Jelisaveta Šafranj, Ph.D.[1]
The University of Novi Sad, Faculty of Technical Sciences
Novi Sad, Serbia
Jelena Zivlak[2]
The University of Novi Sad, Faculty of Technical Sciences
Novi Sad, Serbia

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SPATIAL-VISUAL INTELLIGENCE IN TEACHING STUDENTS OF ENGINEERING

Abstract: The paper deals with the impact of teaching activities that cater for spatial-visual intelligence on students´ achievements in English for Specific Purposes (ESP). The objective of this research was to determine whether the application of a variety of language activities that encourage spatial-visual intelligence result in the improvement in learning English. The research was carried out on two groups of students (58) attending an ESP course. The first group was taught on teaching activities based on visual presentation, creating charts and bulletin boards, mind-mapping, imagination and visualization tasks. The second group was taught according to conventional language teaching practice. Students' language knowledge was tested at the beginning and the end of the course which lasted over the period of one semester. The data analysis was carried out through quantitative analysis which included descriptive analysis and using a series of repeated measures analyses of variance (ANOVA) in *Statistica* statistical software. Post-hoc Scheffe tests were also employed to see if there was any significant difference among the variables. The results show better achievements at the end of semester for the group which was exposed to teaching activities suited to learners with strong spatial-visual intelligence. When students are aware of their strong and weak intelligences, this knowledge may be utilized in their future learning. Teachers may design a syllabus taking advantage of a variety of teaching activities and use different tools and materials intended to cater for certain intelligences. It also helps strengthen creativity in teaching activity, and advances interaction with students.

Key words*:* English for Specific Purposes, Multiple Intelligence Theory, spatial-visual intelligence, teaching activities.

1. Introduction

The Multiple Intelligence (MI) Theory is highly applicable and appreciated in modern education due to its main claim that every individual has eight intelligences and they all work together in a unique way. It was proposed by Howard Gardner in his book "Frames of Mind", and subsequently developed by his team at Harvard University through Project Zero (Gardner, 1983). He offered a unique concept on intelligence and had a pluralistic view of mind which recognizes many different sides of cognition and cognitive styles, since people have different cognitive strengths (Gardner & Moran, 2006). The theory can alter our perception of learning,

[1] corresponding author savetas@uns.ac.rs jsafranj@eunet.rs
[2] zivlakj@gmail.com

since everybody owns all intelligences, but they are not developed equally (Waterhouse, 2006).

The definition of *intelligence* by Gardner is different in comparison with its more conventional usage, when it generally refers to an individual´s IQ (measurable on a Simon-Binet scale) or "g" meaning "general intelligence" as proposed by Charles Spearman in 1927. In MI Theory intelligences can be associated with an individual´s aptitude or potentials - the fact that an individual is either high or low in one specific area does not make him any more or less intelligent in the traditional sense. Here are the proposed intelligences:

- Verbal/linguistic intelligence is an ability to use language effectively and communicate well in speaking and writing. People who excel in this intelligence usually have a good vocabulary, like reading books and manipulate words and languages easily.
- Visual/Spatial intelligence is the ability to visualise space and objects within the mind´s eye. People who prefer to use this kind of intelligence would rather draw a picture than write a paragraph. They notice colour, shapes and patterns and how light falls on the object, and comprehend mental models.
- Logical/Mathematical intelligence is the ability to perceive and think using numbers and logic. People who excel in this intelligence like solving abstract problems and often do so by trial and error. They can see patterns in thought and logic as well as in nature. People who prefer to use logical/mathematical intelligence usually do well on standardized comprehension/written language tests.
- Bodily-Kinaesthetic intelligence is the ability to use one´s body and mimic another´s actions. People with a preference for this kind of intelligence generally have skills such as strength, balance endurance, flexibility and coordination. They use the body skilfully to express ideas and feelings to solve problems, create products or present emotion.
- Musical intelligence is the ability to recognise rhythm and tone. People who are musically intelligent can usually hear music in their heads and learn songs quickly. They like to play some musical instrument or spend hours listening to music. They easily recognize and use nonverbal sounds: pitch, rhythm and total patterns.
- Interpersonal intelligence is the ability to empathise with other people and perceive mood. People with a high preference for this intelligence always have a talent for understanding other people - their feelings, thoughts, motivations, moods, needs and their struggles. They can also use these skills to help and comfort people, to manipulate and persuade people.
- Intrapersonal intelligence is the ability to reflect and be introspective. People with a preference for this intelligence like to ponder questions like "Who am I?" or "What is the purpose of life?". Their goal is to understand themselves, so they take time to become aware of many different emotions that live inside them.
- Naturalistic intelligence is the ability to recognise differences in nature, and classify both the animal and plant kingdoms. People who excel in this intelligence are always concerned with observing, classifying and understanding the parts of the physical environment as well as show understanding of natural phenomena.

MI Theory is comparable to other theories of learner styles, such as VARK model (Fleming & Baume, 2006; Fleming, 2011), which considers four learning styles - Auditory, Visual, Kinaesthetic and Reading or Structure of Intellect (SI) theory from 1950s (Guilford 1950, 1967). However, Multiple Intelligence Theory is more suitable for the study due to the more convenient number of intelligences, learning styles, and aptitudes when adapting course materials. This theory provides sound essentials from which it is possible to distinguish weak and strong student learning areas and take advantage of that information by adapting teaching materials to make them more appropriate to the student´s preferences.

The theory can change the way people think about learning. For example, if a student realizes that he is strong in spatial-visual intelligence but does not excel in linguistic intelligence he can get a whole new perspective on his abilities and change his views about learning (Salem, 2013). In addition, he may practice his stronger intelligences and develop his weaker intelligences (Yenice & Aktamis, 2010). Some authors also argue that there are different ways to be intelligent within each category, reasoning that there is no set standard of features that someone should possess to be intelligent in a particular field of interest (Rahimi & Qannadzadeh, 2010). For example, someone may not be able to read, but could still be very linguistic because he excels in telling a great story or has highly developed oral vocabulary (Akbari & Hosseini, 2008). In addition, there are several factors that influence the development of multiple intelligence, and they include biological factors i.e. hereditary or genetic factors, personal life history i.e. experience with parents, teachers, friends, as well as cultural and historical background (Amiryousefi & Tavakoli, 2011).

Spatial-visual intelligence has been described as an ability to visualize or create an image which characterize the spatial world. According to (Haley, 2004) spatial intelligence considers the ability to mentally reconstruct or modify the outlook of objects in space, concluding with the representation of ideas (Sadeghi & Farzizadeh, 2012). Individuals with highly developed spatial intelligence are also sensitive of colours, shapes and forms. According to Haley (2001) this kind of intelligence also includes the aptitude to graphically represent spatial or visual ideas. People with highly developed spatial intelligence are often designers and architects (Qualter et al. 2012). When considering second language learning and teaching, various tasks such as different use of diagrams, concept mapping or pictures effectively facilitate students who excel in visual-spatial intelligence (Stanciu et al. 2011). This intelligence includes sensitivity to shape, colour, form, line, space, as well as the interactions that exist between these elements. It is also the ability to comprehend mental models, manipulate and shape them spatially and draw them in detail (Loori, 2005). Thus, specifically, people with highly developed spatial-visual intelligence (Ibmian & Hadban, 2013) are known to:

- be good at puzzle building
- be good at reading, writing and understanding charts and graphs
- have good sense of direction
- have good sense of sketching and painting
- have good sense of interpreting visual images
- think in pictures
- create mental images due to retain information
- enjoy looking at maps, charts, pictures
- enjoy watching videos and movies

According to Gardner, students can better understand their individual weaknesses and strengths when they identify their multiple intelligences (MI). Therefore, supporting students to develop their own MI profiles can facilitate them become more willing to purchase required skills for learning foreign language. Students' MI profiles can be used to prepare customized activities due to increase the learning process on the whole. Prior researches reported that MI theory had important implications for teaching language skills because it facilitated the use of metacognitive and cognitive strategies to encourage students to improve their attitude, comprehension, motivation, and language proficiency (Batt, 2008; Branton, 2004; Campbell et al. 2004; Chan, 2006; Christodoulou, 2009; Chen, 2004; Christion, 2004; Christion & Kennedy, 2004; Dylan, 2013; Savas, 2012). However, only a few studies have applied Gardner's theory at higher education. In Serbia, this topic failed to attract the attention of the researchers so far. Therefore, the current study is a contribution to teaching English to college students in our country.

2. Research Methodology

2.1. Purpose of the study

The subject of this research is the impact of the variety of language activities that encourage spatial-visual intelligence in learning English with students of engineering.

The research question is whether the application of a variety of language activities that encourage spatial-visual intelligence result in the improvement in learning English with students of engineering.
The objective of this research is to determine the outcome of the application of a variety of language activities that encourage spatial-visual intelligence result in learning English with students of engineering. Therefore, the research hypothesis has been stated as the following:
H1: Students of graphic engineering and design are good at spatial-visual intelligence since they are engaged in technical field of science as future engineering designers.

2.2. Sample

The research sample of 58 students was divided into two groups. The first group comprised 30 students, and the second group 28 students of graphic engineering and design attending an ESP course at the Faculty of Technical Sciences, University of Novi Sad in winter semester of academic year 2016/2017.

2.3. Research design

The first group of students was taught ESP using course-book level corresponded to the B2 level of the Common European Framework of References for Languages (CEFR). The teaching material included 10 units dealing with the most important areas of graphic engineering field of science and students were taught ESP according to teaching activities and instructional strategies that work best for students with highly developed spatial-visual intelligence. They were learning on exercises based on

a) visual presentation,
b) art activities, and
c) imagination games.

Inductive approach, where learners find rules themselves from examples of the language, was included as well. In addition, problem-solving tasks were used as learners focused mainly on mind-mapping, visualisations and metaphors; also, they acquired familiarity with the vocabulary and structures used through art materials, graphs, maps and picture library. In addition, the teaching activity included investigations and identification of relationships between different things as well as understanding complex ideas. The following teaching activities and instructional strategies were applied:

- *Visualisation* which included creating learners´ own "inner blackboard" in their mind where teaching material has been stored. Thus, students memorize spelling words, different rules or formulas, and essential things considering their vocation. Learners could close their eyes and picture what they have just read or learnt and then explain it to the whole class or draw if possible.
- *Colour cues* included creative ways of using colour as a learning device. It includes writing or drawing with colour markers in front of the class on the board. In addition, students are using colour pencils for their assignments, also students are encouraged to use different colour markers to colour code material used in teaching procedure.
- *Sketching ideas* includes drawing the main idea, core concept, central theme, or key point which has been taught; also, it was used for understanding some concept or idea. Students were used to making fast drawings that express central ideas.
- *Graphic symbols* include using drawings or depicting concepts or ideas to address different learners; for example, showing three states of matter by drawing a solid mass (heavy mark), a liquid mass (curvy mark) and gaseous mass (tiny spots).

The second group of 28 students was taught ESP on the modified teaching material in comparison with the first group. It included the same 10 units dealing with the most important areas of graphic engineering field of science but the language exercises and practice were written, organized and taught according to traditional linguistic strategies and involved:

- *Storytelling* included weaving main ideas, concepts, and teaching objectives into a story that is told to the learners, for example, teaching the notion of offset lithography which is the most widely used printing process, or explaining the process of prepress which includes all the steps carried out before the actual printing.
- *Brainstorming* about facts for initiating a group work, learners´ reflection and feelings about ideas and data, etc. Students were expected to communicate whatever they think that is significant, to make a learning situation where they are free from put-downs or criticisms, or use Venn diagram to organise information, mind map or outline a problem in focus.
- *Digital recording* offered students a possibility to present and express their language strengths, especially to students who have had poorly developed writing skills. They had an opportunity to make a recording of their thoughts and reflections digitally as an alternative mode of expression.
- *Journal writing* engaged students in creating written records considering a particular field of interest that were broad and open-ended or about particular matter or topic. It integrated multiple intelligences by using photos, drawings, sketches, dialogues, or some other non-verbal learning material.
- *Publishing* engaged variety of forms; students' writings were copied and circulated or keyed into a word-processing program and printed in multiple copies; students could offer their assignments to a Faculty magazine or they could be made public on their websites.

2.4. Instruments

Students' language knowledge was tested at the beginning and the end of their ESP course which lasted over the period of one semester. The pre-test was a diagnostic test and the post-test was language achievement test and both comprised of written and oral part.

Written part included reading comprehension; testing grammatical accuracy (verb form, verb use, collocations, word formation, linking words, adverbials, passive voice, conditional sentences, modals); vocabulary items (definitions, synonyms, matching, collocations); and translation from English into Serbian.

Oral part included reading a text from their English language course book, and conversation.

2.5. Data analysis

The data analysis was carried out through quantitative analysis which included descriptive analysis and using a series of repeated measures analyses of variance (ANOVA) in *Statistica* statistical software. Post-hoc Scheffe tests were also employed to see if there was any significant difference among the variables.

3. Results

3.1. Descriptive statistics

Descriptive statistics for variables used in the study are shown in Table 1, separately for all particular test parts, for Written and Oral parts and for the Final test score, for each group. Skewness and Kurtosis values suggest that distributions of the data are close to normal distribution.

Table 1. Descriptive statistic for all tested variables before and after the ESP course

Test	Group	Min_1	Max_1	M_1	SD_1	Sk_1	Ku_1	Min_2	Max_2	M_2	SD_2	Sk_2	Ku_2
Reading Compre-hension	1	51	100	72.40	15.56	0.28	0.43	52	100	77	14.88	0.00	0.43
	2	50	100	80.18	14.47	-0.51	0.44	52	100	81.46	14.25	-0.61	0.44
Gramma-tical Accuracy	1	57	100	76.13	12.58	0.41	0.43	58	100	81.23	13.05	-0.02	0.43
	2	56	100	81.57	13.39	-0.56	0.44	54	100	82.32	13.65	-0.65	0.44
Vocabulary	1	58	100	77.63	13.29	0.28	0.43	58	100	82.27	12.60	-0.21	0.43
	2	54	100	82.29	12.63	-0.59	0.44	55	100	82.93	12.51	-0.66	0.44
Translation from E into S	1	56	100	79.23	13.94	-0.13	0.43	60	100	84.43	12.97	-0.41	0.43
	2	54	100	81	14.10	-0.64	0.44	58	100	82.11	13.25	-0.68	0.44
Reading	1	60	100	77.33	13.63	0.43	0.43	60	100	82	11.26	0.20	0.43
	2	50	100	81.79	13.89	-0.52	0.44	50	100	85.71	13.45	-0.90	0.44
Conversa-tion	1	60	100	76.33	14.02	0.47	0.43	60	100	81	13.48	-0.10	0.43
	2	60	100	84.64	14.78	-0.59	0.44	50	100	85.71	13.17	-1.00	0.44
Written Part	1	57	100	76.35	12.74	0.37	0.43	58	100	81.23	12.01	-0.02	0.43
	2	55	100	81.26	13.19	-0.63	0.44	56	100	82.21	12.93	-0.67	0.44

Oral Part	1	60	100	76.83	13.36	0.58	0.43	65	100	81.50	11.61	0.28	0.43
	2	55	100	83.21	13.69	-0.57	0.44	60	100	85.71	12.38	-0.93	0.44
Final Score	1	59	100	76.59	12.61	0.54	0.43	64	100	81.37	11.40	0.24	0.43
	2	60	100	82.24	13.05	-0.56	0.44	99	100	83.96	12.21	-0.74	0.44

Note: E – English. S – Serbian. Subscription$_1$ refers to Group 1. Subscription$_2$ refers to Group 2. Min – Minimum. Max – Maximum. M – Mean. SD – Standard deviation. Sk – Skewness. Ku – Kurtosis.

3.2. Testing group differences

Group differences were tested using series of Repeated measures analysis of variance (RM ANOVA) in statistical software *Statistica 8.* After looking for the main effects of Group and Time of testing factors, we concluded that the factor called Time of testing had statistically significant main effect, while main effect for the Group factor has not been detected (Table 2). In other words, significant change in test scores over time was obtained.

Table 2. Main effects of Group and Time of testing

Test	Independent factor	*F*	*df*	*p*
Written Part	Group	.78	1	.381
	Time	**94.76**	**1**	**.000**
Oral Part	Group	2.56	1	.115
	Time	**42.87**	**1**	**.000**
Final Test Score	Group	1.64	1	.201
	Time	**88.80**	**1**	**.000**
Reading Comprehension	Group	2.50	1	.112
	Time	**51.56**	**1**	**.000**
Grammatical Accuracy	Group	.90	1	.346
	Time	**46.26**	**1**	**.000**
Vocabulary	Group	.64	1	.427
	Time	**33.63**	**1**	**.000**
Translation from English to Serbian	Group	.01	1	.937
	Time	**42.37**	**1**	**.000**
Reading	Group	1.48	1	.228
	Time	**33.02**	**1**	**.000**
Conversation	Group	3.38	1	.071
	Time	**11.06**	**1**	**.000**

Note. *F* - F-test value; *df* - degrees of freedom, *p* - significance test.

Testing interaction effects between the effects of Group and Test time offered better insight into understanding changes in test scores over time.

Overall results for Written part of the test showed that there is significant interaction between Group and Test time (F (1, 56) = 43.214, p = .000). Post-hoc Scheffe revealed that the only significant difference between pre-test and post-test scores was in Group 1. As it is visible in Figure 1, there was an increase in Written part test score in Group 1, while this kind of improvement was not detected for the participants in Group 2.

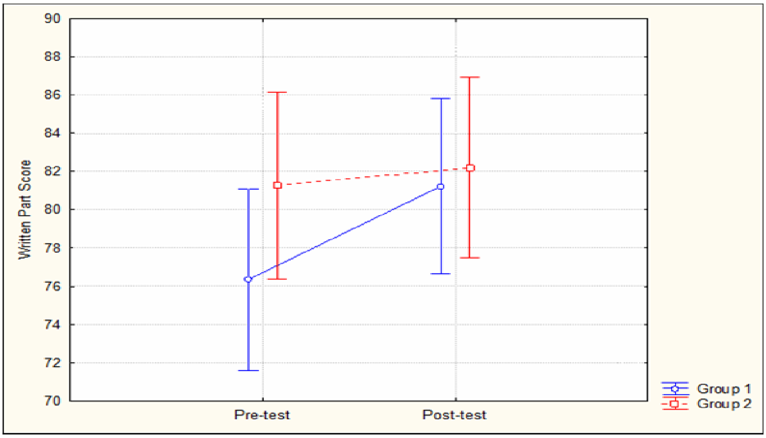

Figure 1. *Written Part pre-test and post-test scores for both groups.*[3]

In the same way, interaction between Group and Test time was tested for the Oral part of the English test. In this case, marginal significance of the interaction effect was obtained (F (1, 56) = 3.92, p = .052) and the post-hoc Scheffe test revealed that there are considerable differences between pre-test and post-test scores in both groups. But as it can be seen in Figure 2, line that represents test scores for the Group 1 has slightly bigger slope than the other one suggesting that there is a tendency for better improvement in test scores within the Group 1. Similar pattern is detected when interaction effect was tested for the Final test score. Significant interaction was obtained (F (1, 56) = 19.59, p = .000), but post-hoc Scheffe suggested that there is an improvement in test scores in both groups. As it was the case when visual inspection of the data was used for Oral part test scores, it seems like the slope of the line that represents change in Final test score for the Group 1 is slightly bigger (Figure 3). This means that we can assume that there is slightly bigger change in test score over the time within Group 1. We could expect that when larger sample is used only difference in pre-test and post-test scores would be detected within the Group 1.

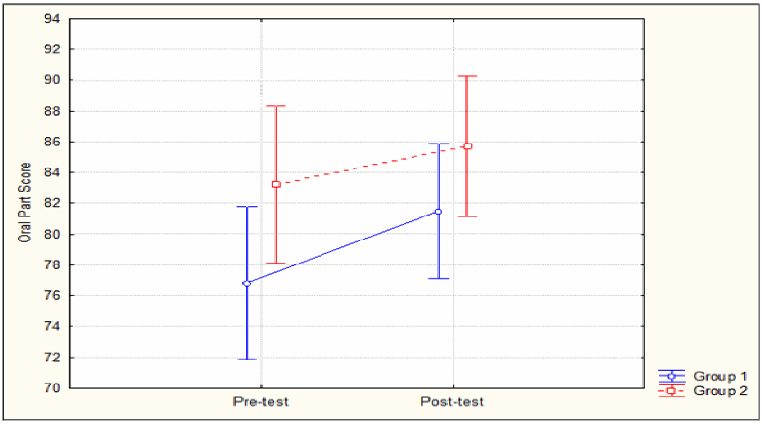

Figure 2. *Oral Part pre-test and post-test scores for both groups.*

[3] Vertical bars in figures denote 95% confidence interval.

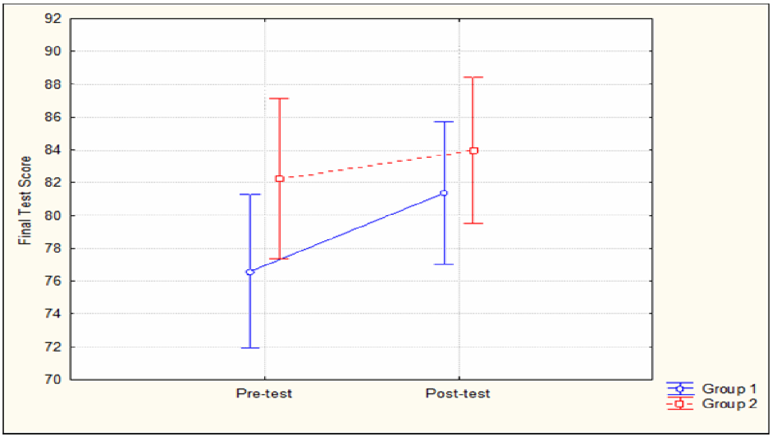

Figure 3. *Final pre-test and post-test scores for both groups.*

Finally, interaction effect between Group effect and Time of testing was calculated for each particular test part. For all test parts (except for Reading part) significant interaction was detected (see Table 3 for the results). Post hoc Scheffe test revealed that there is significant improvement in test scores only for Group 1, while Group 2 improved slightly after ESP course. For the Reading part only the main effect of the Time of testing proved significant (Table 2), which means that both groups improved equally. The fact that Reading and Conversation parts comprise Oral part of the test and that significant interaction was detected for Reading but not for the Conversation part could be used as an explanation of somehow blurry results regarding test scores for the Oral part as a whole.

Table 3. Significance of the interaction between Group and Test time for particular tests

Test	*F*	*df*	*p*
Reading comprehension	16.35	1, 56	.000
Grammatical accuracy	25.58	1, 56	.000
Vocabulary	19.24	1, 56	.000
Translation from English to Serbian	17.85	1, 56	.000
Reading	.24	1, 56	.624
Conversation	4.34	1, 56	.042

Note. F - F-test value. *df* - degrees of freedom. *p* - significance test.

Finally, the research hypothesis H1: Students of graphic engineering and design are good at spatial-visual intelligence since they are engaged in technical field of science as future engineering designers has been confirmed.

4. Discussion

The MI Theory is a useful tool for ESP teachers to further enhance the effectiveness of their input materials and thus, promote students success, since learners who are taught in a way they prefer, are more successful. Therefore, it was decided to examine the impact of teaching activities that cater for spatial-visual intelligence on students´ learning achievements.

Group 2 showed slight improvement in any of the particular tests except for Reading test in the oral part. On the contrary, Group 1 improved more between the diagnostic and achievement tests in every single particular test and, understandably, in their total test scores. However, when considering the oral part and the final score the conclusion is based on more marginal significance, but there are some tendencies that can be observed on the graph. It should be also pointed out that there is a marginally significant interaction effect in the oral part of the test because the difference is obtained for Reading comprehension, but not for Reading. In addition, it should be emphasized, that by plotting the results it seems likely to expect substantial differences at all test scores at larger sample of respondents. Thus, it is likely that instructions made significant changes in participant's success only in the case of Group 1, while Group 2 improved only in their Reading skills. It should also be noted that there were no statistical differences between Group 1 and Group 2 in how well they performed in the pre-test, placing these two groups in equal starting positions. Finally, the research hypothesis has been confirmed and it was shown that the application of variety of language activities that encourage spatial/visual intelligence resulted in the improvement in learning ESP with students of graphic engineering and design since they are engaged in technical field of science as future designers, i.e. people with highly developed spatial intelligence. These findings are consistent with the previous research studies (Branton, 2004; Chan, 2006; Cortright et al., 2015; Leimbach & Maringka, 2010; Posner, 2004; Saricaoglu & Arikan, 2014; Shore, 2004) which pointed out that the multiple intelligences theory was successfully used as a strategy for teaching English as a foreign language.

In addition, the research results reported that students who prefer to use spatial/visual intelligence learn English better through comprehending and dealing with mental models than writing a paragraph. Thus, teaching material selection and development is important because increases in-depth knowledge acquired through immersion, allows teachers to use non-language sources and adapt them to course requirements as well as the same time using ESP sources to their highest potential.

5. Conclusion

Teachers can take advantage of exercises, activities, techniques and materials that help trigger their students' intelligences and thus, encourage them to make use of different intelligences in the process of learning. Students may practice spatial/visual intelligence by providing many opportunities for visual mapping activities which encourage them to vary the arrangements of materials in space, such as by creating charts and bulletin boards. In addition, visual perception of the environment, and ability to create and manipulate mental images can be incorporated into teaching procedure through drawing, painting, sculpting, sharpening observation skills, solving mazes and other spatial tasks, and exercises in imagery and active imagination. Furthermore, in the ESP classroom for engineering students problem-solving tasks are useful as learners focus mainly on meaning, but through constant rereading of a text to solve the problem, they acquire a familiarity with the vocabulary and structures used (Modirkhamene & Bagherian 2012) and also develop and practice the ability to use mind-map activities and manipulate mental images effectively and reason well. This includes such skills as understanding the basic properties of symbols and principles of critical thinking as well (Albitz 2007; Richard & Rodgers 2007).

Many researches (Ibmian & Hadban 2013; Stanciu et al. 2011) reported that the application of Gardner's theory of multiple intelligences on language teaching activity has a considerable impact, therefore it brings about certain implications for language teachers. Since teachers make effort to enhance communicative competence and skills among their students, they should make them more aware of their intelligence profile, so students will be able to utilize their knowledge in future learning.

Another implication of MI theory for teachers is that by paying attention to all kinds of intelligences teachers design a syllabus taking advantage of a variety of teaching activities as well as different tools and materials intended to mix all intelligences, or in certain cases to foster the development of one target intelligence. Therefore, with regard to classroom instruction, teachers should provide conditions that encourage students to use all kinds of intelligence. Although some students might prefer to use just certain types, teachers should recognize and teach to a broader range of talents and skills that depend on a variety of intelligences. In addition, it helps strengthen the creativity in teaching activity, foster interaction with their students and encourages teachers to use teaching materials besides course books.

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***Biographical notes*:**

Jelisaveta Šafranj took her MA in applied linguistics in 2000, and PhD in English language and linguistics at the University of Belgrade, in 2008. She teaches ESP at the Faculty of Technical Sciences, University of Novi Sad. Her main interests are higher education, educational process at university, academic writing, psycholinguistics, applied linguistics, ESP and discourse analysis. She published three monographs on education and over 50 papers and conference articles in international journals.

Jelena Zivlak has a Bachelor with honors in English language and literature and psychology and is currently pursuing her MA in Psychology. Her main interests are psychology of teaching and interpreting. She teaches ESP at the Faculty of Technical Sciences, University of Novi Sad.