



The influence of educational type (virtual and non-virtual) and gender on the executive functions (mental flexibility and selective attention) of students

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ABSTRACT

The main Purpose of the study was to investigate the interaction between education and gender on the mental flexibility and selective attention in groups of virtual and non-virtual students. The population of the study includes the total population of industry engineering students of the virtual and non-virtual Tehran University of Science and Technology. The study was carried out in 2013. A random-cluster method was applied to select the sample. In total, 150 virtual and 148 non-virtual students were involved in this study. The sample group completed the Wisconsin and Stroop tests. The ANOVA variance analysis test was also applied in order to analyze the related data. Results: showed that the interaction between education and gender did not have an influence on selective attention and mental flexibility. However, it was found that only gender had an influence on mental flexibility. Specifically, boys had better function in this respect in comparison to girls. In addition, the virtual students had better function in terms of mental flexibility in comparison with the non-virtual students.

Key words: virtual education, executive functions, mental flexibility, selective attention

INTRODUCTION

Educational success in the information age not only depends on the knowledge skills of students but also increasingly depends on the processing skills. The ability to process information includes the ability to adjust the target, plan, prioritise, organise, be cognitively flexible and manipulate information in the memory. The collection of these skills is called the executive function (Meltzer, 2010). The executive function refers to the totality of the cognitive processes involved in high level conducting and controlling of behaviour (Hughes and Graham, 2000). This term is defined as the complex process that a Person performing a series of problem-solving behavior from beginning to end (Baxter et al., 1997). The first step involves perception in the arrangement associated with processing the information. For this reason, a person should pay attention to the subject in order to enter into the related perception (Groom, 2008). One of the executive functions is subject to selective attention (centralized). The selective attention ability is one of the most essential functions of the central executive system. This activity involves selecting a set of information and removing other information that is being considered (Kane and Engle, 2000; Baddeley, 1996). Another executive function is subject mental flexibility. This is the ability to change one's approaches, tasks and mental moods, such as by ignoring irrelevant tasks and engaging in suitable tasks (Miyake, Friedman, Rettinger and Hegarty, 2000). The elements of preservation error showed with Repetitive movements disable to adjustment and engaging with complicated issues, a lack of balance the motor activities and Inability to think and act in the face of changing environmental changes are specified (Hill, 2004). The requirements in terms of executive functions in order to achieve educational success have been shown in some studies. It appears that a virtual university assignments due to the breadth, diversity and require more reasoning and inference requires executive functions efficiently (TaghiYareh & Siadati, 2007).

The virtual educational environment has its own exclusive features in terms of the individual, such as the relationships, communications, interactions, flexibility and so forth, whereas the traditional educational setting does not have these feature (Cullen, Clark & Esson, 2011). In fact, one of the most promising and growing achievements of information technology associated with the internet is with regard to

learning/teaching communications; indeed, virtual education is the main foundation for the educational process aimed at people who do not operate in a real setting (TaghiYareh & Siadati, 2007). Many studies have been carried out in relation to virtual education; for example, Jefferson and Arnold (2009) have shown in their studies that a suitable educational approach should have bilateral features between the teacher and the student through the use of group-based educational task applying the most sophisticated technology available, such as information technology in the learning environment (Jefferson and Arnold, 2009). Sorensen, Mathiasen and Dalsgaard (2009) specified the effective factors involved in planning virtual educational courses in research aimed at modeling the virtual education process, particularly in college settings. It was shown In a research (Soltani, Hashemi and Sarafi , 2012) aimed at considering the effectiveness of a computer-assisted plan on working memory and on the students' executive function. They concluded that there is a significant difference between the students' executive functions with regard to mathematics disorder and those of normal students. Also the computer-assisted working memory had a significant impact on the students' executive function on the part of those with mathematics disorder (Soltani et al., 2012). The related challenge is subject to the suitability of the virtual educational systems because education and learning are taking place alongside a variety of other factors. Virtual education in the industrial Iranian setting is considered as the most dynamic and innovative technology in the field of telecommunications; therefore, the educational centers and institutions try to match these new innovative challenges alongside the standard educational structure of the country (Lin, 2001). In terms of what has been stated, the main purpose of the study was to compare selective attention and mental flexibility in two groups of students. In addition, the role of gender is considered seriously in this research because gender differences have been a challenging and widely debated topic in terms of cognitive function in recent years. Many different studies have been carried out with regard to the differences between men and women regarding to cognitive function (Allen et al., 2003; Gur et al., 2002; Shikhman, 2007; Wanlass, 2012; Speck et al., 2000 quoted in Teleb and Awamleh, 2012). However, according to Merritt et al. (2007) there have been various limited observations about the difference between the selective attention and the mental flexibility of men and women. Thus, due to what has been mentioned above, the main purpose of the study is to investigate the selective attention and mental flexibility of students (men, women) in virtual and non-virtual educational contexts, and respond to the question as to whether or not these educational affairs and gender can influence the executive function.

METHOD AND MATERIALS

The research plan involves a comparative study. The population of the study includes all engineering students in virtual and non-virtual educational institutions of the Industry and Science University in 2013. A random-cluster method was applied to select the samples. About 150 people (85 female and 65 male) from the non-virtual college and 150 people (68 male and 82 female) from the virtual college were sampled in this study.

Instrument:

- Wisconsin Card Sorting Test (WCST)

The history of the Wisconsin test structure dates back to when Grant began his studies under Berg at Wisconsin University (Berg, 1948 quoted of Strauss et al., 2006; Milner, 1963 quoted in Eling et al., 2008) by applying this test in patients with brain traumatic events. It was referred to as a neuropsychological test. Two forms of this case have been constructed; the most famous case is called the Nelson test and is a short form of the Wisconsin test (Gitzinger, 1990). The software form of this test involves the following: Four cards including one red triangle, two green stars, three yellow crosses and four blue circles are frequently displayed at the top of the monitor until the end of the test. 60 cards, with randomly arranged on the bottom of the screen appeared. Subjects must decide under which this card is the main card. The software is able to be opened directly in an SPSS program (Shahgholian et al., 2011). Two main outputs have appeared in this case: the number of categories completed (achieved) and the number of preservative errors as the main indices of measuring the executive reactions (Rhodes, 2004; Strauss, 2006). The content validity of the test has been confirmed by specialists (Axelrod et al., 1992). Discriminant validity of the revised Eysenck Personality Questionnaire was used in order to investigate the criterion validity of the test (Hollander and Wong, 1996). The results showed that the mean output of the Wisconsin data for both groups (high and low anxiety) was different (Kongs et al., 2000). The validity coefficient was estimated at 0.83 between the assessors of the test (Spreen and Strauss, 1998). Naderi (1996) reported the validity of this test as being 0.85 with regard to the Iranian population (Naderi, 1996). The reliability of the software is achieved in terms of internal consistency (Cronbach alpha coefficient) and Split-half coefficient. The findings showed that the test has a suitable level of reliability. The Cronbach's alpha coefficient for the number of categories completed (Achieved) is 0.73 and 0.74 for the number of preservative errors.

Also the Split-half coefficient is 0.83 and 0.87 for the number of preservative errors (Shahgholian et al., 2011).

- Stroop test:

This test was first applied by Stroop in 1935. It was used for evaluating the level of selective attention and cognitive flexibility (Stroop, 1935). The test has many different forms: paper-based, multiple languages and computer-assisted versions (Chen, 2011). The software form of the Stroop test has two steps: the first step is called naming the colour; the main aim of this step is to train the user in the technique used in the test; the second step is subjected to the display of 48 congruent and incongruent words (the congruent words are related to the colour of the word equally, but the incongruent words are different from the first case). The subject should press the button on the keyboard that only relates to the colour without considering the meaning of the same word (Zarghi et al., 2011). The results of this software are opened directly in an applicable SPSS program. The measured variables include the congruent error and the incongruent error, without the congruent response and without the incongruent response, the time of the congruent reaction and the time of the incongruent reaction, the mean time of the congruent reaction and the mean time of the incongruent reaction, as well as the interference score (Chen, 2011; Moering, Schinka, Mortimer & Graves, 2004).

Golden (1975) reported reliability coefficients of 0.85, 0.82 and 0.73 for the single versions, respectively. In the research undertaken by Ghadiri, Jazayeri and Ashayeri (2006) the number of the correct responses minus the number of wrong responses of the third try is measured; the reliability of the test is reported in terms of the test-retest method for three tries as 0.6, 0.83 and 0.97, respectively (Akbarzadeh et al., 2013). Also differential validity is used for the same validity of the test (achieved with regard to high anxiety patients) and a comparison of the same group is made with a healthy population (Najarian and BaratiSedeh, 1993, pp: 55-56).

Findings:

In Table 1, the descriptive indices of the virtual and non-virtual college students in terms of gender with regard to the executive functions are shown.

Table 1: Summary of the descriptive indices of the flexibility and selective attention of participants in groups of virtual and non-virtual students.

Gender	Elements	Mean	Deviation	Flank	Stretch
Female	Time of reaction	987.01	113.548	0.080	0.579
	Number of correct responses	43.61	4.200	2.314	-1.429
	Completed categories	3.10	1.802	-1.69	-0.135
	Preservative error	9.096	6.009	-0.568	0.862
Male	Time of reaction	986.12	126.383	12.844	-3.125
	Number of correct responses	43.02	7.156	1.403	0.486
	Completed categories	3.61	1.831	-0.655	-0.344
	Preservative error	6.893	6.291	6.423	2.013
Virtual	Time of reaction	984.06	122.859	0.815	0.835
	Number of correct responses	42.65	4.740	4.954	-1.729
	Completed categories	3.84	1.683	-0.578	-0.406
	Preservative error	8.217	6.076	4.473	1.521
Non-	Time of	989.26	115.612	0.757	0.182

virtual	reaction				
	Number of correct responses	44.07	6.473	18.915	-3.793
	Completed categories	2.79	1.828	-1.052	0.020
	Preservative error	8.027	6.389	1.251	1.144

In Table 1 it can be seen that the different indices including the mean, deviation and stretch indices which show that the distribution of the scores of both female and male groups tend towards the normal distribution in terms of the measured variables.

First research hypothesis:

There is an interaction between the type of education (virtual and non-virtual) and gender in the representation of the students' selective attention variance. The elements of the selective attention speed (time of reaction) and selective attention accuracy (number of correct responses) were assessed in order to analyse the related research hypothesis. In the study of the selective attention speed, ANOVA analysis is used due to the existence of two independent variables (education and gender) and one dependent variable (reaction time). The condition of the homogeneity of variance using the Levine test was also evaluated. Due to the obtained degree of $F = 0.302$ and its degree of significance (0.824), the assumption of the homogeneity of variance was confirmed. Thus, Table 2 summarises the between subject effects.

Table 2: Summary of the between subject effects

Change resource	SS	DF	MS	F	Sig	ITA Square
Education	9045.588	1	9045.588	0.719	0.397	0.003
Gender	3286.244	1	3286.244	0.261	0.610	0.001
Education*gender	16709.856	1	16709.856	1.328	0.250	0.005
Error	3547337.081	282	12579.210			

According to Table 2, it can be stated that there is no significant difference was found between the mean scores of the virtual and non-virtual students regarding the time of reaction (speed of selective attention). This result is true in terms of the gender variable. In relation to the interaction between the type of education and gender, there have been some observations that indicate the interaction of these two variables is not significant in representing the variance in reaction time. Hence, with regard to the first hypothesis, the differences in the observations are not enough regarding the selective attention speed. In this study, selective attention accuracy due to the existence of two factors - type of education and gender and one variable - number of correct responses means that we can use ANOVA analysis. Due to the obtained degree of $F = 3.001$ and the degree of significance (0.031), the assumption of the homogeneity of variance was confirmed. Thus, Table 3 summaries the between subject effects.

Table 3: Summary of the between subject effects

Change resource	SS	DF	MS	F	Sig	ITA Square
Education	113.254	1	113.254	3.424	0.065	0.012
Gender	25.104	1	25.104	0.759	0.384	0.003
Education*gender	3.070	1	3.070	0.093	0.761	0.001
Error	9326.261	282	33.072			

According to Table 3, it can be stated that no significant difference was found between the mean scores of the virtual and non-virtual students regarding the time of reaction (speed of selective attention). This result is true in terms of the gender variable. In relation to the interaction between the type of education and gender, there have been some observations that indicate that the interaction of these two variables is not significant in representing the variance of the number of correct responses. Hence, the observations for accepting the first hypothesis are insufficient regarding selective attention accuracy.

Second research hypothesis:

There is an interaction between the type of education (virtual and non-virtual) and gender in terms of the explained variance in the students' mental flexibility. Elements of the number of categories completed (Achieved) and the number of preservative errors were assessed in order to analyse the related research

hypothesis. In the study of the number of categories completed (Achieved), ANOVA analysis was used due to the existence of both independent variables (education and gender) and a dependent variable (number of categories completed). The condition of the homogeneity of variance using the Levine equality test was also evaluated. Due to the obtained degree of $F = 1.011$ and its degree of significance (0.388), the assumption of homogeneity of variance was confirmed. Thus, Table 4 summarises the between subject effects.

Table 4: Summary of the between subject effects

Change resource	SS	DF	MS	F	Sig	ITA Square
Education	64.882	1	64.882	21.456	0.001	0.071
Gender	16.647	1	16.647	5.505	0.020	0.019
Education*gender	5.756	1	5.756	1.904	0.169	0.007
Error	852.775	282	3.024			

According to Table 4, there is a significant difference between the mean scores of the virtual and non-virtual students regarding the variable of the completed categories ($p < 0.05$). Also there is a significant difference between the mean scores of the boy and girl in terms of the same variable ($p < 0.05$). In relation to both education and gender factors, the mean scores of the virtual students are higher than those of the non-virtual students, and boys scores are higher than those of girls. The observations showed that the interaction of these two variables is not significant in the explanation of variance in terms of the number of categories. Hence, the observations are insufficient for accepting the second hypothesis. In the study of the preservative error due to the existence of the independent variable (education and gender) and one dependent variable (preservative error) ANOVA analysis is used. The condition of the variances' assimilation using the Levine equality test was also evaluated. Due to the obtained degree of $F = 1.048$ and its degree of significance (0.372), the assumption of the variances' assimilation was confirmed. Thus, Table 5 summarises the between subjects effects.

Table 5: Summary of the between subject effects

Change resource	SS	DF	MS	F	Sig	ITA Square
Education	21.682	1	21.682	0.729	0.394	0.003
Gender	450.997	1	450.997	15.154	0.001	0.051
Education*gender	99.621	1	99.621	3.347	0.068	0.012
Error	8392.450	282	29.760			

According to Table 5, there is no significant difference between the mean scores of the virtual and non-virtual students regarding the variable of the preservative error. However, there is a significant difference between the mean scores of the girl and boy students regarding the preservative error ($p < 0.01$). In relation to gender, the mean scores of the boys are lower than that of the girls. In relation to the interaction of education and gender, the observations showed that the interaction of these variables is not significant in terms of explaining the variance of the preservative error. Hence, the observations are not sufficient to allow us to accept the second hypothesis in relation to the preservative error, although the significance level is considerable ($\text{sig} = 0.068$).

DISCUSSION

The main purpose of the study was to investigate the impact of virtual and non-virtual education and gender on the selective attention and mental flexibility of the students. Due to the results obtained, the interaction of education and gender did not make has no influence on the other findings of the research. It can be claimed that gender is effective in terms of mental flexibility in that the boys had higher completed categories and lower preservative errors compared to the girls. In other words, the mental flexibility of the boys is higher than that of the girls. Also the education variable was evident in the completed categories; in other words, the mental flexibility of the virtual students was better than that of non-virtual ones. That is to say, the mental flexibility of the virtual students was better than that of the non-virtual students. No study of the interaction between education and gender effects on selective attention and mental flexibility, the research found. But the present study findings coincide with the research of Koshin, Boese and Ferraro (2000) and Teleb and Ovamlehe (2012) who showed no difference between men and women in terms of selective attention. However, this study does not coincide with the results of Dean and Erzerumluglu (2003), Der and Deary (2006), Riccio, Reynolds and Lowe (2001), Noble, Baker and Jones (1964), Welford

(1980), Adam, Paas, Buekers and Wuyts (1999), Barral and Debu (2004), and Rawls, Martin, Spierer, Peterson, Duffy and Corcoran (2010). All of these studies showed that differences exist between men and women in terms of selective attention. Also, it does not coincide with Jausovec's (2009) research regarding the better function of women in terms of selective attention in achieving verbal tasks.

The gender differences in terms of time of reaction (speed of selective attention) has been shown in many studies (Dan and Erzerumlugolu, 2003; Der and Deary, 2006; Riccio et al., 2001). It is specified that men have a fast reaction time compared to women, and this difference does not improve with practice (Noble et al., 1964; Welford, 1980; Adam et al., 1999; Dan and Erzerumoglou, 2003; Blug and Salvine, 1987). However, Teleb and Ovalmeh (2012) did not find any differences between times of reaction in terms of gender. In addition, other studies have suggested that the selective attention accuracy of women is higher than that of men (Baral and Debu, 2004). Other findings of the research are based on the influence of gender on the mental flexibility in both elements of completed categories and preservative error when it comes to improving the mental flexibility of boys compared with girls. This finding is incongruent with the research of Bueno, Miranda, Mastrorosa, Rosario and Coelho (2012), Chelune and Baer (1986), Rosselli (1993), and Su, Chen, Lee and Su (2008). Probably, in the results of the present study, the obtained differences are due to cultural differences in comparison with other studies, because the impact of culture on the performance of the test in many research verified (Shaun et al., 2008; Coelho et al., 2012; Heaton et al., 2005; Shu, Tien, Lunge and Chang, 2000). No study comparing gender in virtual educational on mental flexibility and Wisconsin Card Sorting Test research was found. However, for this finding can be explained by the mental flexibility; as the ability to adapt one's thinking from the previous location to the new location. Also, the ability to overcome habitual responses and thoughts to accommodate the new position is defined. (Deak, 2003; Moore & Malinowski, 2009). In addition, mental flexibility, the ability to simultaneously consider both aspects of an object, idea or position is called (Bigler and Liben, 1992). Based on these definitions, when a person is able to categorize the coloured cards simultaneously, that person demonstrates a high level of mental flexibility (Martin & Rubin, 1995). It seems that virtual education achieved with the assistance of a computer will optimise people in terms of their mental flexibility. This has been shown in the case of persons categorizing the Wisconsin cards under virtual education conditions (Hommel, Colzato, Van Leewen & Van Den Wildenberg, 2010).

CONCLUSION

Although decades have passed since the outbreak of the e-learning system, but the speed of such technology is rapidly increasing among all organizations and institutions. The application of this technology has its pros and cons just as with other issues. The main issue challenging the use of this technology is subject to the expense of this type of education. Knowing the benefits of such an education helps virtual universities to apply the same processes efficiently. Hence, this kind of research can assist institutions to clarify the benefits of applying the technology. Based on this, it is suggested that there is a need to more research involving large samples from different communities to compare the results in relation to the impact of culture on the related process.

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