Applied Cognitive Psychology, 26, 827–832 .

Belens, R., Vote, M., & De Waver, B. (2018). The design of blended learning in response to student diversity in higher education: Instructors' views and use of differentiated instruction in blended learning. Computers & Education, 120:197-212 .

Betrancourt, M. (2005). The animation andinteractivity principles in multimedia learning. Chapter proposed to R.E. Mayer (Ed.) the Cambridge handbook of multimedia learning.

Ceylan, V., & Kesici, A. (2017). The Effect of blended Learning on Academic Success. Journal of human sicence. 14(1): 121-132 .

Clarke, T., Ayres, P., & Sweller, J. (2005). The impact of sequencing and prior knowledge on learning mathematics through spreadsheet applications. Educational Technology Research and Development.53 (5): 15–24.

De Jong, T. (2010). Cognitive Load Theory, Educational Research andInstructional Designs: Some Food for More Thought. Instructional Science, 38, 105-134.

Ebrahim Abadi, H. (2008). Comparison of the effect of two methods of teaching through the web network and traditional teaching on learning and motivation of the academic progress of the second year students of Mofid High School in Tehran. Doctoral dissertation, Tehran: Allameh Tabatabai University, Faculty of Psychology and Educational Sciences.

Esfijani, A. (2018). Investigating the Effects of Blended Instruction on Students' Academic Performance and Satisfaction. New Educational Approaches, 13(1), 45-66 .

Gerjets, P., Scheiter, K., & Catrambone, R. (2006). Can learning from molar and modular worked-out examples be enhanced by providing instructional explanations and prompting self-explanations? Learning and Instruction, 16, 104–121 .

Gerjets, P., Scheiter, K., Opfermann, M., Hesse, F. W., & Eysink, T. H. S. (2013). Learning with hypermedia: The influence of representational formats and different levels of learner control on performance and learning behavior. Computers in Human Behavior, 25, 360–370 .

Gholami, F. (2016). Evaluation of the curriculum implemented in the essay lesson in the seventh grade of the first period of high school. Master's Thesis of Educational Sciences, Department of Educational Sciences and Psychology, Ferdowsi University of Mashhad.

Javadi, H., & Baghchehsara, E. (2016). Blended Learning; Passing from Traditional and Electronic Learning. Global Conference on Psychology and Education, Law and Social Sciences at the Beginning of the Third Millennium, Shiraz. [Persian]

Kahyaoglu, M. (2013). A comparision between gifted students and non-gifted students' learning styles and their motivation styles towards science learning. Educational Research and Reviews, 8(12), 890.

Kalyuga, S. (2006). Rapid cognitive assessment of learners' knowledge structures. Learning and Instruction, 16 (1): 1-1.

Kalyuga, S. (2009). Cognitive load factors in instructional design for advanced learners. New York, NY: Nova Science Publishers, Inc .

Kalyuga, S. (2009). Managing cognitive load in adaptive multimedia learning. Hershey, PA: Information Science References (IGI).

Kalyuga, S. (2012). Instructional benefits of spoken words: A review of cognitive load factors. Educational Research Review, 7, 145-.951.

Kaplan, A, M & Haenlein, M. (2016). Higher education and the digital revolution: About MOOCs, SPOCs, social media, and the Cookie Monster. Business horizon, 59, 441- .054

Kaplan, A. M. (2014). European management and European business schools: insights from history of business schools. European management Journal, 32(4), 529-.435

Khosh Chehrerh, F. (2015). Designing and production of 6th grade math courseware based on Henich's model and its role in academic progress and the level of creativity of 6th grade girls' primary schools in district 1 of Kermanshah province. Master thesis of Islamic Azad University, Kermanshah branch.

Kian, M., Abedini, N., & Zandvanian Naeini, A. (2018). The pathology of the curriculum of the sixth grade of the elementary school. Journal of Educational and Scholastic Studies, 7(18), 99-122.

Kyun, S.; Kalyuga, S.; & Sweller, J. (2013). The effect of worked examples when learning to write essays in English literature. Journal of Experimental Education, 81(3), 385 – 408 .

Lee, C. H., & Kalyuga, S. (2014). Effectiveness of on-screen pinyin in learning Chinese: An expertise reversal for multimedia redundancy effect. Computers in Human Behavior, 27, 11–15.

Ling, Y., & Yang, l. (2017). Academic and learners, perceptions on blended learning as a strategic initiative to improve student learning experience. ENCON, 14(2): 54-76 .

Mahboubi, T. (2013). The Effectiveness of Instructional Design Principles (14 Multimedia Principles of van Merriënboer and Kester) on Learning Issues Cognitive Load and Learning in Multimedia Learning Environments. Educational Psychology, 9(30), 165-186 .

Marsh, D., (2003). Blended learning: Creating learning opportunities for language learners. 1th Ed. New York: Cambridge University Press.

Mayer, R. E. (2003). The promise of multimedia learning: Using the same instructional design methods across different media. Learning and Instruction, 13, 125-139.

Mayer, R. E. (Ed.) (2005). The Cambridge Handbook of Multimedia Learning.Cambridge: Cambridge University Press.

Mayer, R. E., & Moreno, R. (2009). Nine ways to reduce cognitive load in multimedia learning. Educational Psychologist, 38, 43-52 .

Moafian, F. (2002). Investigating the effect of combined training (electronic and conventional) on learning and self-efficacy of nursing students in the course of special cardiovascular care. Master's thesis in nursing. Kerman University of Medical Sciences, Bam International Campus.

Mohammadi, R. (2013). Ways to strengthen writing skills in the sixth grade students of education in the 9th district of Tehran. Master's thesis in educational management, Payam Noor University, Tehran, unpublished.

Mozhe Avar, F. (2006). The effect of computer-aided mathematics education on the attitude and learning of mathematics lesson of second-year female students of the mathematics department of Hashtgard high school. Master's thesis, Department of Psychology and Educational Sciences, Tarbiat Moalem University.

Najafi, H. (2017). The Relationship between the Dimensions of Blended Learning and Learning Quality: A Case of PNU. Information and Communication Technology in Educational Sciences .7(4(28)): 59-80. [Persian]

Norouzi, D., Razavi, S. (2016). Basics of Educational Designing. Tehran: Samt.

Omrani Saravi, B., Hemmati, N. (2010). Combined Learning. Tehran: Boshar with cooperation of Tohfeh.

Paas, F. G., Van Merriënboer, J. J. (1993). The efficiency of instructional conditions: An approach tocombine mental effort and erformance measures. Human Factors: The Journal of the Human Factors and Ergonomics Society, 35 (4), 737-743.

Paas, F., Tuovinen, J. E., Van Merriënboer, J. J. G., & Darabi, A. A. (2005). Amotivational perspective on the relation between mental effort andperformance: Optimizing learner involvement in instruction. EducationalTechnology Research and Development, 53, 25–34 .

Paas, F., van Gog, T., & Sweller, J. (2010). Cognitive load theory: New conceptualizations, specifications, and integrated research perspectives. Educational Psychology Review, 22(2), 115-121.

Papathanassiou, D. (2015). Cognitive load management of cultural heritage information: An application multi-mix for recreational learners. Social & Behavioral Sciences, 188, 57-73 .

Peairs, K. F., Putallaz, M., & Costanzo, P. R. (2019). From A (aggression) to V (victimization): Peer status and adjustment among academically gifted students in early adolescence. Gifted Children Quarterly, 63(3), 185-200 .

Phan, H. P., NGU, B. H., & Yeung, A. S. (2017). Achieving optimal best: Instructional efficiency and the use of cognitive load theory in mathematical problem solving. Educational Psychology Review, 29(4), 667-692

Plass, J., Moreno, R., & Brunken R. (2010). Cognitive load theory. New York: Cambridge University Press.

Salari, M., & Amir Teymouri, M. H. (2017). The Effect of Four-Component Instructional Design Model on the Extraneous Cognitive Load and Complex Task Learning. Educational Psychology, 13(44), 173-197.

Sarikhani, R., & Zare, M. (2015). The relationship between learning and extraneous cognitive load in multimedia instruction method in the chemistry course. Technical Journal of Engineering and Applied Sciences, 5, 418-421.

Sarmad, Z., Hejazi, E., Bazargan, A. (2011). Research Method in Behavioral Sciences. Tehran: Agah.

Scheiter, K., & Gerjets, P. (2007). Making your own order: Order effects in system-and user-controlledsettings for learning and problem solving. In order to learn: How the sequence of topics influences learning, 195-212.

Schnotz, W., & Kürschner, C. (2007). A reconsideration of cognitive load theory. Educational Psychology Review, 19(4), 469-508.

Schnotz, W., Fries, S., & Horz, H. (2009). Motivational aspects of cognitive loadtheory. In M. Wosnitza, S. A. Karabenick, A. Efklides, & P. Nenniger (Eds.), Contemporary motivation research: From global to local perspectives (pp.69–96). New York.

Shabani, H. (2007). Educational and educational skills, "teaching methods and techniques". Tehran: Samt.

Stel, M., & Beest, L.V. (2014). Limited capacity to lie: Cognitive load interferes with being. Judgment & Decision Making, 9(3), 199-206 .

Strenberg, R. (2016). Cognitive Psychology. Translated to Persian by Kamalodin Kharazi and Elahe Hejazi, Tehran: Samt .(

Sweller, J, Van Merrienboer, J. G., & Paas, F. (1998). Cognitive architectureand instructional design. Educational Psychology Review, 10(3), 251-296.

Sweller, J. (2004). Instructional design consequences of an analogy between evolution by natural selection and human cognitive architecture. Instructional Science; 32 (1): 9-31.

Sweller, J. (2010). Element interactivity and intrinsic, extraneous, and germane cognitive load. Educational Psychology Review, 22(2), 123-138.

Sweller, J. Van Merriënboer, J. & Paas, F. (2004). Cognitive architecture and instructional design. Educational Psychology Review, 10, 251–296.

Sweller, J., & Chandler, P. (1994). Why some material is difficult to learn. Cognition and Instruction, 12, 185–233.

Sweller, J., Ayres, P., & Kalyuga, S. (2011). Cognitive load theory. Springer Science & Business Media.

Sweller, J., Van Merriënboer, J., & Paas, F. (2004). Cognitive architecture andinstructional design. Educational Psychology Review, 10, 251-296.

Takir, A., & Aksu, M. (2012). The Effect of an Instruction Designed by CognitiveLoad Theory Principles on 7th Grade Students' Achievement in Algebra Topicsand Cognitive Load. Journal of Creative Education. (3) 2, 232-240.

Tarmizi, R. A. & Bayat, S. (2012). Collaborative problem-based learning in mathematics: A cognitive load perspective. Social & Behavioral Sciences, 32,344-350.

Tarmizi, R. A., & Sweller, J. (1988). Guidance during mathematical problemsolving. Journal of Educational Psychology, 80(4), 400-424.

Trannsue, B, M. (2014). Connectivism and information literacy: moving from learning theory to pedagogical practice. Public Services Quarterly, 9:3, 185-.591

Van Merriënboer, J., & Sweller, J. (2005). Cognitive load theory and complexlearning: Recent developments and future directions. Educational Psychology Review, 17(2), 147-177.

Van Merrinbur, J., & Ayres, P. (2005). Research On Cognitive Load Theory andIts Design Implication for E-Learning. Educational Technology Research and Development (ETR & D.), 53 (3).5-13.

Velayati, E., Kanani, M., & Mosavi Ramezani, S. (2013). The effect of cognitive load control on memorization and retention of English Grammar. The Journal of New Thoughts on Education, 9(1), 105-132.

Yousefi Konjedar, N., & Moosavipour, S. (2016). The Effect of Educational Films Showtime on Female Secondary School Students Learning and Rtention. Journal of Instruction and Evaluation, 9(35), 83-103.

Zakeri, A. (2001). Comparison of the effect of teaching with the help of educational software and the traditional method on the academic progress of the first grade students of middle school in the 8th district of Tehran. Master's thesis, Tarbiat Moalem University, Tehran.

Zangeneh, H., & Haghdoost, M. (2015). Theoretical and practical foundations of educational technology. Tehran: Avaye Noor.

Zare, M. (2014). Examining the external cognitive load of multimedia education based on Merrill's educational design model. Master's thesis; Allameh Tabatabai University of Tehran.

Zare, M., Sarikhani, R., & Mehraban, J. (2015). Investigation impact of educational multimedia designed on the principles of cognitive load on learning and retention in the teaching of biology. Journal of Analytical - Cognitive Psychology, 6(22), 61.