ICTE Journal

Volume 8 2019/1

International Journal of Information and Communication Technologies in Education

editorial

CONFERENCE "TEACHER – INSTRUCTION – INNOVATION"
Tomas Javorcik 3

articles

INVESTIGATING ISSUES IN COMPUTING EDUCATION: USABILITY FACTORS FOR THE USE OF AN OPERATING SYSTEM AMONG AFRICAN AMERICAN AND HISPANIC AMERICAN HIGH SCHOOL STUDENTS
Gabriel Estrada, Maurice Dawson, Jose Antonio Cárdenas-Haro 5

THE NATURE OF THE FACEBOOK GROUP LEARNING ENVIRONMENT: INSIGHTS FROM UNIVERSITY STUDENTS
Juraj Datko 20

SIX TECHNOLOGICAL INNOVATIONS THAT CHANGED ENGLISH LANGUAGE TEACHING
Jana Bekešová, Iveta Romanová 30

ICT AS AN ENHANCING TOOL OF FOREIGN LANGUAGE TEACHING CHILDREN WITH AUTISTIC SPECTRUM DISORDERS
Beáta Jelínková 39

INTERACTIVE LEARNING ENVIRONMENT SUPPORTING VISUALIZATION IN THE TEACHING OF PROBABILITY
Stanislav Lukáč, Tadeáš Gavala 48

ICTE Journal

International Journal of Information and Communication Technologies in Education

ISSN 1805-3726

Volume 8, 2019/1 (issued on March 31, 2019)

Editorial Board

Editorial Office

Kateřina Kostolányová (Editor-in Chief)

Tomáš Javorčík (Executive Editor)

email: ictejournal@osu.cz

University of Ostrava, Pedagogical Faculty

Department of Information and Communication Technologies

Fráni Šrámka 3, Ostrava-Mariánské Hory, Czech Republic

http://periodika.osu.cz/ictejournal/

Conference "TEACHER – INSTRUCTION – INNOVATION"

On Saturday, March 23rd, 2019, the Department of Information and Communication Technologies held a conference for elementary school teachers and principals. Judging by participant reviews, the conference was a success.

The various ways of using modern technology in education were presented to elementary school teachers and principals, as well as their potential future colleagues (the Pedagogical Faculty students), in the form of workshops.

The approximately 120 conference attendees could attend 24 workshops. Some of the workshops were so popular that they had to be presented multiple times. The following are some of the workshops presented at the conference:

- Augmented reality in education
- Use of iPad in teaching pupils with special educational needs
- Ozobot in instruction
- Minecraft in instruction
- iPad in mathematics instruction
- Use of tablets for programming
- Reading literacy with iPad

The positive reviews prove that the conference was successful and useful:

"I would like to thank you for an amazing event! I liked not only the fact that the conference was held on a Saturday (as I teach at a small school where there is not enough substitute teachers), but also that there were so many great workshops that I did not know which one to attend (I wished I could have cloned myself). What I liked the most, however, was that many of the workshops were aimed at programming for children. I have been a 3rd grade informatics teacher for a couple of years now, and have to say that children's approach to informatics changes every year. 8 years ago, children were not familiar with computers at all and had to learn the basics. 4 years ago, children had already learned how to use a computer at home, but they were glad they could create something on it at school. Today, the majority of children know how to use computers and touch devices and they are not interested in the things we used to do in informatics class. Therefore, I need new inspiration and I think children might actually be interested in using robotic toys. That is why I would welcome an event aimed at different kinds of programming (suitable for lower primary school pupils)".

"Extremely thought-provoking, but not enough "playing" time. The hour flew by. Next time, I would like to see it go from Monday through Friday with a shorter lunch break. I would not mind a conference fee, either. It was amazing. Thanks once again to all involved".

"I would like to thank the organizers for a successful and though-provoking conference. I left with many ideas to improve instruction".

Having received so many wonderful reviews, we can assure you that similar conferences will be held in the future.

This event showed us that a university can do more than produce scientific results. It can be an environment that encourages discussions and sharing of experience between teachers. This platform can also be beneficial for us scientists as it helps us understand the problems teachers face, allowing us to try and find solutions to them.

Tomas Javorcik

Executive Editor

sciendo

ICTE Journal

2019, **8**(1): 5–19
DOI: 10.2478/ijicte-2019-0001

INVESTIGATING ISSUES IN COMPUTING EDUCATION: USABILITY FACTORS FOR THE USE OF AN OPERATING SYSTEM AMONG AFRICAN AMERICAN AND HISPANIC AMERICAN HIGH SCHOOL STUDENTS

Gabriel Estrada[1], Maurice Dawson[2], Jose Antonio Cárdenas-Haro[3]

[1]Colorado Technical University, Colorado Springs, Colorado, USA {g.estrada8@my.cs.coloradotech.edu}

[2]Illinois Institute of Technology, School of Applied Technology, Center for Cyber Security and Forensics Education, Chicago, Illinois, USA {mdawson2@iit.edu}

[3]California State University, Bakersfield, California, USA {jcardenas23@csub.edu}

ABSTRACT

African Americans and Hispanic Americans historically have been underrepresented in U.S. jobs in the fields of STEM in large part because of the usability of technology. In this research, the goal was to discover the usability factors relative to operating systems that may limit African Americans and Hispanic Americans from pursuit of computer science higher education. For the purpose of this study, "usability" refers to the "appropriateness of purpose." Categorized by three factors, appropriateness of purpose can be defined as (i) the effectiveness of the users' ability to complete tasks while using technology and the quality or output of those tasks, (ii) the efficiency and the level of resources used in performing tasks, and (iii) the satisfaction or users' reaction to the use of technology (Brooke, 2014). This research examined quantitative analysis based on students' routine computer task knowledge using a survey questionnaire and the SUS. The population included high school students responding to questions on common tasks and usability. A web survey was conducted to assess the measurement and understanding pattern demonstrated by the participants. The quantitative analysis of the computer usability included ANOVA, independent t-tests and orthogonal contrasts. The analysis of the SUS measured usability and learnability. The results of the data analysis showed that the combined African American and Hispanic group has a mean computer usability score that is significantly lower when compared with the other ethnicities and the SUS findings included the highest gap among this most underrepresented group in the STEM field.

KEYWORDS

High school students, Higher Education, operating system, students

1 INTRODUCTION

This analysis represents a vital gap in research relative to the study of the usability of technology and the effects on African American and Hispanic American students' limitations for pursuing computer science in higher education. According to the Association of the Study for Higher Education (ASHE), African American students aspiring to attain a Science Technology Engineering and Math (STEM) degree, to

include computer science, have had the "lowest completion rate among all racial groups" (ASHE Higher Education Report, 2011). Approximately 13.2% of African American STEM degree aspirants completed their degree within five years; not far behind were Hispanic Americans at 15.9%. Additionally, empirical studies show Hispanics to be severely underrepresented among STEM graduates

2 BACKGROUND OF THE PROBLEM

Research has demonstrated that African-American, Hispanic-American and White students have considerably different educational opportunities. This is because White students fare better compared to African-Americans and Hispanic-Americans students in terms of quality of education, curriculum, school populations, all of which impact academic achievement. (Beasley & Fischer, 2012, p. 428). Despite the previous findings, no studies exist where usability was examined to determine limiting factors African American and Hispanic American students face relative to technology.

Nevertheless, where academic preparation may determine the underrepresentation of minority studies in STEM, studies also show that differences in preparation and socioeconomic background among these students continue to exist (Beasley & Fischer, 2012). In light of these, it is evident that underrepresentation of minorities in STEM is not caused by differences in aptitude but a combination of several important factors. One likely aspect of this condition is the usability of operating systems (OS).

3 STATEMENT OF THE PROBLEM

Minorities have historically been underrepresented in U.S. Jobs in the fields of STEM for a variety of reasons as noted in existing literature that attribute to this problem; however, this study examines technology usability. For the purpose of this study, usability refers to the "appropriateness of purpose". Categorized by three factors, appropriateness of purpose can be defined as (i) the effectiveness of the users' ability to complete tasks while using technology and the quality or output of those tasks, (ii) the efficiency and the level of resources used in performing tasks, and (iii) the satisfaction or users' reaction to the use of technology (Brooke, 2014). The specific problem this research will address is the lack of African American and Hispanic American students pursuing computer science higher education by investigating the usability of technology. This serious gap also deprives America's industry of their talents, perspectives and skills. The National Science Foundation's Science and Engineering Indicators published in 2014 noted that of all employed scientists and engineers, by race, ethnicity, and occupation in 2010; 73.8% were white, but only 6% were African American and 6.7% were Hispanic American (National Science Foundation, 2014).

4 SIGNIFICANCE OF STUDY

This study will be the first of its kind to measure usability as it relates to the use of technology by these underrepresented groups. The study surveyed over 300 high school students; although all student volunteers participated in the study for statistical comparison, the focus of the findings will be to identify trends faced by our most underrepresented populations in computer science education, African Americans and Hispanic Americans. By analyzing student responses to complete routine tasks using a computer usability scale from a 20 question survey and the SUS, gaps in computer usability and system usability will be found. Normally using the SUS, testing of groups of 10 or more participants is usually adequate; with over 300 respondents the results will be substantial. In fact, even with only 10 users, if there are major differences with the users, there will be a large variance relative to the mean values measured (Bevan & Macleod, 1994). This study intends to demonstrate that usability is a factor that can adversely affect or discourage these students from pursuing higher education in computer science. The limitations of this research are potential weaknesses in the study and based on factors that cannot be controlled.

5 CURRENT STATUS OF STEM EDUCATION

Approximately 15.9% of Hispanic students aiming to obtain a STEM degree accomplish that goal, higher than other minorities but lower than the AAPI and White populations. Moreover, empirical studies show that Hispanics continue to be severely underrepresented among STEM graduates. Albeit Hispanics

accounted for roughly 14.8% of the national population in 2006, they garnered only 7.7% of bachelor's degrees attained in the fields of science and engineering, as seen in Figure 2 below (ASHE Higher Education Report, 2011). This is the largest gap between national population and earned degrees among all racial groups.

Meanwhile, among those aiming to finish STEM degrees, Native Americans (14%) fare only somewhat better than Blacks (13.2%)and slightly worse than Hispanics (15.9%) (ASHE Higher Education Report, 2011). Nevertheless, they significantly lag behind AAPIs (67%) and Whites (60%) (ASHE 2011). Certain studies show that Native Americans remain underrepresented among those attaining science and engineering degrees (ASHE Higher Education Report, 2011).

6 DATA ANALYSIS AND FINDINGS

The findings are presented as follows. First, the participant demographics, including population and sample, are examined. Second the knowledge base statistics are presented. Third, the knowledge base analysis to address the research questions is described. Next, the System Usability Scale (SUS) results are reviewed. Finally, a summary of the overall findings is provided.

7 PARTICIPANT DEMOGRAPHICS – POPULATION AND SAMPLE

This study used a survey questionnaire with knowledge based questions followed by system usability questions using Google Forms and high school students using Dell Optiplex 3020 and 760 work stations running Windows 7 OS. The representative sampling size (n) was estimated at 319 respondents for this study, based on a confidence interval of 5% and a confidence level of 95%. The sample size was calculated using the System Usability Scale (SUS) Calculator . As many participants were included to increase the accuracy of the data analysis. Representing the 319 survey respondents were 96 African American students, 109 Hispanic American, 25 Asian American, 62 Caucasian American, and 27 listed as other ethnicity with 15 males and 12 females as show below in figure 3 with the distribution of the demographics represented by percentage.

8 KNOWLEDGE BASE ANALYSIS

The questions on the knowledge portion of the survey were used to show the variances between the demographic and gender of the respondents. The intent of this analysis is to address the following research questions, related with a measurement of computer usability.

The foundation of the analysis was to use the 20 item survey to build a properly constructed scale to measure computer usability skills. The first consideration the analysis answers is whether or not these 20 variables can be considered as measurements of the same construct. For such purpose, a reliability analysis was conducted for all the 20 items in the survey.

Table 1 below shows that Cronbach's Alpha for the 20 items is α =0.816, and this greater than the commonly accepted threshold of 0.7 for a reliable construct (Santos, 1999), which implies that all the twenty items are measuring the same construct and they can all the used to build a valid scale.

Table 1 Overall Reliability

Reliability Statistics - Overall	
Cronbach's Alpha	N of Items
816	20

Based on the nature of the item questions, this scale will measure computer usability skills of the respondents. All the item responses are coded as: 0 = No, 1 = Unsure, 2 = Yes). So then, the computer usability skills scale is computed by adding up the values of the 20 items (there is no need for reversal

recoding, as all the questions point in the direction of having or not a certain skill, and "Yes" implies having such skill). The minimum value of the scale is 0 and the maximum value is 40.

Table 2 below shows the corresponding descriptive statistics for the scale that was constructed, with a mean of M = 28.65 (SD = 6.62).

Table 2 Descriptive Statistics

Mean	Variance	Std. Deviation	N of Items
28.65	43.814	6.619	20

On the other hand, Table 3 shows that the value of Cronbach's alpha does not change significantly by removing any of the items, which is a good indication that the scale is a validly constructed scale due to relatively higher Cronbach's alpha and that there is not much room for the improvement of alpha by removing any item.

Table 3 Chronbach's Alpha

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Do you know how to log in/out?	26.66	43.747	.032	.818
Do you know how to import a picture/spreadsheet on a Word Document?	27.98	35.364	.683	.787
Do you know how to create a spreadsheet?	27.17	40.403	.251	.816
Do you know how to rename a file or folder?	27.48	35.974	.597	.793
Do you know how to create a shortcut to a document on the desktop?	27.88	35.030	.694	.786
Do you know how to create a Power Point presentation?	26.67	43.687	.035	.818
Do you know how to set the date/time on your computer?	27.55	35.544	.625	.791
Do you know how to change the background wallpaper?	26.81	41.861	.245	.814
Do you know how to create a new folder?	27.24	37.275	.519	.799
Do you know how to create a Word Document?	26.66	43.740	.036	.818
Do you know how to change the monitor resolution?	27.96	38.429	.400	.808
Do you know how to delete a document	26.67	43.755	.011	.818
Do you know how to restore a file after it has been deleted?	27.42	37.187	.493	.801
Do you know how to format a document with 1.5 line spacing?	27.92	35.972	.616	.792
Do you know how to restore the computer?	28.17	38.546	.472	.803
Do you know how to search for a file?	26.67	43.554	.075	.818
Do you know how to print a document?	26.66	43.843	-.027	.818
Do you know how to open an existing document?	26.66	43.733	.027	.818
Do you know how to delete browsing history?	27.38	36.922	.515	.800

Do you know how to shutdown the computer?	26.66	43.960	-.098	.819

Table 4 shows the results of an ANOVA to assess research question #1. The mean computer usability skill score for African Americans is M = 25.48 (SD = 6.73), the mean computer usability skill score for Asians is M = 34.76 (SD = 4.79), the mean computer usability skill score for Whites is M = 30.05 (SD = 6.18), the mean computer usability skill score for Hispanics is M = 28.60 (SD = 5.77), and the mean computer usability skill score for Other Race is M = 31.22 (SD = 6.09).

Table 4 Descriptive Statistics for Computer Usability by Ethnicity

	N	**Mean**	**Std. Deviation**	**Std. Error**	**95% Confidence Interval for Mean**			
					Lower Bound	**Upper Bound**	**Min**	**Max**
African American	96	25.4792	6.72619	.68649	24.1163	26.8420	16.00	40.00
Asian	25	34.7600	4.78957	.95791	32.7830	36.7370	25.00	40.00
Caucasian - White	62	30.0484	6.18148	.78505	28.4786	31.6182	18.00	40.00
Hispanic	109	28.5963	5.76567	.55225	27.5017	29.6910	17.00	40.00
Other	27	31.2222	6.09119	1.17225	28.8126	33.6318	20.00	40.00
Total	319	28.6458	6.61924	.37061	27.9166	29.3749	16.00	40.00

Table 5 below shows that the assumption of homogeneity of variance is met, $F(4, 314) = 1.539, p = .191 > .05$.

Table 5 Homogeneity of Variances

Computer usability skill score			
Levene Statistic	**df1**	**df2**	**Sig.**
1.539	4	314	.191

The ANOVA table below shows that the null hypothesis of equal means is rejected,

$F(4, 314) = 14.709, p < .001$ This indicates that the sample data provides enough evidence to claim that not all ethnicities have the same mean computer usability skill scores.

Table 6 ANOVA

Computer usability skill score					
	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	2198.693	4	549.673	14.709	.000
Within Groups	11734.278	314	37.370		
Total	13932.972	318			

Table 7 below shows the results of the Tukey Test (post-hoc). The post-hoc test results indicate that the mean computer usability skill score for Asians is significantly higher than the mean computer usability skill score for Whites, Hispanic and African Americans. On the other hand, the mean computer usability skill score for Other Race and Whites is significantly higher than the mean computer usability skill score for African Americans. No other pair difference is significant.

Table 7 Computer Usability Skill Score by Ethnicity

Tukey HSD				
What is your ethnicity	**N**	**Subset for alpha = 0.05**		
		1	**2**	**3**
African American	96	25.4792		
Hispanic	109	28.5963	28.5963	
Caucasian - White	62		30.0484	
Other	27		31.2222	31.2222
Asian	25			34.7600
Sig.		.118	.258	.053

A t-test for independent means was used to address the second research hypothesis. Table 8 shows that the mean computer usability score for girls is M = 28.36 (SD =6.62), and the mean computer usability score for boys is M = 28.85 (SD =6.63).

Table 8 Gender Comparison

Gender Statistics

	Gender	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
Computer usability skill score	Female (girl)	134	28.3582	6.61668	.57159
	Male (boy)	185	28.8541	6.63123	.48754

Table 9 shows that the assumption of equal variances is met, as shown by Levene's test, F = .011, p = .915 > .05. Under the assumption of equal variances, the t-statistic is t(317) = -0.660, p = .510 > .05, which indicates that there is not enough evidence to reject the null hypothesis.

Table 9 Levene's Test for Equality of Variances

Independent Samples Test

		Levene's Test for Equality of Variances		**t-test for Equality of Means**						
		F	**Sig.**	**t**	**df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**	**95% Confidence Interval of the Difference**	
									Lower	**Upper**
Computer usability skill score	Equal variances assumed	.011	.915	-.660	317	.510	-.49585	.75154	-1.97448	.98279
	Equal variances not assumed			-.660	287.082	.510	-.49585	.75127	-1.97455	.98286

Therefore, the sample data does not provide enough evidence to claim that there is a significant difference in mean computer usability score by gender. For the third question, three contrasts were estimated as shown below in Table 10.

Table 10 Contrast Coefficients

Contrast Coefficients

Contrast	Ethnicity				
	African American	**Asian**	**Caucasian - White**	**Hispanic**	**Other**
1	1	0	-2	1	0
2	1	-2	0	1	0
3	1	0	0	1	-2

Table 11 shows the results of the contrast tests. It is found that all three null hypotheses are rejected, with $p = .001$, $p < .001$ and $p < .001$, respectively. Also, for all three tests the t-statistic is on the left-tail.

Table 11 Contrast Tests

		Contrast	**Value of Contrast**	**Std. Error**	**t**	**df**	**Sig. (2-tailed)**
Computer usability skill score	Assume equal variances	1	-6.0213	1.77288	-3.396	314	.001
		2	-15.4445	2.59063	-5.962	314	.000
		3	-8.3689	2.50369	-3.343	314	.001
	Does not assume equal variances	1	-6.0213	1.80040	-3.344	102.183	.001
		2	-15.4445	2.10871	-7.324	35.025	.000
		3	-8.3689	2.50458	-3.341	33.769	.002

Therefore, it is concluded that the mean of the combined African American and Hispanic group has a mean computer usability score that is significantly lower when compared with the other ethnicities.

Usability Scale Analysis

The system usability scale measures usability, in this study "usability" refers to the "appropriateness of purpose." Categorized by three factors, appropriateness of purpose can be defined as (i) the effectiveness of the users' ability to complete tasks while using technology and the quality or output of those tasks, (ii) the efficiency and the level of resources used in performing tasks, and (iii) the satisfaction or users' reaction to the use of technology (Brooke, 2014). Table 12 describes the 10 questions that make up the SUS.

Table 12 System Usability Scale

1	I think that I would like to use this system frequently.
2	I found the system unnecessarily complex.
3	I thought the system was easy to use.
4	I think that I would need the support of a technical person to be able to use this system.
5	I found the various functions in this system were well integrated.

6 I thought there was too much inconsistency in this system.

7 I would imagine that most people would learn to use this system very quickly.

8 I found the system very cumbersome to use.

9 I felt very confident using the system.

10 I need to learn a lot of things before I could get going with this system.

Note: The SUS uses the following response format:

Strongly Disagree 1 2 3 4 5 Strongly Agree

Interpreting a SUS Score

The SUS score is converted into a grade, research done by Bangor, et al, 2009, below shows the rating scale on Table 13.

Table 13 SUS Grade Conversion (Adapted from Bangor et al. 2009)

Raw SUS Score	Grade Scale	Acceptability Range	Adjective
90-100	A	Acceptable	Best Imaginable
80-90	B		Excellent
70-80	C		Good
60-70	D	Marginal	OK
50-60	F		
40-50		Not Acceptable	Poor
30-40			
20-30			Worst Imaginable
10-20			
0-10			

SUS grading is based on a curve developed by Jeff Sauro and Jim Lewis to update the grades based on normal distribution of the SUS scores. They assigned an equal number of "A's as F's and B's as D's with the bulk receiving C's" (Lewis & Sauro, 2009). They also added plus and minus to the letter grades to offer the varying levels as shown in Table 14 below.

Table 14 Sauro & Lewis SUS Grading Scale (Sauro, 2011)

SUS Score	Percentile	Grade
84.1-100	96-100	A+
80.8 – 84.0	90-95	A
78.9 – 80.7	85-89	A-
77.2 – 78.8	80-84	B+
74.1 – 77.1	70-79	B
72.6 – 74.0	65-69	B-
71.1 - 72.5	60-64	C+
65.0 -71.0	41-59	C
62.7 - 64.9	35-40	C-
51.7 - 62.6	15-34	D
< 51.7	0-14	F

9 RELIABILITY AND VALIDITY

According to the practical guide, once a set of subscales exist, assessment of reliability (basically repeatability) using a measure of internal reliability called coefficient alpha or Cronbach's alpha (Sauro, 2011). According to Sauro, this is the measures of how consistently users respond to items in the questionnaire. The highest possible score is 1.00, with .70 considered to be the lower boundary of acceptable internal reliability (Nunnally 1978). If the total questionnaire or subscales have low internal reliability (Cronbach's alpha < .70), then questions and subscales are added and removed until the reliability becomes acceptable.

10 USABILITY AND LEARNABILITY

There are in fact two significant factors in SUS. They are "usability" and what is referenced and measured as "learnability." There are eight items on the survey question to determine usability while the other two are used to measure learnability. The learnability items are numbers 4 and 10 ("I think I would need the support of a technical person to be able to use this system" and "I needed to learn a lot of things before I could get going with this system").

As noted by Sauro, "To compute the learnability and usability scores:"

1. Scale your scores from 0 to 4 as with the regular SUS (being sure to reverse the negative items).

2. For the learnability scale: total the scores for items 4 and 10 and multiply the result by 12.5. (This scales the results from 0 to 100.)

3. For the usability scale: Total the scores for the other 8 items and multiply the result by 3.125. (This scales the results from 0 to 100.)

11 SUS FINDINGS

The SUS Calculator results for the overall number of respondents to the survey are as shown below in Table 15 which includes the mean SUS score of 76.4, standard deviation of 12.3, number of respondents (319) and internal reliability of 0.826 which is categorized by good on the calculator. In addition, the scales for SUS, Usability and Learnability are listed for comparison.

Table 15 SUS Results for Overall Survey

Mean SUS Score	76.4		
StDev	12.3		
(n)	319	*Coding Check:*	Values appear to be coded correctly from 1 to 5
Cronbach Alpha	0.826	*Internal Reliability:*	Good

Scales		
SUS	**Usability**	**Learnability**
76.4	76.2	77.2

Table 16 displays the raw SUS score as converted into a percentile rank according to the products tested, in this case all products for the SUS benchmark and the corresponding grades as determined by the corresponding scale. The raw SUS score (76.4) indicates that the operating system used for this study has a higher SUS score than 77.8% of all products tested. For the purpose of this study, we will compare the Sauro & Lewis grading scale. Using that scale the usability grade calculated is a "B."

Table 16 Raw SUS Score to a Percentile Rank and Grade for Overall Survey

Input		**Results**	
Raw SUS Score	76.4	Percentile Rank:	77.8
SUS Benchmark	All Products Tested	Adjective :	Good
		Grade (Bangor):	C
		Grade (Sauro & Lewis):	B
		Acceptability:	Acceptable

SUS Results for Male Participants

For the 185 males participating in the overall study, Table 17 includes the mean SUS score of 76.4, standard deviation of 12.6, number of respondents (185) and internal reliability of 0.832 which is categorized by good on the calculator. In addition, the scales for SUS, Usability and Learnability are listed for comparison. Note: the SUS score in the male category is the same as the overall SUS score for the study, but the standard deviation goes up slightly along with learnability from the overall study.

Table 17 SUS Results for Males in Overall Survey

Mean SUS Score	76.4		
StDev	12.6		
(n)	185	*Coding Check:*	Values appear to be coded correctly from 1 to 5
Cronbach Alpha	0.832	*Internal Reliability:*	Good

Scales		
SUS	**Usability**	**Learnability**
76.4	76.0	78.0

Table 18 displays the raw SUS score from the male participants as converted into a percentile rank according to the products tested, in this case all products for the SUS benchmark and the corresponding grades as determined by the corresponding scale. The raw SUS score (76.4) indicates that the operating system used for this study has a higher SUS score than 77.8% of all products tested. The Sauro & Lewis grade is a "B" same as the overall study.

Table 18 Raw SUS Score to a Percentile Rank and Grade for Males in Overall Survey

Input		Results	
Raw SUS Score	76.4	Percentile Rank:	77.8
SUS Benchmark	All Products Tested	Adjective :	Good
		Grade (Bangor):	C
		Grade (Sauro & Lewis):	B
		Acceptability:	Acceptable

SUS Results Female Participants

For the 134 females participating in the overall study, Table 19 includes the mean SUS score of 76.3, standard deviation of 12.6, number of respondents (134) and internal reliability of 0.820 which is categorized by good on the calculator. In addition, the scales for SUS, Usability and Learnability are listed for comparison. Note: the SUS score in the female category is lower than the overall SUS score for the study and the learnability goes down considerably.

Table 19 SUS Results for Females in Overall Survey

Mean SUS Score	76.3		
StDev	12.0		
(n)	134	*Coding Check:*	Values appear to be coded correctly from 1 to 5
Cronbach Alpha	0.820	*Internal Reliability:*	Good

Scales		
SUS	**Usability**	**Learnability**
76.3	76.4	76.1

Table 20 displays the raw SUS score from the female participants as converted into a percentile rank according to the products tested, in this case all products for the SUS benchmark and the corresponding grades as determined by the corresponding scale. The raw SUS score (76.3) indicates that the operating system used for this study has a higher SUS score than 77.5% of all products tested. The Sauro & Lewis grade is a "B" same as the males and overall studies.

Table 20 Raw SUS Score to a Percentile Rank and Grade for Females in Overall Survey

Input		Results	
Raw SUS Score	76.3	Percentile Rank:	77.5%
SUS Benchmark	All Products Tested	Adjective :	Good
		Grade (Bangor):	C
		Grade (Sauro & Lewis):	B
		Acceptability:	Acceptable

Table 21 displays how each group of respondents scored accordingly by Grade, SUS Score, Usability, Learnability, and Reliability. This table shows the differences between demographic including those between gender.

Table 21 Overall Grade, SUS Score, Usability, Learnability and Reliability Results

Demographics	Grade	SUS Score	Usability	Learnability	Reliability
Overall	**B**	**76.4**	**76.1**	**77.2**	**.826**
Males	B	76.4	76.0	78.0	.832
Females	B	76.3	76.4	76.1	.820
African American	**C+**	**71.1**	**71.1**	**71.2**	**.865**
Males	C+	71.8	71.8	71.9	.867
Females	C	70.0	70.0	70.2	.861
Hispanic American	**B+**	**77.2**	**76.8**	**78.9**	**.750**
Males	B	75.8	75.3	77.7	.781
Females	B+	78.7	78.3	80.1	.697
Caucasian American	**A-**	**80.2**	**79.9**	**81.7**	**.758**
Males	A	81.4	80.9	83.6	.721
Females	B+	77.8	77.8	77.5	.806
Asian American	**A**	**81.0**	**81.4**	**79.5**	**.822**
Males	A	81.3	80.7	83.6	.834
Females	A-	80.6	82.6	72.2	.846
Others	**A-**	**78.9**	**78.7**	**79.6**	**.802**
Males	B+	77.2	76.3	80.8	.789
Females	A	81.0	81.8	78.1	.822

Figure 1 below provides a SUS Score, usability and learnability comparison with side-by-side differences between demographics. It is clearly noticeable that African Americans and Hispanic Americans have lower scores than the other groups; however, the scores from the African American respondents represent the largest gap.

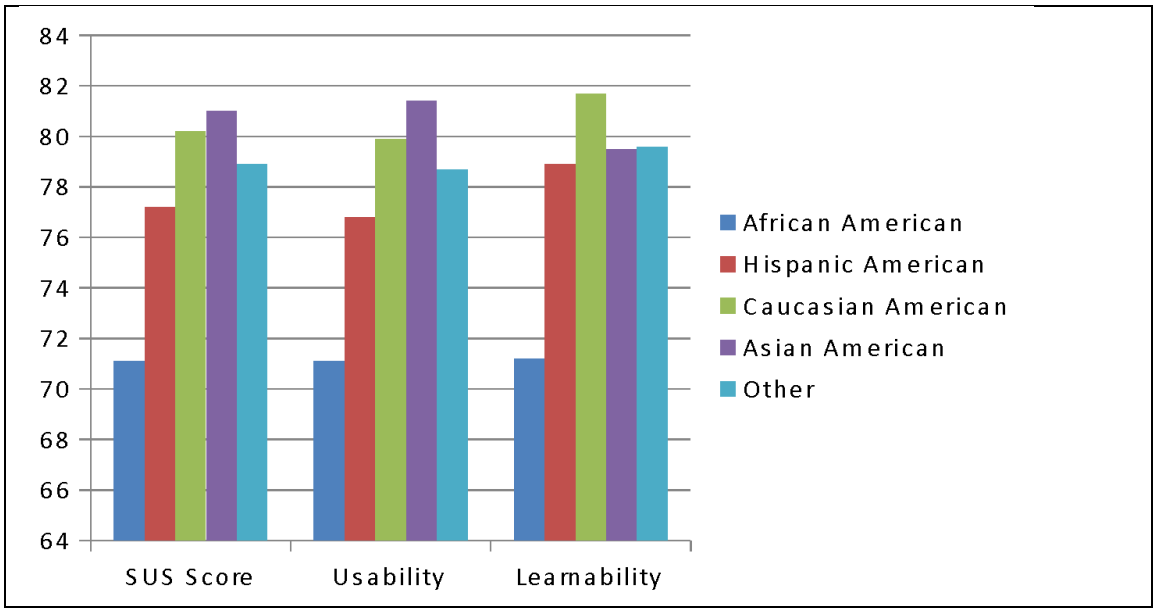

Figure 1 SUS Score, Usability and Learnability Result Comparison

Figure 2 below represents the letter grade distributions by demographics. Once again the largest gap is found between African American respondents and the other participants in the study. The letter grades in the chart represent both male and female grades provided by the SUS calculator.

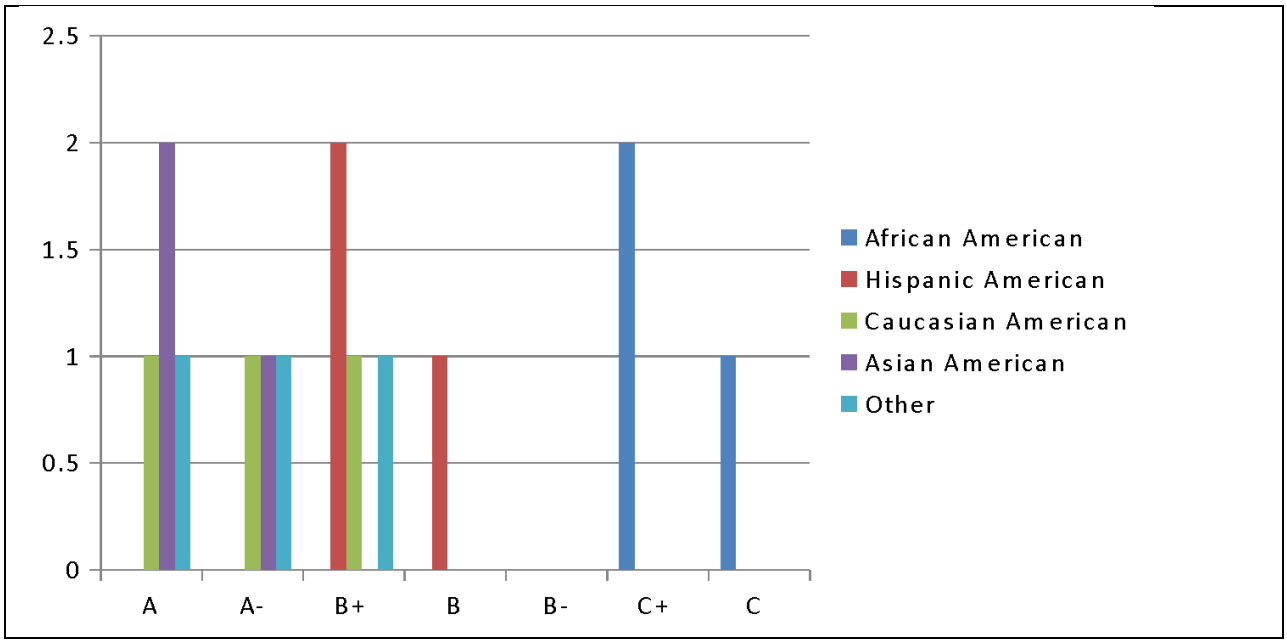

Figure 2 Grade Distributions by Respondent Demographics

The Sampling

A total of 319 high school students volunteered to participate in the study using Dell Optiplex 3020 and 760 work stations running Windows 7 OS. The school was chosen based on their diverse population as shown in Table 22.

Table 22 High School Demographic Data

Demographic Trends 2014 - 2010

		Free and Reduced Lunch		*Race and Ethnicity*							*English Language Learner*		*Special Education*	
School Year	Enrollment	Students Receiving FRL	% FRL	Hispanic	White	African American	Asian / Pacific Islander	American Indian	Multiple Races	% Minority	ELA Students	% ELA	SPED Students	% SPED
2010-11	1,605	880	54.8%	432	392	620	68	7	86	75.6%	337	21.0%	164	10.2%
2011-12	1,510	827	54.8%	435	374	547	69	7	78	75.2%	383	25.4%	142	9.4%
2012-13	1,485	804	54.1%	455	397	473	78	7	75	73.3%	383	25.8%	147	9.9%
2013-14	1,424	792	55.6%	449	387	435	78	7	68	72.8%	365	25.6%	146	10.3%
2014-15	1,359	765	56.3%	425	378	397	84	7	68	72.2%	376	27.7%	146	10.7%
Trends														
% Change Since 2010	-15.3%	-13.1%	1.5%	-1.6%	-3.6%	-36.0%	23.5%	0.0%	-20.9%	-3.4%	11.6%	6.7%	-11.0%	0.5%

Multiple: Students claiming 2 or more races (unless one ethnicity is Hispanic) FRL: Free and Reduced Lunch, one measure of socioeconomic status
ELLs: Students eligible for ELA services, including ELLs with a PPF 3 (parent opt out of ELA services). These ELLs are not necessarily receiving ELA services.

Data Collection and Validation

The survey questions in this study were designed to understand respondents' knowledge relative to computer use during the first 20 questions using descriptive statistics and the next 10 questions assessed their individual usability score using the SUS responses using the SUS Calculator. For the knowledge portion of the survey ANOVA, two-independent samples t-test and orthogonal contrasts were used and overall grade, SUS score, usability, learnability and reliability results from the SUS calculator were used to analyze the data.

13 RESEARCH FINDINGS

The summary of the research findings are as follows:

Research Question 1: Is there a significant difference in computer usability skill by ethnicity? H1o: There is no significant difference in computer usability skill by ethnicity, all are equal. The analysis showed the null hypothesis rejected and resulted in H1A: There is a significant difference in computer usability skill by ethnicity.

Research Question 2: Is there a significant difference in computer usability skill by gender (Boy or Girl). There was insufficient evidence in the analysis to support H2A: There is a significant difference in computer skill by gender; therefore, H2o*:* There is no significant difference in computer skill by gender, both are equal was more likely.

Research Question 3: Is there a significant difference in computer usability skill when comparing African & Hispanic Americans (combined) to the ethnic groups. Analysis results indicated H3A: There is a significant difference in computer usability skill when comparing African & Hispanic Americans (combined) to other ethnic groups was accurate. The findings did not hold true for H3o: There is no significant difference in computer usability skill when comparing African & Hispanic Americans (combined) to other ethnic groups.

14 IMPLICATIONS

Given the findings during this study, certain demographics may continue to be underrepresented in STEM fields still exists. However, more evidence will be necessary to conclude that these factors alone limit African Americans and Hispanic American from pursuing higher education in computer science. The results of the data analysis showed a significant gap in the knowledge of certain group's ability to use computer OS to complete routine tasks. The usability findings for the students using Windows 7, does not entirely suggest that similar Windows OS will mitigate usability at this level of education. The use of computers is the key to success in higher education, specifically in computer science. The insight provided by the respondents may lead to identifying trends that may discourage some students from pursuing computer science higher education and may enable educators to mitigate these factors in the future through closer examination.

15 CONCLUSIONS

The study's objective was to understand operating system usability factors limiting African Americans and Hispanic American from pursuing higher education in computer science. The focus was to assess user knowledge base given routine tasks and operating system usability using a web survey. Several key findings emerged during this research study. There was a clear difference in computer usability between African American and Hispanic American students as compared to their peers in the knowledge portion of the study. In the system usability portion, there were two major gaps identified the grades and scores assigned to African American and Hispanic American students were much lower than their counterparts; plus, the SUS score and learnability assigned to these groups were also lower. Given the results of the overall study, we have a better understanding of operating system usability factors limiting African Americans and Hispanic American from pursuing higher education in computer science.

As a recommendation for future research, given the results of the data analysis of this study, we believe there may be significant value in longitudinal studies on the effects of usability given a person's knowledge over several years during their education. Without the insight on what users have learned prior to completing a usability study, we are unable to determine what gaps could have been addressed in previous experiences with technology. Also future studies should consider a mix of qualitative and quantitative inquiry approaches to determine how students learn, when students are exposed to technology and how student experiences with technology affect their decision to pursue higher education in computer science and STEM related fields.

REFERENCES

ASHE Higher Education Report (2011). Introduction, context, and overview of the volume. *ASHE Higher Education Report*, 36(6), 1-25.

Bangor, Aaron, Kortum, Philip T. & Miller, James T. (2009). " Determining What Individual

SUS Scores Mean: Adding an Adjective Rating Scale". *Journal of Usability Studies, Volume 4, Issue 3, May 2009, pp. 114-123.*

Beasley, M. A., & Fischer, M. J. (2012). Why they leave: The impact of stereotype threat on the attrition of women and minorities from science, math and engineering majors. *Social Psychology of Education: An International Journal*, *15*(4), 427-448

Bevan, N. & Macleod, Miles (1994). *Usability measurement in context*. Behaviour and Information Technology, 13, 132-145 (1994) National Physical Laboratory, Teddington, Middlesex, UK

Brooke, J. (2014) SUS - A Quick and Dirty Usability Scale. Redhatch Consulting, Ltd. Early Reading RG6 2UX, United Kingdom

Lewis, J. R., & Sauro, J. (2009, July). The factor structure of the system usability scale. In *International conference on human centered design* (pp. 94-103). Springer, Berlin, Heidelberg.

National Science Foundation. (2014). *Science & engineering indicators* 2014. Arlington. Retrieved from: http://www.nsf.gov/statistics/seind14/index.cfm/chapter-3/c3s5.htm on 8/16/14.

Nunnally, J. (1978). Psychometric theory NY: McGraw-HillPallant J (2011). *A step by step guide to data analysisusing SPSS program survival manual 4th edition. Allen& Unwin, 83*.

Santos, J. R. A. (1999). Cronbach's alpha: A tool for assessing the reliability of scales. Journal of extension, 37(2), 1-5.

Sauro, J. (2011). Measuring usability with the system usability scale (SUS).

sciendo

ICTE Journal

*2019, **8**(1): 20–29*
DOI: 10.2478/ijicte-2019-0002

THE NATURE OF THE FACEBOOK GROUP LEARNING ENVIRONMENT: INSIGHTS FROM UNIVERSITY STUDENTS

Juraj Datko[1]

[1]Department of Language Pedagogy and Intercultural Studies, Faculty of Education, Constantine the Philosopher University in Nitra, Slovak Republic {jdatko@ukf.sk}

ABSTRACT

The paper analyses the inherent features of the Facebook learning environment that were identified by university students enrolled in an English for Academic Purposes course. The presented case study is based on students' subjective theories that have been reconstructed from semi-structured interviews and diaries. The research material involves qualitative data acquired from thirty-four university students. The identified characteristics relate to four areas, namely motivation, distraction, security, and structure. The dominant strengths and weaknesses of the discussed learning environment are singled out.

KEYWORDS

Facebook group, learning environment, teaching/learning English as a foreign language, university student, case study

1 INTRODUCTION

Multimodal didactic approaches that blend classroom interaction with a learning management system (LMS) are widely used in higher education settings. These electronic systems are certainly valuable tools, as they help teachers to organize the course and curriculum, serve as a storage for digital study materials, provide a platform for different types of activities, and allow various forms of interaction, feedback, and assessment. In our teaching experience at the tertiary level of formal education, however, we often come across various students' complaints about these tools. They are mostly related to their rigidity, outdated and complicated user interface, or improper functionality. These problems made us think about adopting an alternative blended-learning model in which face-to-face instruction is supported by an e-platform that is appealing, similar in functionality, and tightly connected to students' lives.

To use a Facebook group as a substitute for a traditional Moodle course was a choice based on social constructivist theories which reflect the ongoing changes in the ways how digital natives learn. Furthermore, as it is a dynamic environment, it "challenges the learners […] to provide original and creative solutions for learning" (Meishar-Tal, Kurtz & Pieterse, 2012, p. 37). These reasons have provided a solid ground for the application of this tool into the English as a foreign language (EFL) learning process. But how do students view the language learning environment of a Facebook study group? That is the principal question that is addressed in the paper.

2 LITERATURE REVIEW

In the last decade, authors have continually researched the potentials of Facebook groups for the higher education English classroom. The researchers discuss the topic from two (often) intertwined perspectives, namely intra-linguistic and extra-linguistic. However, the former is marginalized in this report, and we focus on the latter in terms of motivation, stresslessness/stressfulness, distractibility, and structure.

The research indicates that Facebook groups adopted as supplements to English as a foreign language (EFL) courses are viewed as suitable language learning platforms that can positively influence students' motivation to learn English (Romano, 2009) and their overall attitudes towards this activity (Kabilan, Ahmad & Abidin, 2010; Al-Shehri, 2011). A limited number of studies point to the audience of the Facebook group as an important factor affecting EFL students' engagement in writing activities. Sun (2010) and Yunus, Salehi & Chenzi (2012) noted that foreign language learners often become more motivated and engaged in tasks focused on writing because of the extended exposure of their writing output. On the other hand, research also shows that students' motivation to learn English either was not visibly affected (Simpson, 2012) or vanished after the novelty faded (Hsu, 2013).

This alternative learning platform can create a safe environment where the students can produce English without any "pressure". This assumption is in line with Simpson (2012) and Small (2014) who agreed that social networking sites enable EFL learners to be more self-confident and relaxed while they use the target language, since such electronically-mediated communication can suppress the inhibiting factors of direct, inter-personal communication. Hsu (2013) concluded that the environment was perceived as "pressure-free", because the EFL learning process took place in a closed Facebook group with a limited number of members.

Facebook is often criticized for its negative impact on students' academic performance (e.g. Pasek, More & Hargittai 2009; Kirschner & Karpinski, 2010; Paul, Baker & Cochran, 2012), with the distraction aspect being seen as one of the main causes of this undesired influence. Facebook's potential to distract learners from their educational objectives seems to be a relevant topic also in foreign language education, since Yunus et al. (2012) and Bani-Hani, Al-Sobh & Abu-Melhim (2014) agreed that students might not focus on learning English when they are utilizing Facebook.

Another potential drawback of Facebook groups adopted in EFL education is related to students' difficulties with following group postings. Students concentrate on the group posts in a limited way due to their hectic daily schedule (Razak, Saeed & Ahmad, 2013) or tiredness caused by exam preparation (Hsu, 2013). Furthermore, the dynamic, non-hierarchical organization of the group was seen as a serious disturbance, as it brought difficulties with orientation and retrieval of content (Meishar-Tal, Kurtz & Pieterse, 2012). However, the non-static nature of Facebook content triggers active participation (ibid.).

3 RESEARCH STRATEGY

The aim of the paper is to identify how university students perceive the EFL learning environment created on a Facebook group platform. A qualitative case study was designed to gain insight into this complex problem, while it examines students' perspectives and uses two sources of data, namely semi-structured interviews and diaries.

Data Collection

Semi-structured interviews with university students were used as a primary data source. The role of this data collection method in the presented case study was to obtain an interviewee's subjective response to a known situation or experience. Following the model presented by Scheele & Groeben (1988), this rich inventory of one's personal perceptions, views, beliefs, opinions, and attitudes is in our study covered by the umbrella term subjective theory. We use the semi-structured interview to reconstruct participants' subjective theories of the EFL learning environment provided by the Facebook group. Pre-interviews (conducted after the first contact with the Facebook group) and post-interviews (conducted after the study experience with our blended learning model) were used to get more reliable and valid data.

Semi-structured student diaries presented a secondary data source; i.e., they were supplemental and subordinated to the interviews. The method of diary studies was used to further validate the pre-/post-interviews, to track potential discrepancies in the data, and to illuminate otherwise hidden contexts of students' EFL learning activities and progress.

Data Analysis

The first step of the analytic process was based on identification of items relevant to our research in the interview transcripts and their categorization with codes. The preliminary code labels emerged from the raw interview data. Since coding is dynamic (Benaquisto, 2008), the initial codes were further refined and reconceptualized. This process resulted in creating the final analytic framework.

Due to the above mentioned supplemental role of student diaries, we applied the developed coding system in their analysis too. The diary entries were processed by seeking out connections, phrases, ideas, or actions related to the interview analytic framework. However, some codes remained interview-exclusive.

Sample

Undergraduates from a mid-sized, public university (n=34) participated in the research. The participants attended the "English for Academic Purposes 1" (EAP 1) elective course and agreed to use its Facebook module. The research sample included student teachers (n_1=22) and students of the "Occupational Safety and Health" study program (n_2=12), while those who enrolled for the course in summer 2016/2017 are labelled with "a" and those who were enrolled in the course in winter 2017/2018 are labelled with "b". Random sampling was used to select seventeen students for the interviews, while the duration ranged from 17′46″ to 50′30″. All research participants (n=34) kept diaries. These textual records were submitted on a weekly basis and covered an eight-week period of the EAP 1 course. The research material contained 606 written entries.

4 FINDINGS

Motivation

We identified different ideas related to the motivational aspect forty-seven times in the data. The highest frequency of reoccurrence implies that the ability to affect motivation is a significant feature of this alternative EFL learning environment.

From the fifteen participants who perceived the Facebook group as motivating, thirteen attached the group audience to motivation. *The students marked each others' English writing output, with members' ability to see students' work as the source of the group's motivational effect.*

Students 17a, 10b, 14b, and 18b stated that the EFL performance of more proficient group members motivated them to do their best. In one of her pre-interview responses, student 17a valued the opportunity to compare her EFL proficiency level with others and noted that "it pushes me towards improvement". Student 10b claimed in his diary (and also in both interviews) that postings from more proficient students and their expressive ability motivated him "to do [his] best in learning English". When student 14b read a post from a more proficient classmate, she was "definitely not satisfied with [her] level of English" (pre-interview). On the other hand, it motivated her to maximize her learning effort. The initial interview with student 18b uncovered that: "It motivates me when I see comments from more proficient classmates or yours in which you explain something". Later, she explained that "I was motivated, because I did not understand everything, but I wanted to".

Students 2a, 4a, 7a, 13a, 14a, 18a, 8b, and 9b were motivated by others' work. Student 2a replied in the pre-interview that after she had seen "that everyone wrote something, it was not like pressure, but rather something that made [her] want to write a comment". Similarly, student 7a explained in her response that she ignored an extra task at first, but after she had seen that nearly every member had commented on it, she asked herself: "Am I going to be the last one again? Are they better than me?". Then, she also wanted to complete the given extra task. However, "it was not pressure; it was motivation", as she explained in a diary entry. Student 8b responded in the post-interview that it was motivating for him to see other students completing extra tasks "not just with a few words, but they wrote five or six sentences [...]. You could see the effort behind it". Influenced by others' comments, student 18a "tried to post more complicated sentences and not just some simple ones" (pre-interview), while student 13a "tried writing more" (post-interview).

Student 9b seemed to be motivated by the creativity of others' work. He praised some of the added postings (assignments completed by others) and admitted in the interviews that their originality and creativity "motivated [him] to perform better next time". In the initial interviews, students 4a, 13a, and 14a agreed that comments from the group members were motivating, as they aided in writing their own. In case they did not understand something, students 4a and 14a viewed how others completed an assignment. For student 13a, it was motivating that she could "use something from their sentences and then reformulate [her] comment in some other way".

Besides the motivational effect of others' work, student 7a also mentioned in the diary that she tried to do her best due to the fact that the audience could see her EFL output. Consistently, student 5b noted in one of the interviews that as her posts were visible to other students in the group, she "focused on correct grammar" and was forced to think about English. She "was motivated to do it correctly, so [she] would not have to feel ashamed".

A group of ten interviewees connected motivation with extra points (that could be earned by completing optional tasks in the Facebook group). Students 2a, 4a, 10a, 5b, and 10b agreed that the opportunity to get extra points for extra activities in the Facebook study group was motivating. For example, student 4a replied: "when I know that I can get something additional for my activities, it motivates me". From the perspective of student 10a, motivation was embedded "in the chance to get some points that can help in getting a better grade". Students 7a, 13a, 18a, 9b, and 14b, on the other hand, did not perceive the chance of earning extra points as motivating, but the extra point itself as motivating. In the post-interviews, students 9b and 14b characterized the extra points as "definitely motivating". Student 13a noted initially that "it was both others' comments and extra points that motivated [her]". "Sometimes [she] completed an extra task only to get a bonus point", as she admitted in the post-instruction interview.

Four research participants felt that the Facebook group itself is motivating. Student 9b appreciated "that the group motivated [him] to use English in a more practical way". It was highlighted again in the post-interview, that the study group "was motivating mostly due to the opportunity to use English in practical contexts". Student 14b viewed the EAP 1 course as "more interesting and motivating than traditional seminars" thanks to the Facebook module. Dealing with English on a social network increased student 20b's motivation to learn the foreign language. "It motivated [him] to learn vocabulary and grammar". Moreover, Student 7a recorded in her diary that the Facebook group implanted a more positive attitude towards English.

Two interviewees added that daily contact with English enabled by the Facebook group is motivating. Student 10a was motivated, because she "used English regularly, almost daily, not only once a week". Student 8b promoted the group to "a part of [his] everyday life". It was motivating for him, since he could be in contact with English on a daily basis.

In one case, *an interviewee underlined the motivational effect of regular homework / extra tasks*. Student 14a praised the given tasks, as they "motivated [her] to do something". She did not complete them "only to get the points".

Distraction

The distraction potential is another important characteristic of the language learning environment created on Facebook, since it was recognized forty-three times in our data. In our case study, the participants (n=17) expressed mixed opinions, while the negative views prevail.

Five participants assigned the distraction potential to private messages. The initial interview with student 4a revealed that she would prefer replying to a friend's message to doing homework in the group. In the post-interview, she said that after a few weeks she used to turn off chat while doing homework, as it would otherwise take her hours instead of minutes. In her diary, however, she admitted that completing homework on Facebook took her sometimes longer than she expected, because she was distracted by private messages. Student 10a replied to the pre-/post-interview question in a similar manner. She faced

a dilemma "whether to do homework or chat and loose twenty minutes" (pre-interview). After the study experience, the same person noted that she started to chat with someone while doing homework from English, and "ten-minute work turned into two hours". Student 16b, who participated only in the pre-interview, stated that "the distraction factor is definitely present there", while he advised others to turn off chat when doing homework in the Facebook group. Although students 2a and 7a had rejected the group's potential for distraction from EFL learning in the initial interviews, they later admitted that private messages had distracting effects. In her diary, student 2a wrote the following entry: "It took me longer to do homework when someone messaged me".

Three students perceived the Facebook group itself as having negative effects on concentration. Student 14b replied in both interviews that the study group is "very distracting". A deeper context was presented in her diary: "The presence of the study group on Facebook seems disturbing on its own. My point is that we can receive messages, be notified about new postings, and this distracts me from learning English". She also acknowledged several times spending thirty minutes doing homework instead of ten due to the mentioned distracters. After experiencing the discussed mode of EFL instruction, student 12a concluded that the Facebook study group "has definitely distracted her attention". Her negative perception (expressed in the post-interview) is further explained in the following diary entry: "I couldn't concentrate on my task on one hundred percent. While working on homework, I could see when someone sent me a message or I just heard the sound of something new happening there. It was disturbing in any case. Another example is when we had a task to write our answers in comments. It was even more disturbing and tempted me to surf on Facebook". In the post-instruction interview, student 18a noted that the group was a bit distractive from time to time. However, it is not clear from her data within what setting.

Another *two students admitted that being present on Facebook delays doing homework*. Student 13a mentioned in the pre-interview: "Somebody had posted something on my wall, so I viewed it. Then, I returned to writing my comment, but something appeared in our study group. It took me almost half an hour until I started to do homework, but I had logged in to Facebook with the intention to do homework". Her post-interview response also clearly reflects this code, as she noted that she viewed posts in other groups and consequently had to start doing homework all over again. In the diary, the same participant concluded that she would delay doing homework if something new happened or appeared on Facebook. The post-interview with student 9b uncovered another particular situation in which using Facebook had put EFL learning aside. While doing homework (answering a tricky job interview question), the student learned that his favorite ice hockey team had lost a match. He wanted to know why, so he read an article and watched a video on his Facebook wall. The student added that "such things collided with doing homework in the Facebook group", and consequently he started to work in the group at 1:00 a.m.

Although negative subjective theories are dominant, *seven interviewees mentioned that the Facebook group is a non-distracting environment for learning English*. It seems that these students were able to separate school (EFL learning) from private life (chat with friends) and thus did not feel distracted. In the pre- and post-interview, student 17a claimed that she "always did homework before reading messages". She focused on her duties first and then on personal matters. Another student (18b) replied in both interviews that she did homework first and then continued communication with friends. Similarly, student 20b noted: "When I work in the Facebook study group, I do my homework first and read messages after I'm done. When I start doing something in the group, I finish it, because I want to get rid of it". Student 8b claimed that he can separate personal matters from academic duties, and thus was not distracted. If too many friends messaged, he simply disabled chat, completed the given task, and only "then returned to personal things". Student 5b stated: "I wouldn't let anything distract me from focusing on homework". In the post-interview, she explained that she simply did not pay attention to private messages while doing homework. Student 14a was also consistent in both interviews and stated that: "I continue with my personal matters after completing Facebook homework" (pre-interview). "In case I receive a message, I reply after completing the task. I'm not interested in anything else, when I'm focused on doing homework" (post-interview).

Student 10b offered no specific details in the interviews besides saying that the Facebook group "has no potential for distraction from EFL learning".

Security

We identified thirty-nine responses thematically related with students' perceptions of how relaxed or stressed they felt in the discussed language learning environment. The data (collected from seventeen students) communicated mixed perceptions of this EFL learning environment, although the positive ones dominate.

Thirteen interviewees felt that the Facebook group provides a stress-free environment for EFL learning. Ten interviewees were consistent in their pre- and post-interview responses. They inclined towards the view that the Facebook group allowed them to use English without being "pressed". Students 2a, 4a, 7a, 10a, 14a, 8b, 10b, 14b, 16b, and 20b did not perceive anything negative related to the group audience. Student 14a mentioned that the Facebook group was "collective". Students 2a, 4a, 7a, 8b, and 14b described the group as "relaxed". Students 2a, 4a, and 14b were also not afraid of making mistakes. They did not think about other group members being able to see their work. For example, student 4a stated: "Doing homework on Facebook was more relaxed than writing an essay on a sheet of paper. It was absolutely natural for me. I was not afraid that someone could see my mistakes in my posts. I wasn't stressed at all". Student 8b added that the study group was not only relaxed but also suitable for his EFL learning. He explained that: "When you stand in front of the class, there is this noise, someone laughs or talks, and it affects me negatively. Facebook is different, as there are no such things but just the "raw" opinion".

Students 17a, 18b, and 5b agreed that it was not easy to add posts in the study group at the beginning of the course. However, the post-interviews revealed that these students later perceived the study group environment as pressure-free for EFL learning. Student 17a "was afraid of making mistakes", as they were visible to the group audience (pre-interview). According to the second interview, she was not aware of any pressure in the Facebook group and considered it an "opportunity to improve" her English. Furthermore, "it became natural" for her to add posts in the study group. Similarly, student 18b felt "kind of pressure", because everyone could see her postings (pre-interview). Later, she did not feel any pressure while using English in the study group, and she "wasn't interested in others' opinions" (except for the teacher's comments). Student 5b noted that it was "more difficult and doubtful" during the first three weeks. In the post-interview, the environment of the Facebook group was described as "safe and stress-free". The same person added that she did not notice any irregular uses of English such as informal abbreviations or slang.

Four students (4a, 14a, 14b, and 18b) also *defined the Facebook group as a secure environment for EFL learning*. In three cases, the participants praised the teacher's decision to make the group private and closed. Students 4a and 14b knew that only their classmates (and not their Facebook friends) could see them working in the study group and thus felt secure. Similarly, student 18b liked the fact "that the group is only related to the students who are its members". A different sense of security was recognized in the post-interview with student 14a. She admitted to feel more confident and secure in the Facebook group (focused on writing) than in contact classes (focused on speaking).

Four participants viewed the Facebook group as a stressful environment for EFL learning. In her diary, student 1a noted that she "felt tension in the EAP 1 Facebook group". However, a deeper context is lacking in her data. The interviews with students 13a, 18a, and 9b revealed that the "pressure" stemmed from the audience (although they perceived it as motivating too). Student 9b mentioned that: "A posted comment is a presentation of my skills in English, and it is embarrassing for me to make a beginner mistake like the one with 'do' and 'does'. [...] my work is visible to everybody in the group, and they see my mistakes. It doesn't matter whether they are visible to a closed group of people or to public. The pressure is caused by the ability of the audience to see my work". Student 13a said that she was under pressure while using English. Later in the post-interview she mentioned that: "I've checked homework five times before posting it in the group, but still I've found some mistakes after it was online. I didn't like it". Her diary offers further explanations. Most importantly, it was unpleasant for this student to add a posting in the group, as others

could read it. However, she also admitted to "have problems with commenting on things" while using Facebook for personal matters. Student 18a maintained a consistent point of view throughout the whole semester. In particular, she explained that: "When I chat with an American, I focus on making no mistakes. If I make some, I feel a bit ashamed. It is nearly the same in the group".

Structure

Ideas related to the organization of the Facebook group were recognized twenty-eight times among thirteen participants. The analyzed data again reflect mixed results, with a considerable dominancy of negative views.

Nine participants noted that the Facebook group was a chaotic environment for EFL learning. Students 12a, 2b, 7b, and 17b perceived the EAP 1 Facebook group as disorganized. In his diary, student 7b simply noted that "it was difficult to orientate in the group". Student 12a recorded in her diary that "the page seemed quite chaotic" and "the posts were disorganized". In her post-interview and diary, she highlighted difficult orientation in the group as a problem. It was mentioned, that she "missed some comments or [teacher's] tasks" (post-interview). Sometimes, she "did not even notice that there was an assignment to accomplish" (diary entry). She further explained that "every time someone posted something in the group, it automatically popped up at the top of the page and it was complicated to find the task when everybody was already posting homework. That's why I couldn't fulfil every task". According to her diary, student 2b could not easily locate a file, and she "had to scroll down the wall of the Facebook group in order to find the vocabulary list from a seminar". The student also recommended an improvement. She would have arranged files from individual seminars into folders. Student 17b labelled the study material as "a bit disarranged", and "it took [him] some time to find the requested study material related to schooling in English-speaking countries".

Five students (3a, 5a, 14a, 5b, and 18b) agreed that the study group became confusing after it contained more postings. For student 3a it was sometimes difficult to match the homework task with the corresponding file or comment. In her diary, she suggested that a file should also contain a comment with the task. In one of the diary entries, student 5a complained that sometimes she felt overwhelmed by the amount of group posts and "could not easily find the one she was looking for". Student 14a stated (in the post-interview and diary) that she had lost orientation and felt confused after more posts were added in the group. In the post-interview, student 5b replied: "Later, orientation in the group and finding comments and files became problematic. I didn't remember the file names, so I couldn't find them via the search bar". Very similarly, student 18b wrote in her diary that "after the group contained numerous posts, it was difficult to find the older ones". She added that she did not know about the "search this group" function during the semester.

Four research subjects viewed the Facebook group as an organized environment for EFL learning. In her diary, student 18a considered "quick content navigation" as one of the group's benefits. In the post-interview, student 9b compared the study group with a literature course in Moodle and concluded, that it was not as time-consuming to look for study materials in the group as it was in the Moodle course. In particular, "it took [him] eight minutes to get to the study material from Realism [in the Moodle course], but only one minute to locate a file in the Facebook group". He added in his diary that it was easy to find the required (even older) posts in the study group. Though there was no trace of related data in the initial interview, student 14b later said: "The group was easy to navigate. I simply typed the key word in the search bar each time I had to find something. Each file also included a detailed description". The post-interview with student 10b uncovered that the EAP 1 course Facebook group was "easy to navigate". In his diary, he also appreciated its structure. Furthermore, he "was not annoyed by scrolling down the page in order to find older posts".

Tab. 1 The nature of the Facebook group learning environment

Categories	Times occurred	Codes	Times occurred + source
I.) Motivation	**47x**	***a.) the group audience is motivating***	**27x** (I: 23x; D: 4x)
		b.) extra points are motivating	**12x** (I: 12x)
		c.) the group itself is motivating	**5x** (I: 4x; D: 1x)
		d.) daily contact with English is motivating	**2x** (I: 2x)
		e.) regular homework / extra tasks are motivating	**1x** (I:1x)
II.) Distraction	**43x**	***a.) a non-distracting environment for EFL learning***	**16x** (I: 16x)
		b.) private messages are distracting	**12x** (I: 8x; D: 4x)
		c.) presence on Facebook delays doing homework	**8x** (I: 3x; D: 5x)
		d.) a distracting environment for EFL learning	**7x** (I: 5x; D: 2x)
III.) Security	**39x**	***a.) a stress-free environment for EFL learning***	**30x** (I: 30x)
		b.) a stressful environment for EFL learning	**5x** (I: 3x; D: 2x)
		c.) a secure environment for EFL learning	**4x** (I: 4x)
IV.) Structure	**28x**	***a.) a chaotic environment for EFL learning***	**19x** (I: 6x; D: 13x)
		b.) an organized environment for EFL learning	**9x** (I: 3x; D: 6x)

Legend: I.) Motivation - a wider category used to cover related ideas; **47x** - codes related to the category appeared forty-seven times in the data; ***the group audience is motivating*** - a more precise code is used to cover similar ideas; **27x** (I: 23x; D: 4x) - the code was recognized twenty-seven times in the data (23x in the interviews and 4x in the diaries)

CONCLUSION

According to the subjective data (and frequency of occurrence), motivational character was the most significant (and for EFL education also the most beneficial) attribute of the Facebook group learning environment. The strongest source of motivation was the audience of the Facebook group. Less proficient students attempted to approximate the EFL performance of more proficient group members. Other students were motivated by peers' work, particularly by creativity, effort, complexity, and assistance. The audience could also access students' EFL writing output, and this motivated students to deliver an error-free outcome, thus encouraging autonomous learning. The Facebook group itself also affected students' motivation in a positive way, since it contained regular and extra assignments, presented an unusual model of instruction, and enabled the research participants to earn extra points and use English daily and meaningfully. Moreover, the group implanted a more positive attitude towards the English language.

The unwanted distraction effect turned to be the second most important feature of the Facebook group environment (when considering the frequency of occurrence in the data). A majority of the research participants who provided an insight into this topic via their subjective data felt distracted. They connected this distractibility with private messages, notifications, wall posts, and presence on Facebook. As consequence, they spent longer time or delayed doing homework. On the other hand, a smaller group of participants was not distracted by anything related to the Facebook group. First, they focused on doing

homework/studying and then moved to private matters. In other words, they separated academic duties in the study group from their virtual private life on this social networking site.

The group was also perceived as a stress-free language learning environment. Moreover, some of the students added a sense of security to its relaxed nature. However, a minority felt a sort of pressure or stress that was bound with the group audience. Particularly, it stemmed from exposing students' EFL output (potentially filled with mistakes) to others. We can deduce from the data that the group audience seems to be a significant factor that not only influences students' motivation to learn the target language but can also stress the students when they produce it.

Nearly one third of the students described the Facebook study group as a chaotic EFL learning environment. The dynamic structure caused confusion and problems with completing assignments or orientation. On the other hand, some research subjects viewed the Facebook study group as an organized language learning environment. Based on their subjective theories, it was easy to use, quick to navigate, well-structured, and time-saving.

From an overall perspective, the motivating and stress-free nature of the discussed learning environment was viewed as a significant benefit for the EFL learning process, but the threat of obstructing it by distraction and disorganization caused that the Facebook group was not perceived as an outstanding language learning environment.

ACKNOWLEDGEMENTS

This article is a part of the following projects: UGA V/1/2018 - Facebooková študijná skupina ako alternatíva k LMS; APVV-15-0368 - Prax v centre odborovej didaktiky, odborová didaktika v Centre praktickej prípravy.

REFERENCES

Al-Shehri, S. (2011). Connectivism: A new pathway for theorising and promoting mobile language learning. *International Journal of Innovation and Leadership on the Teaching of Humanities*, *1*(2), 10-31.

Bani-Hani, N. A., Al-Sobh, M. A., & Abu-Melhim, A-R. H. (2014) Utilizing Facebook groups in teaching writing: Jordanian EFL students' perceptions and attitudes. *International Journal of English Linguistics*, *4*(5), 27-34. http://dx.doi.org/10.5539/ijel.v4n5p27

Benaquisto, L. (2008). Codes and coding. In Given, L. M. (Ed.). *The SAGE Encyclopedia of Qualitative Research Methods* (pp. 85-88). Thousand Oaks: SAGE Publications.

Hsu, L. (2013). Leveraging interactivities on social networking sites for EFL learning. *International Journal of English Language Education*, *1*(3), 244-270. https://doi.org/10.5296/ijele.v1i3.4063

Kirschner, P. A. & Karpinski, A. C. (2010). Facebook and academic performance. *Computers in Human Behavior*, *26*(6), 1237-1245. https://doi.org/10.1016/j.chb.2010.03.024
Available at: <http://www.sciencedirect.com/science/article/pii/S0747563210000646>. ISSN 0747-5632.

Kabilan, M. K., Ahmad, N., & Abidin, M. J. Z. (2010). Facebook: An online environment for learning of English in institutions of higher education? *The Internet and Higher Education*, *13*(4), 179-187. https://doi.org/10.1016/j.iheduc.2010.07.003

Meishar-Tal, H., Kurtz, G., & Pieterse, E. (2012). Facebook groups as LMS: A case study. *The International Review of Research in Open and Distance Learning*, *13*(4), 33-48.

Pasek, J., More, E, & Hargittai, E. (2009). Facebook and academic performance: Reconciling a media sensation with data. *First Monday*, *14*(5). https://doi.org/10.5210/fm.v14i5.2498

Paul, J., Baker, H. M., & Cochran, J. (2012). Effect of online social networking on student academic performance. *Computers in Human Behavior*, *28*(6), 2117-2127. https://doi.org/10.1016/j.chb.2012.06.016

Razak, N. A., Saeed, M., & Ahmad, Z. (2013). Adopting social networking sites (SNSs) as interactive communities among English foreign language (EFL) learners in writing: Opportunities and challenges. *English Language Teaching*, *6*(11), 187-198. https://doi.org/10.5539/elt.v6n11p187

Romano, T. (2009). Defining fun and seeking flow in English language arts. *English Journal*, *98*(6), 30-37.

Scheele, B. & Groeben, N. (1988). *Dialog-Konsens-Methoden zur Rekonstruktion Subjektiver Theorien*. Tübingen: Francke Verlag.

Simpson, M. N. (2012). ESL@Facebook: A teacher's diary on using Facebook. *Teaching English with Technology*, *12*(3), 36-48.

Small, M. (2014). Theoretical implementations of various mobile applications used in English language learning. *Teaching English with Technology*, *14*(1). 35-46.

Sun, Y. C. (2010). Extensive writing in foreign-language classrooms: A blogging approach. *Innovation in Education and Teaching International*, *47*(3), 327-339. https://doi.org/10.1080/14703297.2010.498184

Yunus, M. M., Salehi, H., & Chenzi, Ch. (2012). Integrating social networking tools into ESL writing classroom: Strengths and weaknesses. *English Language Teaching*, *5*(8), 42-48. http://dx.doi.org/10.5539/elt.v5n8p42

sciendo

ICTE Journal

*2019, **8**(1): 30–38*
DOI: 10.2478/ijicte-2019-0003

SIX TECHNOLOGICAL INNOVATIONS THAT CHANGED ENGLISH LANGUAGE TEACHING

Bekešová Jana[1], Romanová Iveta[2]

[1]Department of Language Pedagogy and Intercultural Studies, Faculty of Education, Constantine the Philosopher University in Nitra, Slovak Republic {jane.bekesova@gmail.com}

[2]Department of Language Pedagogy and Intercultural Studies, Faculty of Education, Constantine the Philosopher University in Nitra, Slovak Republic {iva120@gmail.com}

ABSTRACT

The paper focuses on six technological innovations which have influenced English language teaching and learning. Their potential is analysed and the way suggested how they could be creatively used. In the research part, authors introduce the most popular ones among English teachers and present those they would like to apply within the lessons. Being able to analyse the opposite point of view as well, small number of English students were asked which of these technological tools their English teachers use the most and on the other hand, would like to experience when learning English. In addition, we compare the difference in their choice when teaching and learning English at primary and secondary school.

KEYWORDS

English language, teaching, learning, technology, innovations

1 INTRODUCTION

Traditional classroom-based teaching in which students are just passive recipients of information provided by a teacher has commonly been replaced. Living in the technological age, a wide range of tools which boost the effectiveness of second language teaching and help to avoid boredom and the routine of using only a coursebook can be observed in the classrooms.

In the theoretical part, six of them – whiteboard, smartphone, Skype, blogging, podcasts and online games which, in our opinion, have mostly changed English language teaching and learning will be presented. In the research part, we try to identify the most popular ones among English teachers and those they would like to try within lessons. We analyse whether teachers are willing to experiment with new technologies or they are rather resistant and afraid. In order to get the opposite point of view as well, English students were also asked for their opinions and experience. In addition, we compare whether there is some difference in the choice of technological innovations among English teachers and students at primary and secondary school.

2 THEORETICAL PART

English language teaching is evolving all the time following the technological development. However, which technological innovations have had the strongest impact on teaching English? Six of them were selected which seem to be the most important ones.

Smartphones

Mobile phones are devices that are owned by almost every person in the world. Smartphones are their upper version and they are perfectly known to a younger generation. Especially this group of people use their phones not only to phone or text but mainly for taking pictures, playing games and downloading different apps. Such applications can be used for fun or they can be both funny and educational. Within smartphone apps we chose 4 that focus on general or concrete knowledge, vocabulary, listening comprehension and speaking.

Socrative works on phones, tablets, computers and laptops. The app is for classroom use, it is for free and available for teachers and students. The teacher uses his account to create a public room for a maximum of 50 pupils per session. He makes a list of the students in one group or he can divide them into smaller groups. The teacher creates a quiz, gives a time limit, checks the results and gets the students' feedback and experience. It is a good and entertaining way of testing the knowledge while you do not need any online connection, just a charged battery and a phone that offers Google Play shop.

Wordable is a social English vocabulary game powered by Cambridge dictionary that supports learning by playing fun word games, while the children are able to learn about 3000 most useful general English words from different word packs like newspaper, school, sport, work, travel, etc. There are also 1500 essential work words that cover business, construction, food, housekeeping, retail, etc. The application fulfils the social function because it enables to compete with friends and learners all over the world; it is fun because it tests the English vocabulary in minigames; it accelerates the learning with wordable's memory technology.

Tri Pro English application works exclusively for tablets and mobiles. It brings English exams in three levels – easy, intermediate and advanced. The exercises offer wide range of listening activities for B1, B2 and C2 learners. Each listening part has its reading comprehension questions, the listened text and answer to check the correctness. A big advantage is that learners can study anywhere, anytime and without the need of an Internet connection. It is available at App Store in mobiles and tablets. The exercises can be done individually or within a lesson with a teacher.

Fluent U is a unique app that takes real-word-videos including news, cartoon, music videos, commercials and inspiring talks. We can say this is an untraditional way of learning experience in which students learn English as it is spoken in real life. Fluent U contains lots of authentic English materials, so the children are excited while watching their favourite videos pop up in the classroom. All the videos are sorted by skill level and come with built-in language lessons. This type of app is not only used by teachers when writing curriculum but they are also fantastic for students during classroom activities or unstructured classroom time. It is recommended for teachers who want to teach with fun content and whose learners are more likely audio-visual. It is not only great for in-class activities but also for group projects and solo homework assignments. The good news is that the app is also for free available in the App Store.

Google Translate is definitely the app that everyone who learns or teach foreign languages should have on their phone. It can translate almost all the languages, not just English, and can be used in many activities. It has wide usage – either when being abroad, travelling or working on a project outside the classroom. This program also brings a disadvantage which comes with translating whole sentences. Learners must be careful

because the translator functions on a word by word translation configuration and this can lead to misunderstanding or wrong translation of the words.

Google Docs is a free web-based application where the files and spreadsheets are created, edited and stored online. Those can be installed to an Android phone, iPod or tablet from the Google Play apps. To access the files, it is required to have an Internet connection and this can be a disadvantage. Such documents can be saved on *Google Drive* which is a safe place for not only these types of documents but also pictures or videos. They are reachable form any smartphone, tablet or computer. Within Google Drive disk we can highlight its good points mentioned in the Google Play Store:

- safely store your files and access them from anywhere,
- search for files by name and content,
- easily share files and folders with others,
- quickly view your content,
- set access levels for who can view, comment, or edit,
- quickly access recent files,
- see file details and activity,
- enable viewing of files offline,
- use your device camera to scan in paper documents,
- access pictures and videos from Google Photos.

Whiteboard

"Interactive whiteboards (IWBs) have become more and more prevalent in the classroom over the years. And it is no wonder – the benefits are vast and offer teachers new, inventive ways to demonstrate core and supplemental concepts. As children become more familiar with smart technology at home, the classroom is catching up and teachers are using the benefits of technology to their advantage. Even more exciting are the advantages this technology offers students" (Hosman, 2017).

As Hosman continues, using interactive whiteboards (IWBs) teachers have much more opportunities for learners to engage. Most of the learners are visual which means they use colours, pictures, images to organize, separate and learn information so the existing curriculum can be supported by videos, moving diagrams, stories or online content. In other words, teachers can increase student interest by adding stimulating visual aids to new and existing curriculum and moreover everything what is done on the computer can be seen on the IWB.

We need to mention that the IWB is a digital aid and it works under electricity, so when it is suddenly off, the teachers must improvise and find another way of how to make the learning process interesting and innovative for students.

Skype

Skype was released 15 years ago, in 2003, and therefore it might difficult to perceive it as a modern technology. However, its potential for teaching English is undoubtable. It is an easy and inexpensive way which gives students and teachers an opportunity to connect with the outside world without leaving their seats. In the language classroom, learners can contact native speakers everywhere in the world and fine-tune their English language skills. Learning becomes more authentic, inspirational and engaging when it transcends the walls of the classroom (Krishnasamy, Raman, 2015, p. 21). Skype can be used to provide a variety of authentic language experiences, including an interview with an English author or the international collaborative projects with other classrooms. Moreover, it does not have to be used only for developing

speaking skills. Function of instant messaging and chatting is great for students who need to practise writing and reading skills.

Although Skype could be arguably considered less sophisticated than other web or video conferencing tools, its simplicity makes it an accessible tool for teachers who are reluctant to use technology due to lack of skills, confidence or high levels of anxiety.

Podcasts

A podcast is an audio or video file which is produced in a series and could be broadcast via Internet or downloaded to a computer or mobile device (Müllner, 2009, p. 3). In terms of language teaching, students can listen to existing podcasts and to improve listening comprehension or to create their own podcasts and to practise speaking skills. Both options are much more engaging than traditional listening and speaking tasks included in the coursebooks mainly because of students' independence in the choice of topics. It is recommended to encourage them to find a podcast that takes their attention and to listen regularly.

There are many existing resources that can be used for language learning purposes. Firstly, authentic podcasts are released by broadcasters from all over the world and are primarily intended for native speakers, but they can expose students to natural language use. Secondly, language learning podcasts are focused on the specific area of language, e.g. vocabulary, colloquial language, idiomatic phrases or grammatical structures. According to Hashmi and Jain (2013, p. 159), this web-based environment effectively narrows the gap between the formal English which dominates most second language classroom and the informal English used in most real-life communication events. It provides them with plenty of meaningful language use which is highly desirable for second language acquisition (Hashmi, Jain, 2013, p. 159). In addition, they specify the following concrete activities which could be used within English lesson:

- Podcasts containing conversations between the native speakers,
- Podcasts based on that encourage careful listening by the learners,
- Podcasts based on comprehension activities, interviews and vocabulary,
- Podcasts based on idiomatic expressions with their usages,
- Story-based podcasts followed by listening comprehension questions.

If students decide to create their own podcast, they can do it individually or as a group, introducing some interesting personal information, stories or book and film reviews. With the rapid growth of technology, it is now easy for teachers and students to produce podcast. All they need is a computer, the Internet and a headset. In addition, they can upload these podcasts to the school website, so the other students could listen to them as well. As Nuan (1995) points out more the learners practise podcast texts, rehearse them and record them, the more proficiency will come in their speech.

Blogging

While podcasts can serve as a great toll for improving learners' listening and speaking skills, blogging mainly focuses on the area of reading and writing. A blog is a frequently updated website that often resembles an online journal. In terms of English language teaching, class blog could be used as a shared space, in which teacher and students can actively participate on building its content. According to Stanley (2006), it is a way of opening up the classroom walls and showing the wider world what is happening and creating a small language learning community.

Blogging builds confidence, self-expression, autonomous learning and provides a space in which even the shyest students can participate. Within the scope of classroom-based blog activities, assignments can require the student blogger to communicate closely with a specific group of student bloggers. Moreover, reading and writing the blog can be almost instantaneous or at home. This combination of planned and spontaneous communicative exchanges inside and outside the classroom makes blogging a meaningful and engaging social exercise (Blackstone, Naganuma, Spiri, 2007, p. 2). Its multimedia features, simple web

publishing, interactivity and ability to support cooperative and autonomous learning confirm the fact that blogs can effectively facilitate language teaching and learning.

Research conducted on 42 English students reflects that majority of them (78 %) enjoyed posting, reading classmates' and teachers' posts and making comments on them (Aggarwal, Ahluwalia, Gupta, 2011, p. 38). It should be also pointed that the role of teacher and classmates is crucial – when students upload their posts on the blogs and receive comments and feedback from their peers and teachers, they feel highly motivated and learning is much more effective.

Online Games

Online games are primarily perceived as the source of entertainment; however, they can be also used for teaching English. Using online games in the language classroom requires much more preparation for teachers than using books but Seli (2015, p. 5) states that when learners start playing the game they will be eager to solve the problems, answer the questions and complete the mission to go to the next level. This opinion has been also proved by research findings showing that English students playing online language games tend to learn more appropriately, could retain the new words for a longer period of time and retrieve more words in comparison to those who are not provided with such games (Kwan, Yip, 2006). If the games are fun, relaxing, motivating and confidence boosting, the learners' interest will increase. Nevertheless, to guarantee learning effectiveness, games which provide students with a sense of achievement and scope for development are required.

Among the most popular, *The Grammar of Doom* is an adventure-style game where learners explore secrets hidden within an old, magical temple. There are 10 rooms in the temple, and each room has its own series of puzzles that have to be solved using English grammar and vocabulary to move to the next room and eventually beat the game. It needs to be stressed, that online games do not have to be necessarily used for teaching and practising only vocabulary or grammar. *The Call of Duty* series include some of the most popular action games of all time. In these games, students play the role of a soldier, where with their classmates work together to defeat the other team. It is based on voice chat feature where they can come up with strategies and have conversations.

2 RESEARCH PART

In the theoretical part, we have introduced six technological innovations which have undoubtedly influenced English language teaching. All of them dispense with a great potential, make teaching and learning more effective, interesting and motivational. On the other hand, some of them are directly dependent on the Internet or financial resources of school and sometimes require even more preparation from English teachers in order make sure that learning objectives will be achieved. Being able to find out how they are perceived by English teachers and students at primary and secondary schools in Slovakia, a small-scale research has been conducted. An online anonymous questionnaire was used as the main research method. At the beginning, we state following research hypotheses – expectations:

1. *Whiteboards for teaching English are used by more primary than secondary school teachers.*
2. *More students at secondary than at primary school would like to experience using smartphones within English lessons.*
3. *More teachers than students would like to experience using Skype within English lessons.*

Being able to find the answer to these research hypotheses, 40 English teachers (20 at primary and 20 at secondary school) were addressed with the following two questions:

1. *Which of the following technological innovations do you use most frequently within English lessons?*

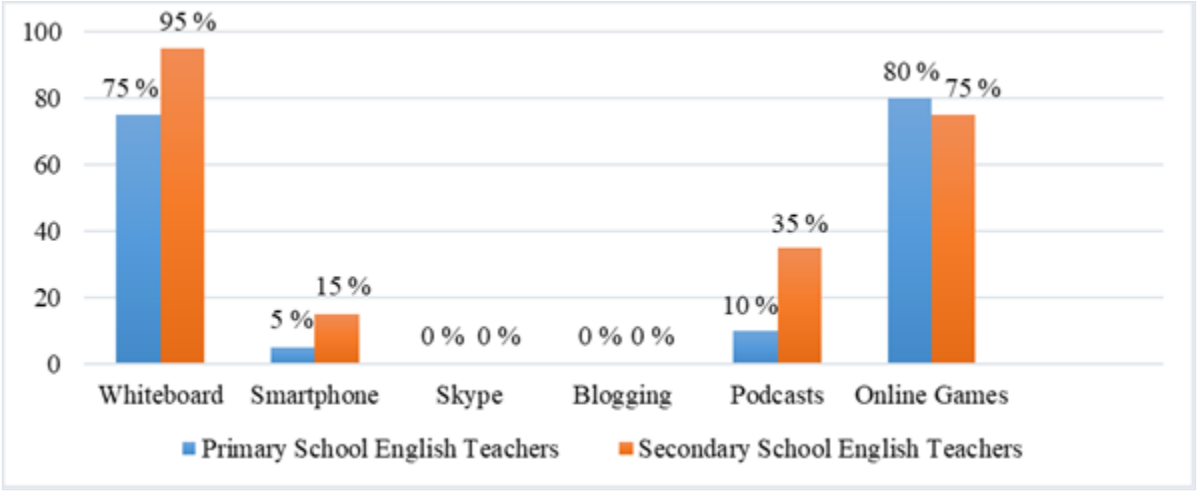

Figure 2 The use of technological innovations among English teachers

Figure 1 reflects that whiteboard is absolutely the most popular technological innovation among English teachers. Since it has been claimed by 75 % of primary and 95 % of secondary school English teachers, it seems that there is not a difference between its frequency of use. However, the lower number of primary school English teachers might be caused by the age and language level of learners. At primary school, more attention is probably paid to drilling exercises and work with a coursebook. Secondly, online games seem to be frequently used as well. It confirms our theoretical assumption that they are not only funny and motivational but also give students a chance to learn, practise and to review English language in a pleasant atmosphere. Unfortunately, only small number of the addressed English teachers prefer smartphones and podcasts for language teaching and none of them use Skype or blogging.

2. *Which of the following technological innovations would you like to apply within English lessons?*

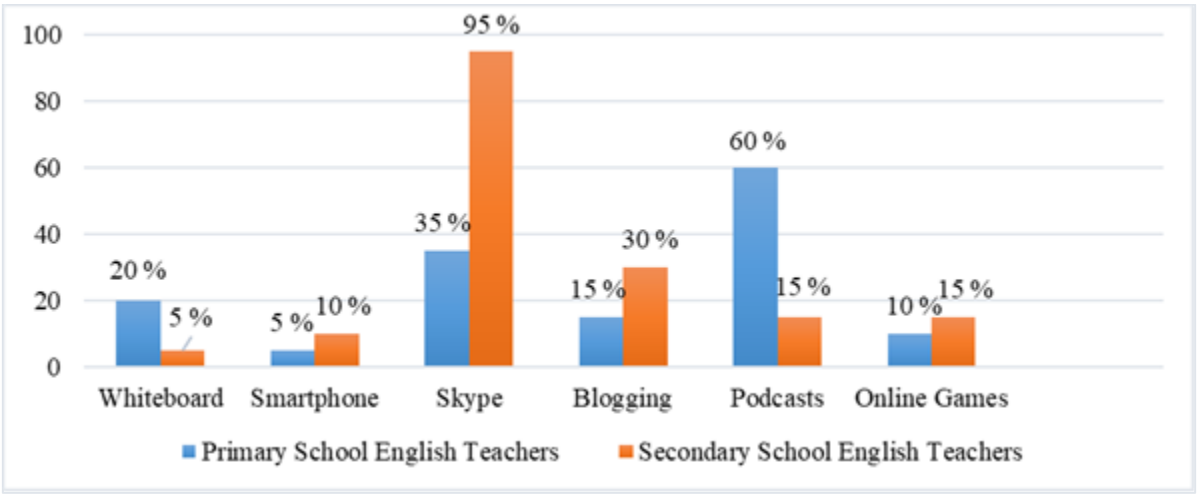

Figure 2 Technological innovations that English teachers would like to try within lessons

Figure 2 shows that teachers are willing to use smartphones, Skype, blogging or podcasts and are not afraid of their use. However, there is a difference in the choice among primary and secondary school English teachers. While majority (95 %) of secondary school English teachers would prefer trying Skype, more than half (60 %) of primary school English teachers would choose using English podcasts. This result is surprising because according to Figure 1, only 10 % of primary school English teachers use them for language teaching. On the other hand, only small number of English teachers would try blogging and almost

none of them smartphones, probably because all learners would be expected to own one, preferably with the Internet access, what might be financially difficult for schools as well as for some of the students.

Being able to analyse opposite viewpoint as well, 40 English students (20 at primary school, aged 10 – 14 and 20 at secondary school, aged 15 – 18) were asked two similar questions:

1. *Which of the following technological innovations does your teacher use most frequently within English lessons?*

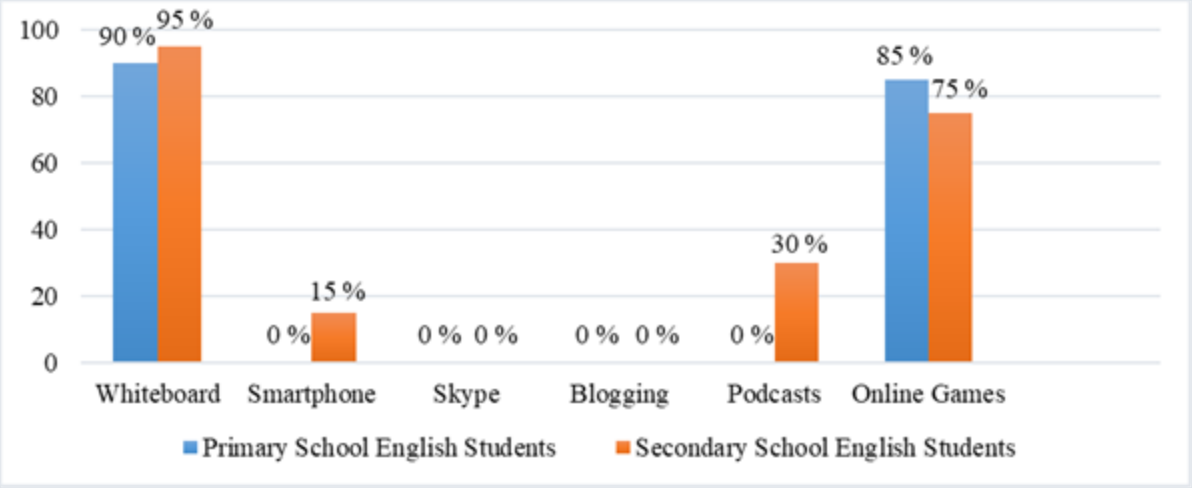

Figure 3 The use of technological innovations for teaching English from students' viewpoint

Figure 3 confirms the results which are reflected in Figure 1. Whiteboard and online games are the most popular technological innovations among English teachers both at primary and secondary school and their dominance for English language teaching is unquestionable. Only small number of English students claimed that they have experienced using smartphones and podcasts within English lessons.

2. *Which of the following technological innovations would you like to experience within English lessons?*

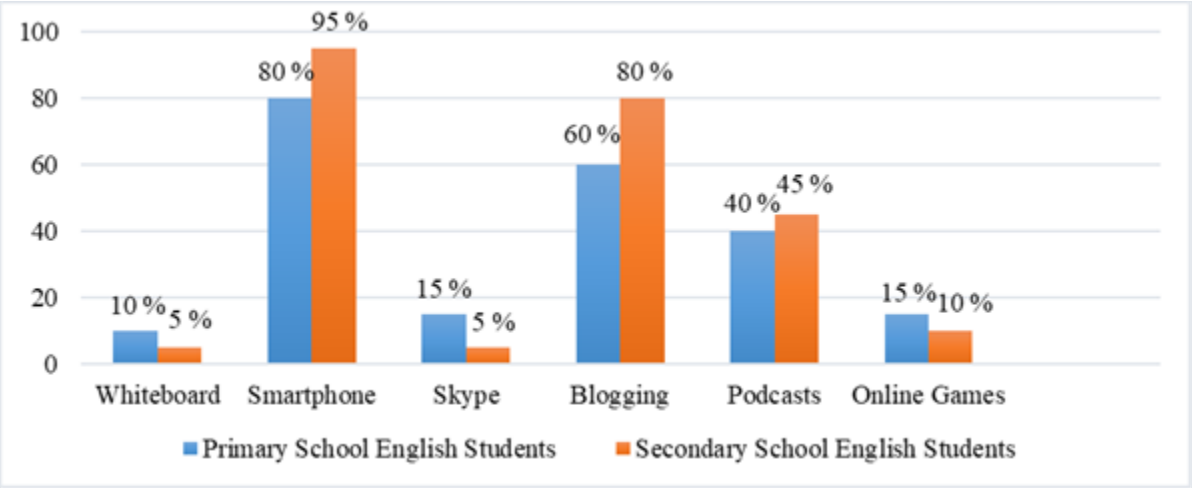

Figure 1 Technological innovations that students would like to experience within English lessons

According to Figure 4, learners have opposite viewpoint in comparison to the teachers when it comes to using new technological innovations within English lessons. Majority of them would like to experience smartphones for learning English, followed by blogging and using podcasts. What is the most important, only small number of English teachers claimed that they would like to try smartphones and blogging, therefore students' expectations are totally different. Research results indicate that English learners,

regardless of age or language level, are more eager to use the latest technological tools, while teachers stick more to traditional ones, which might be also caused by financial resources and technological equipment of schools. In addition, while primary and secondary school English teachers differ in their choice of technological innovations they would like to try for language teaching, students' opinions are much more homogeneous.

To conclude, our first research hypothesis has been rejected because more teachers at secondary (95 %) than at primary (75 %) school use whiteboard within English lessons. On the other hand, second research hypothesis has been proved because more students at secondary (95 %) than at primary (80 %) school would like to experience using smartphones for English language learning. Finally, the third research hypothesis has been proved as well because more teachers than students would like to try using Skype within English lessons.

CONCLUSION

Today´s learners and young people belong to ICT generation who are able to serve a phone, computer or tablet at early pre-school age. They spend on their phone from five to six hours a day on average. All the technology is well known to them and it seems they are able to work with electronic devices in or outside the classroom.

The research showed that a whiteboard and online games are frequently used within English lessons either at primary or secondary schools. Teachers find the whiteboard helpful, easy to control, and although it has been in use for years, it is still more interesting than using a traditional blackboard. The opinions of primary and secondary teachers do not differentiate which was also confirmed by the students. On the other hand, smartphones and podcasts are rarely used for teaching English while Skype or blogging are not used at all. The survey also showed that teachers would like to try or experience new technology innovations and forms of teaching English but they are maybe afraid. The reason can be, for example, finances, lack of equipment or fear of losing control while using smartphones within lessons.

There were found opinion differences between primary and secondary teachers about using the technology; this can be caused by age or language level of learners. Based on our questionnaire, primary school English teachers would welcome podcasts while those at secondary school would vote for Skype. Although the questioned teachers are for innovations in teaching, they are not very keen on smartphones or blogging and would never try it. Students' reaction was unsurprisingly different – smartphones and blogging are the means they would definitely try within their English lessons.

Nevertheless, due to the low number of participants, the research results could not be globalized and they provide just the introduction into the topic. In order to gain a more complex picture, more of them should be addressed for the future research. In addition, it needs to be stressed that a huge age difference between primary and secondary school English learners could distort the results. Younger learners might have opposite choices in comparison to the older ones. However, the attention should be paid to the fact that there seems to be differences between expectations of students and teachers which technological innovations should be used for English language teaching and learning in general.

Available literature, websites, apps or materials offer a huge range of teaching ideas. Teachers are able to choose from various programs that might interest their students. The generation of children who grew up on using computers, tablets and phones would like to be motivated in a new and up-to-date way.

REFERENCES

Aggarwal, D., Ahluwalia, G., Gupta, D. (2011). The Use of Blogs in English Language Learning: A Study of Student Perceptions. *Profile Issues in Teachers' Professional Development, 13*(2), 29-41. https://files.eric.ed.gov/fulltext/EJ1051503.pdf.

Blackstone, B., Naganuma, N., Spiri, J. (2007). Blogs in English language teaching and learning: Pedagogical uses and student responses. *Reflections on English Language Teaching, 6*(2), 1–20. http://www.nus.edu.sg/celc/research/books/relt/vol6/no2/1-20blackstone.pdf.

Hashmi, F., Jain, S. (2013). Advantages of podcasts in English language classroom. *Journal of Indian Research, 1*(2), 158-163. http://mujournal.mewaruniversity.in/jir2/23.pdf.

Hosman, T. (2017). *Using Interactive Whiteboard Technology to Increase Engagement in the Classroom.* Retrieved 2 November 2018, from https://www.alfred.com/blog/using-interactive-whiteboard-technology-increase-engagement-classroom/.

Krishnasamy N. H., Raman, A. (2015). *Skype in the English language classroom*. Proceeding Kuala Lumpur International Communication, Education, Language and Social Sciences 1 (KLiCELS 2), 20-27. https://www.researchgate.net/publication/286451914_SKYPE_IN_THE_ENGLISH_LANGUAGE_CLASSROOM.

Kwan, A., Yip, F. (2006). Online vocabulary games as a tool for teaching and learning English vocabulary. *Educational Media International, 43*(3), 233-249. https://www.researchgate.net/publication/263249087_Online_vocabulary_games_as_a_tool_for_teaching_and_learning_English_vocabulary.

Müllner, E. A. (2009). *A Tool for Teaching English: Podcasts*. Norderstedt: Druck und Binding: Books on Demand GmbH, 2009. 44 p. ISBN 978-3-656-13887-7.

Nuan, D. (1995). Closing the gap between learning and instruction. *TESOL Quarterly, 29*(1), 133-158.

Seli, S. (2015). Teaching English through Online Games for Junior High School Students. *Premise Journal, 4*(1), 1-10. http://ojs.fkip.ummetro.ac.id/index.php/english/article/view/281/242.

Stanley, G. (2006). Blog-EFL: *Observations and comments on the use of weblogs, emerging technologies & e-learning tools for English language teaching*. Retrieved 1 November 2018, from http://blog-efl.blogspot.com/ (online video: 2:00-2:56).

sciendo

ICTE Journal

*2019, **8**(1): 39–47*
DOI: 10.2478/ijicte-2019-0004

ICT AS AN ENHANCING TOOL OF FOREIGN LANGUAGE TEACHING CHILDREN WITH AUTISTIC SPECTRUM DISORDERS

Beáta Jelínková[1]

Department of Language Pedagogy and Intercultural Studies, Faculty of Education, Constantine the Philosopher University in Nitra, Slovakia {beata.jelinkova@ukf.sk}

ABSTRACT

This paper reports on teaching/learning a foreign language of children having autistic spectrum disorders (ASD), particularly Highly functioning autism and Asperger´s syndrome by virtue of help of ICT. The content includes theoretical background of the strengths and weaknesses of ASD students. It also includes research on four foreign language skills – listening, speaking, reading and writing of the examined group and provides proposals for farther investigation.

KEYWORDS

Autistic spectrum disorders, highly functioning autism, information and communication technology (ICT), individualised educational programme, attention deficit hyperactivity disorder

1 INTRODUCTION

The number of children with various diagnoses, including Autistic spectrum disorders (ASD) - Asperger´s Syndrome and Highly Functioning Autism, that are integrated into mainstream schools, specifically foreign language classes is still raising, thereupon causing worries to teachers. The occurrence of Autistic Spectrum Disorders is 1%, with prevalence of male to female 4:1 (Baron – Kohen, 1998).

The reason could lie in improved diagnostic tools, teachers are more experienced in recognition of the symptoms on autistic spectrum disorders. Equally important is the fact that parents are more informed on the issue and look for professional advice themselves. Frequently happens that the child is diagnosed with ASD before enrolling to school. The factors responsible for autism are still the matter of scientific research and thus there are not any remedies yet.

2 FORMULATION OF THE PROBLEM

Kanner (American psychiatrist) was the first person who described unusual behaviour of a group of children in 1945. He characterized these symptoms as a specific disorder called autism. The origin of the word autism is derived from Greek word "autos", that stands for self. In addition to the name of diagnosis, Kanner specified children suffering from autism as captured in their own world and incapable of friendship (1945, p.248-250).

Along with Kanner, Asperger (Vienna´s medical doctor) also noticed symptoms of strange behaviour in a group of boys. For instance, they had limited ability to create bonds and their conversation was often without the need of response. On his honour the disorder was named Asperger's Syndrome. Since the first diagnostics of autism was made by Kanner (1945), diagnostic tools have progressed significantly. For

instance, the UK National Institute of Health recommended to use of semi-structured interviews and observation (Falkmer, 2013).

"Exceptional human beings must be given exceptional educational treatment, which takes into account their special difficulties" (Thorová, 2012, p.34). This idea could form the ground in education of the ASD students. Despite facing many challenges, children suffering from autistic spectrum disorders (ASD) can reach satisfactory educational results; however, they demand different approach and accommodation compared to the neurotypical students. Sensory abnormalities ought to be considered as the trigger of behavioural challenges (Jelínková, 2004, p.20).

As Ostatníková stated, autism is a huge challenge for everyone who has encountered it. The autistic spectrum disorders are characterized by certain common features. As it is a spectrum, there is no uniquely typical behaviour and symptoms of a disorder. Because every person is different and unique, the behaviour of children with ASD also differs (2010, p.9).

Weaknesses of ASD students in foreign language learning

The results of study made by specialists in autism (e.g. Lord C. et al. 1994, Rutter M. et al. 2003, Mattila L.M. 2010), present that ASD children suffer from the higher occurrence of comorbid psychiatric disorders, such as depression, anxiety and Rott syndrome. However, the highest occurrence was ADHD (attention deficit disorder) – more specifically 31% (Toth, 2008). The diagnosis ADHD itself causes learning problems with syntax, semantics, metalinguistics, auditory processing and metacognition. These students have difficulty with problem solving, especially with audio information processing that is caused by the weakened short-term memory that affects the ability to follow instructions, namely in the disturbing environment that school is.

In addition to ADHD, anxiety, depression and behavioural problems, closely linked to their behaviour, are other frequently recorded comorbid disorders in those patients. Furthermore, ASD students can have developmental learning disabilities – dyslexia, dyscalculia, dyspraxia, secondary dysgraphia or attention deficit disorders, causing special learning needs.

Commonly known feature of people with ASD disorder is their low adaptability. Moreover, sudden changes in their lives cause them not only stress but also anxiety and panic. These children enjoy prepared activities, often pre-arranged scenarios. Planning in advance and predictable activities help them overcome anxiety and lessen their frustration (Van Eylen, 2011). Many students with ASD have problems with time management and therefore need help with efficient use of time. As ICT meets the requirement on predictable changes, it is suitable an enhancing tool of foreign language teaching children with ASD.

Strengths of ASD students

Researchers directed by Mottron (2011) studied images of 357 people with autism and came to conclusion that they had more activated part of brain associated with visual detection and identification. On the contrary, less activities were shown in the areas of brain responsible for planning and controlling thoughts and actions. "*Through this meta-analysis, we were able to observe that autistics exhibit more activity in the temporal and occipital regions and less activity in frontal cortex than non-autistics. The identified temporal and occipital regions are typically involved in perceiving and recognizing patterns and objects. The reported frontal areas sub serves higher cognitive functions such as decision making, cognitive control, planning and execution"*. These results explain outstanding capacities of ASD people in visual tasks.

The research proved that ASD children are visual learners, having excellent visual long-term memory. This ability is very beneficial for learning foreign languages and facilitates the process of learning.

Moreover, compared to neurotypical population, some ASD can have a lot of advantages. There were proved cases of individuals that they can decode language in early age and achieve high level in language learning by devoting a lot of time, especially if it is their interest. They are also very consistent and focused on details. They may be even precocious readers and therefore have an excellent range of vocabulary.

Most students suffering from Asperger syndrome have good memory for rote learning and some of them have a fascination for using this new code for familiar objects. Moreover, they can easily achieve functional competence also been called phatic language use, by performing language functions in communication skills such as ritual enquiries about health, weather and basic social contacts with others (Duda & Riley, 1990, p.29).

3 SCHOOLING OF ASD STUDENTS

Since the English language as a foreign language is a compulsory subject for all children of primary and secondary schools in Slovakia, ASD students are not an exception. The document "*Concept of foreign language teaching in primary and secondary schools*" is part of the national project Millennium, chapter 3.1, which puts priority to "*develop a system of foreign language teaching - at least from the third year of the primary school to begin teaching at least one compulsory foreign language and gradually the second foreign language as a compulsory elective".*

The schooling of students with High function autism and Asperger´s syndrome is accomplished under terms of State educational programme guideline. As it fully specifies, teachers need professional advice from psychologists who prepare the tailored Individualised educational programme (IEP) as well as recommendations on the student´s teaching and compensational aids (Kednal, 2008). The purpose of such a document is to help both students and teachers to find the best way to make a progress in education considering the student´s needs (Zelinková, 2006, p.172-173).

Foreign language acquisition of ASD students

In order to learn a foreign language, one must reach certain components like memory abilities, phonetic coding ability, grammatical sensitivity and inductive learning ability. Farkašova mentioned that factors responsible for learning the foreign language are complex and the person´s individuality always needs to be taken into consideration as well as internal and external learning conditions, including the impact of modern technologies that play a very important role (In Pokrivčáková et al, 2008, p.39).

As stated by Zelinková (2005, p.161), "*Teaching foreign languages is a difficult problem to solve looking for the optimal ways of educating individuals. It comes from the logic that a student who has difficulty in acquisition of a mother tongue will have more serious problems in learning foreign languages as well".*

Yet other important factors for foreign language learnings are motivation and willingness. The motivation for learning foreign language is greatly influenced by their interest in the subject (In Pokrivčáková et al. 2008, p.40).

Provided that students must meet a set of requirements, goals, and competencies when acquiring a foreign language. ASD students face some difficulties in foreign language learning compared to neurotypical children. ASD students do not have impaired memory and have intellect in the average range. It was also proved that ASD children have relatively intact visuospatial abilities (DeMyer 1981; Lincoln 1988; Shah 1983), good auditory short-term and rote memory skills (Bartak 1976; Hermelin 1970; Wing 1976), as well as remarkable memory for specific kinds of information (Kanner 1943; Wing 1976).

For that reason, visual aids or written word are very appropriate for ASD students. They mostly have problems with long assignments and it is appropriate to divide questions into smaller parts. Entries can be understood more easily when described in the simplest way and as one step (Zelinková, 2009, p.167).

The solution of that issue is in the use of technologies with a visual dimension – digital video, photography, video conferencing that engage students and provide a collaborative working and discussion. The great benefit of ICT is the student´s feeling of control over the technology.

Four languages skills of ASD students

Generally, ASD students loathe to handwrite, even though they are mostly visual learners. They show the signs of secondary dysgraphia, dyspraxia and fine motor skills deficiency. The study compared handwriting

of children with and without ASD in 5 categories: legibility, form, alignment, size, and spacing. The results show that ASD children have overall worse performance on a handwriting task. Furthermore, problems with short-term memory have direct impact on ASD students and their difficulties with handwriting. ASD students can forget spelling, capitalization, grammar rules, forget about lines and therefore dislike writing. The best accommodation for ASD children is to use a keyboard for writing (Fuentes, 2009).

Students with ASD like reading and often have broad vocabulary, especially if reading in foreign language is their hobby. For instance, they acquire vocabulary from English films and videos. They like graphic novels with illustrious characters from everyday life like "Calvin and Hobbes". Besides acquiring vocabulary in English, they are improving social skills. These findings were proved by a computer mediated interaction in Asperger´s syndrome, in which four male adolescents with ASD were involved. The results of "Bubble Dialogue" induced an improvement in interpersonal understanding a social interaction (Rajendran, 2000).

Due to occurrence of spam attention disorders in ASD, listening skills in foreign language are less developed. If their subject matter does not interest them, they can refuse to do such exercises, because they do not find them important.

Impairments in social interaction are a key feature of autism and are associated with atypical social information processing. Imaging of magnetic resonance show that individuals with autism failed to activate a brain region in response to vocal sounds, whereas they showed a normal activation pattern in response to non-vocal sounds. These findings suggest abnormal processing of auditory information in autism (Gervais, 2004).

Ostaníková presents several challenges in the communication of students with ASD. One big challenge is non-verbal communication, which is often missing or inappropriate. Common language dialogues also require non-verbal communication, social interaction between a student with ASD and a teacher or his classmates, and that is precisely the area with which ASD learners have difficulty (2010, p.234-237).

In pragmatics, ASD students experience difficulties in the use of people's names or greetings, have inappropriate facial expressions and eye contact, interrupt others, do not allow others to talk, ignore their answers and talk mostly about subjects of their interest in which they have plenty of information.

ICT as an enhancing tool in teaching/learning of ASD students

The analyses of 350 published papers on the impact of ICT in education proved the positive impact of implementation of ICT in modern world. The increased numbers of papers have been published on the teaching children with learning needs since 2000. The fastest escalation of studies published on ICT-assisted learning intervention was between the period 2006 – 2011. Nonetheless, the least frequent were publications on the integration of autistic spectrum disorders via ICT in mainstream schools (Starcic, 2014, p.218).

It has been proved in many publications that ICT have a positive impact on learning/teaching of foreign languages, namely they have a huge potential to adapt the teaching/learning materials according to learner´s needs. They allow to blend audio and video inputs along with practicing vocabulary and pronunciation. Moreover, internet, smart phones, video games and music players are used to target language raise, by increasing the student´s motivation and language awareness (Altun, 2015).

As a tool for accommodation ASD students, psychologists often recommend using laptops, iPads, smart phones in educational process. The consequent question is the reason why educational specialists advise to implement ICT as a tool to accommodate students suffering from ASD and what benefits it brings. Taken into consideration all weaknesses and strength of ASD students, it can be supposed that implementation of ICT in education process of ASD students is beneficial for them. Special educational needs of students, particularly suffering from Autistic spectrum disorders include plenty of various learning difficulties that prevent the progress in their studies without the appropriate accommodation.

Wire as an experienced teacher of Autistic spectrum disorders children gives advice on teaching and learning foreign languages (2005, p.123-128) "*Incorporate using a computer, CD ROMs and associated technology into teaching and learning as much as possible, and allow the use of a laptop where appropriate, so homework tasks, including factual investigations, could be set to be done on the computer at home".*

Putman (2008) in her study described the view of software developers, designers and researchers looking for a help how to educate children with ASD via software and technologies. Between 1st October and 15th November 2007 anonymous on-line surveys on open-ended questions aimed at strength and weaknesses of ASD children and their use of ICT in education were collected. Totally she received 114 submission concerning people with ASD, from which 102 ASD children the age 0 – 18. The questionnaire included 5 questions on the type of used technology, experience with their use, missing software, attitude towards technology and interests in ICT, and were asked to scale from 1-5, based on their effectiveness.

Table 1 shows purpose of ICT use by ASD

Use of ICT	Results
reading	28
socialising	14
watching films	29
sci-fi stories	7
writing	36

Parents of ASD children reported mainly positive experience with used technology as the ICT taught them social communication and provided academic help.

Swettenham (1996) sees computers as an ideal educational tool for ASD students for many reasons. For instance, computers provide social interaction, accommodate the autistic need and allow the student to take control and work at your own pace.

CASE STUDY RESEARCH

The aim of the case study was to compare students having ASD with neurotypical population aged 10-15. The research sample included 51 students, diagnosed with ASD and 59 students without ASD. The questions were aimed at identifying four language skills of ASD students – speaking, writing, listening and reading. The same questionnaires were given to primary school children at the same age without ASD. The answers were scored from 1 to 5. The score 1 means the least points and 5 the most.

Research question: Do you like speaking in English?

Table 2 Speaking in English languages

Answers / Number of students	Strongly Disagree	Disagree	Neither Agree / Disagree	Agree	Strongly Agree	Sum	Average
with ASD	14	11	11	0	15	51	45 %
without ASD	12	15	16	9	7	59	41 %

As the results show the students with ASD do not have more troubles with speaking in foreign language than the neurotypical counterparts.

Research question: Do you like writing in English?

Table 3 Writing in English language

Answers / Number of students	Strongly Disagree	Disagree	Neither Agree / Disagree	Agree	Strongly Agree	Sum	Average
with ASD	34	10	4	1	2	51	16 %
without ASD	25	11	10	4	9	59	26 %

It was proved that ASD children do not like writing in foreign language, however, very similar results were observed in students without ASD.

Research question: Do you like listening in English?

Table 4 Listening in English language

Answers / Number of students	Strongly Disagree	Disagree	Neither Agree / Disagree	Agree	Strongly Agree	Sum	Average
with ASD	8	10	14	15	4	51	50 %
without ASD	8	16	18	11	6	59	46 %

Research question: Do you like reading in English?

Table 5 Reading in English language

Answers / Number of students	Strongly Disagree	Disagree	Neither Agree / Disagree	Agree	Strongly Agree	Sum	Average
with ASD	8	12	10	10	11	51	52 %
without ASD	10	20	12	11	6	59	42 %

The results are depicted in tables and show that ASD students do not have significant differences in examined language skills than students without ASD. The biggest challenge of ASD students is writing, however, the other skills do not fall behind the neurotypical children.

Moreover, many respondents from both groups claimed that they like listening to songs in English, watching videos, films and online games and they gain vocabulary from those activities.

CONCLUSION

The occurrence of ASD children among the neurotypical population has steadily increasing tendency. For that purpose, teachers need to find out the approach to accommodate the ASD children´s needs. Because of integration of ICT in educational process is commonly known as beneficial for students and teachers, it is enhancing for ASD students.

Although the teaching ASD children a foreign language via the help of ICT was not extensively researched, some results were proved by 43 teachers from eight schools and 85 students, 37 were diagnosed with ASD. Virtual reality and video modelling, implemented in lessons proved that the integration of ICT enhances social communication skills, and consequently the ability to interact socially (Weiss, 2017, p.115-119).

Moreover, the study made by Harrison (2002) found that ICT use promoted greater student´s engagement with the subject. In addition, the use of word processing accelerated and enhanced writing development.

Equally important results justified that ICT technologies empower children to be actively involved in the process of education. The inclusion of ASD in mainstream classes via ICT was proven in HANDS project

– Helping Autism Diagnosed Navigate and Develop Socially in three mainstream UK secondary schools in 2011, in which eight ASD students participated. The results show the huge potential for ICT, namely smart phones to develop ASD students´ social skills (Mintz, 2013).

ASD students have a highly positively approach to the use of technologies in teaching/ learning languages. In addition, ICT can be used for not only language teaching but also to train ASD students' social competencies as they have problems with the understanding of social goals in foreign language teaching. It is related directly to their disorder, they have the same problem with learning mother tongue. Nevertheless, more research should be done on the impact of therapeutic and educational interventions for children with ASD and language learning via the use of ICT.

ASD students spend plenty of time playing games, watching videos, listening songs, however, further research ought to be done on that issue.

REFERENCES

Altun, M. (2015). The integration of technology into foreign language teaching. *International Journal on New Trends in Education and Their Implications*, *6*(1), 22-27.

Ameli, R., Courchesne, E., Lincoln, A., Kaufman, A. S., & Grillon, C. (1988). Visual memory processes in high-functioning individuals with autism. *Journal of Autism and Developmental Disorders*, *18*(4), 601-615.

Baird, G., Douglas, H. R., & Murphy, M. S. (2011). Recognising and diagnosing autism in children and young people: summary of NICE guidance. *BMJ*, *343*(d6360), 10-1136.

Baron-Cohen, S. (1998). Does autism occur more often in families of physicists, engineers, and mathematicians? *Autism*, *2*(3), 296-301.

Bartak, L., & Rutter, M. (1976). Differences between mentally retarded and normally intelligent autistic children. *Journal of autism and childhood schizophrenia*, *6*(2), 109-120.

Condie, R., & Munro, B. (2007). The impact of ICT in schools: Landscape review.

DeMyer, M. K., Hingtgen, J. N., & Jackson, R. K. (1981). Infantile autism reviewed: A decade of research. *Schizophrenia bulletin*, *7*(3), 388-451.

Fuentes, C. T., Mostofsky, S. H., & Bastian, A. J. (2009). Children with autism show specific handwriting impairments. *Neurology*, *73*(19), 1532-1537.

Falkmer, T., Anderson, K., Falkmer, M., & Horlin, C. (2013). Diagnostic procedures in autism spectrum disorders: a systematic literature review. *European child & adolescent psychiatry*, *22*(6), 329-340.

Gervais, H., Belin, P., Boddaert, N., Leboyer, M., Coez, A., Sfaello, I., & Zilbovicius, M. (2004). Abnormal cortical voice processing in autism. *Nature neuroscience*, *7*(8), 801.

Harrison, C., Lunzer, E. A., Tymms, P., Fitz-Gibbon, C. T., & Restorick, J. (2004). Use of ICT and its relationship with performance in examinations: a comparison of the ImpaCT2 project's research findings using pupil-level, school-level and multilevel modelling data. *Journal of Computer Assisted Learning*, *20*(5), 319-337.

Hermelin, B., & O'connor, N. (1970). Psychological experiments with autistic children.

Istenic Starcic, A., & Bagon, S. (2014). ICT-supported learning for inclusion of people with special needs: Review of seven educational technology journals, 1970–2011. *British Journal of Educational Technology*, *45*(2), 202-230.

Jelínková, M., 2004: *Pedagogicko-psychologické hodnocení a výchovně vzdělávací strategie u žáků s autismem,* Praha: Vydavateľstvo Portál. ISBN 80-86859-00-3.

Lincoln, A. J., Courchesne, E., Kilman, B. A., Elmasian, R., & Allen, M. (1988). A study of intellectual abilities in high-functioning people with autism. *Journal of autism and developmental disorders*, *18*(4), 505-524.

Lord, C., Rutter, M., & Le Couteur, A. (1994). Autism Diagnostic Interview-Revised: a revised version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. *Journal of autism and developmental disorders*, *24*(5), 659-685.

Kanner, L. (1943). Autistic disturbances of affective contact. *Nervous child*, *2*(3), 217-250

Kendal, C., 2009: *The Asperger´s Syndrome Survival, Guide. What You and Your Family need Know,* Solana Beach: Visions Publishing Inc.ISBN: 978-0-984103-0-8

Kim, Y. S., Leventhal, B. L., Koh, Y. J., Fombonne, E., Laska, E., Lim, E. C., ... & Song, D. H. (2011). Prevalence of autism spectrum disorders in a total population sample. *American Journal of Psychiatry*, *168*(9), 904-912.

Machado, C., Estevez, M., Rodriguez, R., & Leisman, G. (2017). Letter re: The autism "epidemic": Ethical, legal, and social issues in a developmental spectrum disorder. *Neurology*, *89*(12), 1310-1310.

Mattila, M. L., Hurtig, T., Haapsamo, H., Jussila, K., Kuusikko-Gauffin, S., Kielinen, M., ... & Pauls, D. L. (2010). Comorbid psychiatric disorders associated with Asperger syndrome/high-functioning autism: a community-and clinic-based study. *Journal of autism and developmental disorders*, *40*(9), 1080-1093.

Mintz, J. (2013). Can smartphones support inclusion for autism in mainstream? *Journal of Assistive Technologies*, *7*(4), 235-242.

Mottron, L., Dawson, M., Soulieres, I., Hubert, B., & Burack, J. (2006). Enhanced perceptual functioning in autism: an update, and eight principles of autistic perception. *Journal of autism and developmental disorders*, *36*(1), 27-43.

Pokrivčáková et al., 2008: *Inovácie a trendy vo vyučovaní cudzích jazykov u žiakov mladšieho školského veku.* Nitra ISBN: 978-80-8094-417-9.

Putnam, C., & Chong, L. (2008, October). Software and technologies designed for people with autism: what do users want? In *Proceedings of the 10th international ACM SIGACCESS conference on Computers and accessibility* (pp. 3-10). ACM.

Rajendran, G., & Mitchell, P. (2000). Computer mediated interaction in Asperger's syndrome: The Bubble Dialogue program. *Computers & Education*, *35*(3), 189-207.

Rutter, M., Le Couteur, A., & Lord, C. (2003). Autism diagnostic interview-revised. *Los Angeles, CA: Western Psychological Services, 29*, 30.

Shah, A., & Frith, U. (1983). An islet of ability in autistic children: A research note. *Journal of child Psychology and Psychiatry*, *24*(4), 613-620.
Swettenham, J. (1996). Can children with autism be taught to understand false belief using computers? *Journal of Child Psychology and psychiatry*, *37*(2), 157-165.

Thorová, K., 2012.: *Poruchy autistického spektra* Praha: Vydavateľstvo Portál. ISBN: 9788026202158.

Toth, K., & King, B. H. (2008). Asperger's syndrome: diagnosis and treatment. *American Journal of Psychiatry*, *165*(8), 958-963.

Weiss, P. L., Cobb, S. V. G., & Zancanaro, M. (2014). Challenges in developing new technologies for special needs education: a force-field analysis. In *10th International Conference on Disability, Virtual Reality and Associated Technologies, Sweden*.

Wing, L., & Wing, J. K. (Eds.). (1976). *Early childhood autism: Clinical, educational, and social aspects*. Pergamon

Van Eylen, L., Boets, B., Steyaert, J., Evers, K., Wagemans, J., & Noens, I. (2011). Cognitive flexibility in autism spectrum disorder: Explaining the inconsistency

Wire, V. (2005). Autistic spectrum disorders and learning foreign languages. *Support for Learning*, *20*(3), 123-128.

Zelinková, Z., 2009: *Poruchy učení,* Praha, Portál ISBN: 978-80-7367-514-1.

sciendo

ICTE Journal

*2019, **8**(1): 48–60*
DOI: 10.2478/ijicte-2019-0005

INTERACTIVE LEARNING ENVIRONMENT SUPPORTING VISUALIZATION IN THE TEACHING OF PROBABILITY

Stanislav Lukáč[1], Tadeáš Gavala[2]

[1]Institute of Mathematics, Faculty of Science, Pavol Jozef Šafárik University in Košice, Slovak Republic {stanislav.lukac@upjs.sk}

[2]Institute of Mathematics, Faculty of Science, Pavol Jozef Šafárik University in Košice, Slovak Republic {tadeas.gavala@student.upjs.sk}

ABSTRACT

The probability is exceptional in the teaching of mathematics because students often have difficulties to understand the basic terms and the problem solving strategies. Understanding lacks of the probability concept and various types of misconceptions arise from the misleading intuition and misinterpretations of experience with the stochastic phenomena. The probability concept seems too abstract to some students therefore it is advisable to use mathematical problems based on real-life ideas, such as drug efficacy testing, tests for diagnosing of diseases in medicine, sports competitions, and games. By eliminating misconceptions and improving understanding of the problem solving strategies, it is possible to use various types of visualization to solve problems from this field of mathematics. Tables and different types of graphic diagrams can help students to understand the basic rules and problem solving techniques. This paper describes the main objectives and the structure of an interactive worksheet, prepared in spreadsheet environment, in which students are guided to use the visualization to solve probability problems. The implementation of an automatic feedback enables to evaluate the students' answers. In the case of incorrect answer, solutions of the additional tasks using tree diagram or a tangram are recommended to the students. Students can decide which type of the visualization is more understandable for them to solve the probability of random events. Solving different task sequences using the selected types of visualization allows more learning paths for students. The final part of the paper contains an evaluation of the results and experiences of problem solving in the teaching of probability at grammar schools.

KEYWORDS

Misconceptions, visualization, teaching of the probability, interactive worksheet, problem solving.

1 INTRODUCTION

Theme probability has in mathematics teaching exceptional position for several reasons. Students meet this difficult theme at secondary schools for the first time. Several authors (Garfield & Ahlgren, 1988; Knejpová & Vrábelová, 2009; Peard, 1987; Shaughnessy, 1992) agree that the teaching of probability is a difficult task because it is full of paradoxes and the basic principles of probability may seem too abstract for students. It is also difficult for students to understand the concept of probability and its regularities because the results analysis is often contrary to students' convictions and intuitions. Misconceptions and sources of misunderstanding are sometimes passed on to students by teachers themselves, who place emphasis in teaching on the application of definitions and formulas.

In the textbooks, the theme Probability follows the theme Combinatorics. For this reason, in the teaching of probability, a combinatorial approach, emphasizing the application of combinatorial rules, does not lead to an understanding of the basic principles of probability theory. Shaughnessy (1977) recommends that the

teaching of probability should be based on the practical group or individual students' activity focused on making random experiments and analysing the results obtained.

Effective ways and means for supporting the teaching of probability are offered by modern digital technologies (DT), which enable computer simulations to be performed on various probability problems (Simon, Aktinson & Shevokas, 1976, Weissglass & Cummings, 1991). Simulation and analysis of a large number of random experiments allows applying a statistical approach to the teaching of probability. The results of several studies and researches (Arcavi, 2003, Presmeg, 1986, Zahner & Corter, 2010, Zimmermann, Cunningham, 1991) show that modelling using visualization can help students to understand solving of different probability problems and thus eliminate misconceptions, which arise in their minds based on experience and intuition.

2 MISCONCEPTIONS IN PROBABILITY

The teaching of probability should not only focus on explaining concepts and mastering problem-solving strategies but should tend to create new ideas, experiences, and the development of the probability thinking (Shaughnessy, 1992). If students learn to analyse the causes of wrong thinking in solving tasks and explain the reasons of conflicts between their calculations and the correct results of tasks, they can successfully develop their probability thinking.

The reason for the misunderstanding of the probability concept and students' failure in problem solving are misconceptions which resulting from incorrectly created ideas, misunderstood concepts, relationships, and misapplied methods of problem solving. Misconceptions are a critical aspect of the process of acquiring knowledge and skills and development of problem solving skills in the teaching of probability (Shaughnessy, 1992). In some cases, combinatorial considerations and basic combinatorial rules may also be used to solve probability problems. Therefore, the classification of mistakes and misconceptions in probability can be based on sources of mistakes and misunderstandings in combinatorics. For example, Batanero, Navarro-Pelayo, and Godino (1997) developed a detailed system for mistake classification in combinatorics.

Several authors have dealt with an analysis of probability misconceptions. Fischbein and Schnarch (1997) described several probability misconceptions and developed the following classification of misconceptions:

- Representativeness – people estimate the likelihood of an event according to how well it represents its reality;
- Negative and positive recency effects – "the negative recency effect" or "the gambler's fallacy" is if someone tosses a coin four times and gets four heads may then believe that the fifth toss is more likely to be tails. However, the belief that the fifth toss is more likely to be heads is called "the positive recency effect";
- Simple and compound events – if two dice are rolled, obtaining two sixes has the same likelihood as obtaining a five and a six;
- Conjunction fallacy – the probability of a random event appears to be higher than the probability of the intersection of the same event with another;
- Effect of sample size – people tend to neglect the influence of the magnitude of a sample when estimating probabilities;
- Availability – probability is estimated by the ease with which instances can be brought to mind;
- Time-axis fallacy (also called the Falk phenomenon) – people are likely to answer incorrectly based on the principle that an event cannot act retroactively on its cause.

LaiHuat Ang and Masitah Shahrill (2014) also characterized other misconceptions such as:

- Equiprobability bias – people tend to assume that random events are equally probable by nature. They view the chances of getting different outcomes as equally likely events;
- Beliefs – people think, that eventual outcome of an event depends on a force, which is beyond their control. Sometimes this force is God or some other force such as wind, other times luck or wishes;
- Human control – people generalise the behaviour of random generators such as dice, coins and spinners. They think the results depend on how one throws or handles these different devices.

Tversky, Khaneman (1982) and Shaughnessy (1981) think that most misconceptions in probability are based on misconception of representativeness. Madsen (1995) has grouped misconceptions into three more general classes:

- Representativeness – when asked to identify an outcome that is 'most likely' to occur, people will choose an outcome that appears representative. For example, in a series of six coin flips, we know that all sequences of H's and T's are equally likely. Given a choice among several possible sequences, people will often choose an outcome such as HHTHTT as being more likely than HHHHHH.
- Availability, experience - in trying to determine if an event is likely or unlikely (probable or improbable), the response is based on how readily an example of the event comes to mind. For example, people may determine the probability of winning a lottery by trying to recall people they know who have won.
- Outcome approach – people view a probability as a means of predicting the outcome on a single trial and they do not view it in terms of relative frequency of occurrence. If a probability greater than 0,5 is assigned to an event, then people would say that the event "should" occur and if it does not occur, then the assigned probability is wrong. For example, if a weather forecast says that there is an 80% chance of rain and if it does not rain, people using this interpretation will say that the forecast was "wrong".

Students often do not think about logical deduction and reasoning of the problem solving process but they try to get the results of the tasks by applying one of the acquired rules by which they perform the calculations with the given numbers.

In the paper, we focused on evaluation the level of understanding of the basic rules for calculating the probability of random events. Understanding the addition and multiplication rule in probability is one of the basic capabilities that can be used to solve different real-life probability problems. We designed and developed an interactive worksheet to diagnose the level of understanding of these rules. The interactive worksheet provides visualization to students who have failed when calculating the probability of two random events to facilitate understanding of these rules and their application to solve tasks. The interactive worksheet is created using spreadsheet MS Excel. The automatic feedback implemented in the worksheet provides the evaluation of students' tasks solutions and, in case of an incorrect answer of the introductory task, it leads students to use the visualization in solving problems.

3 VISUALIZATION IN PROCESS OF SOLVING PROBABILITY TASKS

In some fields of mathematics (e.g. geometry), visualization is an indispensable part of the learning process and students' problem solutions. In other fields of mathematics, visualization may not be an important part of the process of acquiring knowledge, but can often be used as a means of solving problems (Presmeg, 2006). One of these areas of mathematics is, according to Zahner and Corter (2010), the probability where visualization can help a student not only to understand the task assignment but also to look for problem solving strategy. Ideas about relationships highlighted in the clear pictures and diagrams can be important to understand the concept of probability and solving problems. According to Güler and Çiltaş (Güler & Ciltaş, 2011), teaching practices focused on the use of visualization forms are important for developing students' ability to solve problems and for motivating students.

Multiple studies (De Hevia & Spelke, 2009; Edens & Potter, 2008; Uesaka, Manolo & Ichikawa, 2007; Zahner & Corter, 2010) point out that visualization helps to solve probability problems and there is appropriate to introduce visualization into the teaching of probability. Some authors argue that the students' misconceptions in probability can also be eliminated by the use of visualization forms, because these models allow visualizing the abstract probabilistic terms and relationships.

Zahner and Corter (2010) point out that, in order for visualization to be a useful tool in solving problems, due attention must be paid to selecting a suitable visualization form. These authors emphasize that inappropriately chosen visualization forms do not lead to higher success of students in solving problems. Novick and Hmelo (1994) consider the selection of a suitable visualization form in the context of a given task to be an important skill in solving probability problems and thus they confirm these conclusions. The use of visualization is also associated with the discovery of strategies used for solving mathematical problems. These problems should be reasonably difficult in order for visualization to be necessary and to have the desired effect.

Various forms of visualization can be used for explaining probabilistic concepts, rules, and solving probability problems: images, sketches, schemas for ordered listings of random experiment results; (contingency) tables; Venn diagrams; tree diagrams; circular diagrams; tangrams (unit squares); coordinate systems; stochastic node graphs. Various visualization forms have different structural aspects or properties that determine the range of their usability. For example, tree diagrams are naturally suited for solving sequential problems (e.g. multiple coin tosses, throw a dice) or for listing all possibilities, while tables or Venn diagrams are suitable for representing compound events. It turns out that selecting a suitable visualization form is a key element in solving a probability problem. In the paper, we focused on visualization forms such as tree diagram and tangram, which are useful for illustration of application of addition and multiplication probability rule in solving the probability problems.

4 CONCEPT AND DEVELOPMENT OF THE INTERACTIVE WORKSHEET

Interactivity and feedback are implemented through logical functions and macros in the interactive worksheet. Therefore, the proper functionality of active components requires permission to run the macros when opening a worksheet. Tasks are placed on separate sheets. The Evaluation button provides evaluation of student's answer. A student receives information about the correctness/inaccuracy of the answer and, if necessary, the instruction for his/her next activity. After closing the feedback window, a sheet with the following task or a sheet with the final evaluation of the student's work is displayed. The choice of the next task is determined by the correctness/incorrectness of the task solution on the active sheet. The implementation of feedback enables to create the individual learning paths. If a student does not master the multiplication rule for calculating the probability of random events, he/she must complete a supplementary explanatory part in which visualization is used to repeat and explain the multiplication rule in probability.

Creation of a worksheet concept required selection of two tasks (marked as IW1 and IW2) with increasing difficulty, in which the addition and multiplication rules for calculating the probability of random events should be used. An additional task is an introduction of the explanatory part, in which students are guided to use the visualization. When working on other tasks in the interactive worksheet, students can create pictures and diagrams on paper. This practice is a concrete application of a link-based approach of

computer-aided mathematical learning and paper-based learning, which is emphasized by Hähkiöniemi (2013). The task 1 (IW1) allows the distribution of students according to their knowledge of the multiplication rule in probability and their ability to apply it in solution of a typical task. Solving this task requires calculating the probability of a random event that when spinning two roulettes, the sum 6 of the numbers comes out. The sum 6 can only occur if the first roulette will stop at the number 4 and the second roulette will stop at the number 2. Correct solving of the Task 1 ensures that the student can continue to a more difficult Task 2 (IW2). Figure 1 shows the response of the interactive worksheet to a typical student error by adding the probability of individual random events.

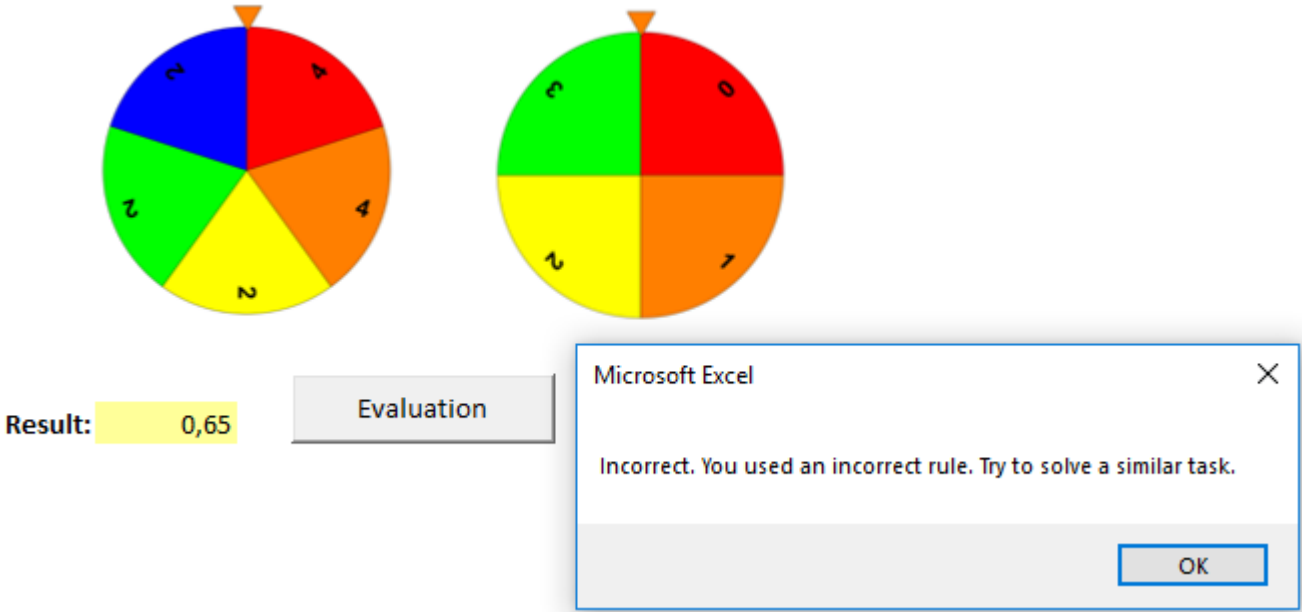

Figure 3 Evaluation of an incorrect answer in the Task 1

If a student solves the Task 1 incorrectly, he/she continues with the explanatory part, which contains the additional and control task. The additional task: *Specially trained dogs are at airports to check the presence of drugs in the luggage of the passengers. Dog A with a probability of 0,9 correctly determines whether drugs are hidden in the suitcase. Dog B with a probability of 0,85 correctly determines whether drugs are hidden in the suitcase. The customs officers will select the suitcase to check for dog A and then dog B. How likely is dog A and dog B to be mistaken when checking the suitcase?* The multiplication rule for calculating the probability of random events is explained in additional task using visualization. The part of the task is incomplete visualization forms such as tree diagram and tangram. The student can select a visualization form that is more comprehensible to him/ her, and append the result of an additional task (see Figure 2) to the yellow background cell in the selected diagram. If a student solves the additional task incorrectly, a final evaluation of his/her learning path will be displayed.

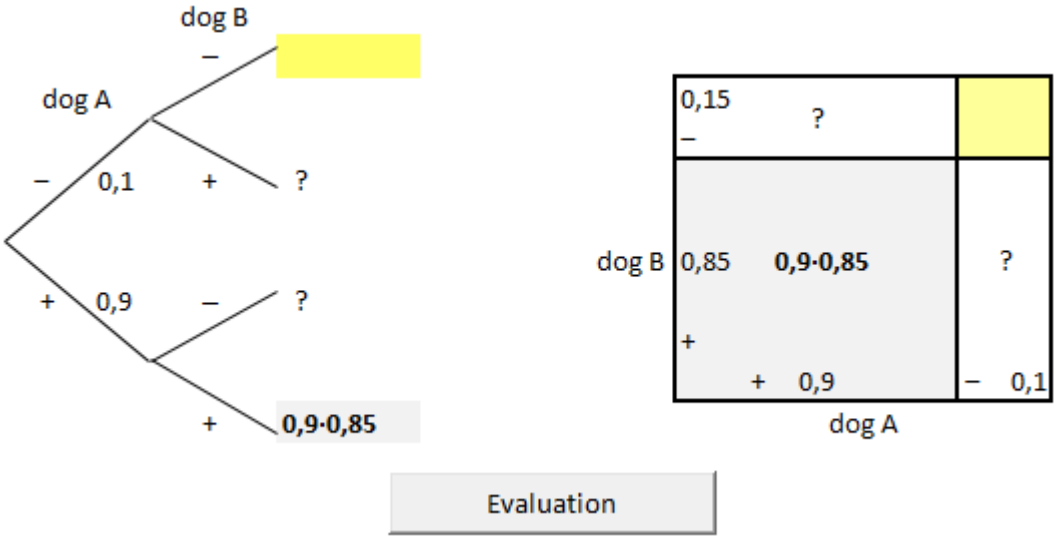

Figure 4 Visualization forms for solving the additional task

If a student solves the additional task correctly, he/she has to demonstrate understanding of the explained rule in solving of the control task. Only when the control task has been successfully solved, a student receives the assignment of the Task 2 (IW2): *The health organization estimates that 5% of the population has diabetes. Based on previous tests, they estimate that the medical laboratory's success in diagnosing people with diabetes is 0,98. In 2% of cases, the test in people with diabetes is negative. When testing healthy people, the success rate of the diagnostic test is 0,96. What is the likelihood that the result of a diagnostic test will be correct for a randomly selected person?* Solving this task requires the application of addition and multiplication rules for calculating the probability of random events. To solve this task, it is also advisable to use the visualization form. In this case, the student can already draw his/her own model on paper.

Finally, each student will get an evaluation sheet with the corresponding overall evaluation according to the learning outcomes. The evaluation allows dividing students into five groups. The first group consists of the best students who correctly solved the Task 1 as well as the Task 2 (or they did not solve the Task 1 correctly but then solved additional task, control task and the Task 2 correctly). In other groups, there are already students who have not received a positive evaluation. The evaluations of these students are indicated by letter N. We present them with an explanation of the relevant student learning outcomes.

N1: (The student did not solve the additional task correctly; he/she did not make the expected mistake of the incorrect use of the addition rule for calculating the probability of random events.) You did not understand the assignment of the task and its graphical interpretation. Ask for help from a teacher.

N2: (The student incorrectly used the addition rule for solving the additional task.) The random events occur independently of each other. Think about what rule is used to calculate the probability that both random events occur. Ask for help from a teacher.

N3: (The student solved the additional task correctly but did not solve the control task correctly.) You did not learn to solve the task calculating probability of two random events for which the probability of one event occurring does not affect the probability of a second random event. Ask for help from a teacher.

N4: (The student solved the Task 1 correctly but he/she solved the Task 2 incorrectly or the student solved the Task 1 incorrectly, but he/she solved the additional task and control task correctly and then he/she solved the Task 2 incorrectly.) You could not analyse the possible outcomes of random events and correctly apply the addition and multiplication rules in calculating the probability of two random events.

After completing the work with the interactive worksheet, the teacher will get a quick overview of students' knowledge and skills to solve the problems calculating the probability of random events based on the final

evaluation. The teacher can use the obtained information for analysing students' solutions at the final stage of teaching. Students' results also provide the teacher a material for the formative assessment, including individual discussion with students leading to the detection of mistakes (Keeley & Tobey, 2011) and providing individual help to understand the basic rules for calculating the probability of random events.

5 PEDAGOGICAL EXPERIMENT TO DETECTION OF LEARNING RESULTS IN PROBABILITY

The main aim of our research is to find out whether students try to use visualization to solve probability tasks and how visualization helps them to find the solution of tasks. We focused on diagnosing the rate of acquisition of the basic rules used to determine the probability of random events at secondary school.

We have identified the following research questions for our research:

1. To what level did students know the addition rule and multiplication rule for calculating the probability of random events?
2. Which type of visualization form prefers the students to solve tasks, in which two random events occur?
3. How are students able to apply the acquired knowledge to solve probability problems?

We prepared two research tools in the form of the interactive worksheet and the printed worksheet to find answers to research questions. We do not force students to use different forms of visualization in the interactive worksheet. An explanatory part containing two forms of visualization: a tree diagram and a unit square. They were offered only to students who have failed in solving the first task. Students could decide independently whether they use visualization to solve tasks in the printed worksheet.

We chose one class from the third grade of grammar school for pilot research. The research sample consisted of 24 students. Students from the selected class finished the theme Probability approximately three weeks before the experimental lesson. Interviews with a teacher, who teaches mathematics in this class, pointed out that they were using tables and schemes for solving probability tasks using the listing of possibilities.

Tasks solutions in both worksheets were analysed from two aspects: the correctness of the solution and the way of the use of the visualization. According to small research sample, we focused on qualitative analysis of students' solutions. When analysing students' solutions, we focused on assessing the correctness of tasks solutions and on reviewing whether visualization helps students in solving the probability tasks.

The lesson lasted 90 minutes. Resolving tasks in the interactive worksheet required independent work of students at the computer. After completing the work with the interactive worksheet, the students started to solve tasks in the printed worksheet. The printed worksheet contained two main problems (marked as W2 and W4). Before these two problems, there were included auxiliary tasks (marked as W1 and W3) designed to guide students to solve the main problems. The auxiliary task for the first problem (W1) was very simple and we did not included it to overall evaluation. The problem (W2) was similar to the Task 2 (IW2) about diabetes diagnosis. It describes a game based on throwing two regular dodecahedrons, in which figures different numbers of different and same images of the animal. The students had to calculate the probability of player winning based on throwing the pictures of the same animals. Task solving could be based on listing of possibilities or creating a suitable visualization form.

To increase the interest of students, we tried to choose a problem with popularizing content. Problem 2 was preceded by an auxiliary task (W3): *Four cards with the number 1 and two cards with the number 2 are in the first bag. The second bag is empty. Peter took one card with the number 1 and one card with the number 2 and put it in an empty bag. John then randomly chose one bag and picked one card out of it. What is the probability that the card with the number 1?*

Problem 2 (W4): *Headsman brought two identical bags and ten white and ten black marbles to the prisoner. On the next morning, the headsman will choose one bag randomly and then he will pick one marble out of it. If it is white, they will grant a grace to the prisoner, if it is black, the prisoner will execute. How does a prisoner have to split the marbles into both bags so that neither bag remained empty and have the biggest chance of granting a grace? Calculate the likelihood that the prisoner will grant a grace for your distribution of marbles to the bags.*

The problem 2 is more difficult because the students had to find a distribution of the marbles into two bags, giving the prisoner the biggest chance of granting a grace and subsequently calculating the probability of picking a white marble from a randomly selected bag.

6 RESULTS AND DISCUSSION

We selected for evaluation the main tasks from both worksheets. The average students' success rates are presented in the following graph.

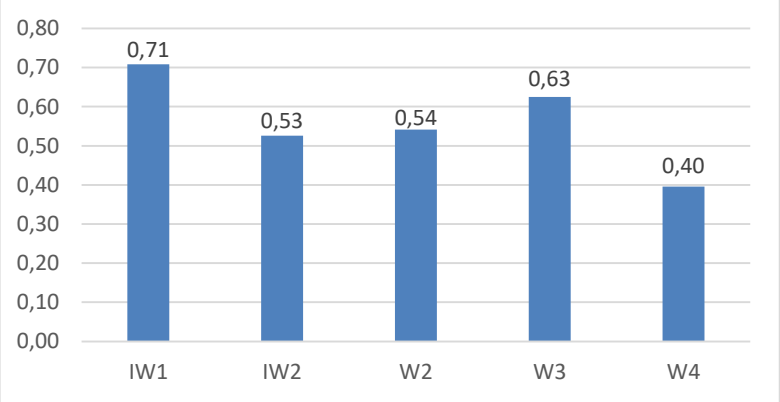

Figure 3 Average students' success rates

The results of the students' solutions in the interactive worksheet provided data to answer the first research question. Seven students solved Task 1 (IW1) incorrectly and therefore they had to go through an explanatory part of the interactive worksheet containing the additional and control task. Three students used the addition rule instead of the multiplication rule in solving this task. It shows that these students misunderstood the basic rules for calculating the probability of independent random events. Five of seven students solved the additional task correctly and two of these five students solved the control task correctly and that is why they could solve the task 2 (IW2). Only 19 students solved this task. From these results, it can be concluded that students have learned the basic rules for calculating the probability of random events at the average level.

When creating an explanatory part of the interactive worksheet, we assumed that students had already used some forms of visualization to solve combinatorial and probability problems. Therefore, the explanatory part was brief and it contains the two most frequently used forms of visualization in solving the tasks included in the worksheet. Students could choose visualization in the form of tree diagram or tangram. Five students chose a tree diagram and two students chose a tangram. The tree diagram allows making a clear representation of the possibilities that can occur, and the tangram clearly demonstrates the use of the multiplication rule in probability of random events. We think that the preference of the tree diagram is also affected by the fact that students already have had experience with using this diagram when they were solving combinatorial tasks. This tendency has also clearly emerged when they were solving tasks from the printed worksheet. When answering the second research question, we can say that students prefer the tree diagram. Although this diagram is suitable for analysing the results of random experiments, it is also appropriate to use a tangram, which connects multiplication rule of probability with calculating the rectangular area (Płocki, 2007).

All 24 students solved tasks in the printed worksheet. Problem 1 (W2) associated with throwing two dodecahedrons was presented to the students as a game. Students' success rate in solving this problem is comparable with the success rate of solving the task 2 (IW2).

Students also tried to use visualization in solving Problem 2 (W4) and the related auxiliary task (W3). Therefore, when evaluating the results of problem solving from the printed worksheet, we will focus on evaluating the students' solutions of Problem 2 and the related auxiliary task. Nine students used some form of visualization in solving the auxiliary task W3. Six students used a tree diagram and five of them solved the task correctly.

Solving the Problem 2 (W4) requires combining the basic addition and multiplication rule. Even seven students intuitively assumed that it would not be possible to find the distribution of the marbles in bags to make the probability of selecting a white marble greater than 0,5. This false supposition caused by the misconception called "Equiprobability bias" has greatly influenced students' solutions. In formulating the answer to the third research question, it can be concluded from the above results that students have difficulties to apply the basic probability rules in solving problems requiring analysis of several cases where the systematic listing of possibilities cannot be easily used. Lower student success in solving probability problems is often caused by misunderstanding of the problem and excessive reliance on intuition and experience from real life.

We evaluate the use of visualization and the students' success in solving tasks in the interactive and printed worksheet. Seven students solved the explanatory part but only two of them completed this part successfully. These two students solved the task 2 (IW2) only partially. These students did not understand the basic rules for calculating probability and the brief introduction to graphical expression of relations was not sufficient for them. When solving the tasks in the printed worksheet, students mostly used visualization to solve tasks W3 and W4. We divided students into two groups: students who did not use the visualization and students who use the visualization at least in one task. We calculated the average success rate for both groups in solving these tasks. Results are displayed in the following table (see Figure 4). It was shown that the less clever students achieved worse results although they tried to use the visualization forms more often. Clever students, who acquired basic rules for calculating the probability of random events, based their solutions on calculations using these rules without visualization.

Group	Number	Succes rate
Visualization	10	47,5%
No visualization	14	53,6%

Figure 4 Comparing students' success rate in created groups

In following qualitative analysis, we describe selected students' mistakes and ways of visualization in solving the tasks. Information from a mathematics teacher showed that various forms of visualization in combinatorics and probability teaching were used in the experimental class. Therefore, we expected that students would use the visualization to solve problems. In spite of our expectations, students used the visualization in a small extent, and they used from different visualization forms mainly tables and tree diagrams. Most students used tree diagrams to solve the auxiliary task to Problem 2. Especially students who have completed the explanatory part in the interactive worksheet have tried to use visualization to solve tasks in the printed worksheet. For example, we chose a tree diagram created by this student to solve the auxiliary task to Problem 2 (see Figure 5).

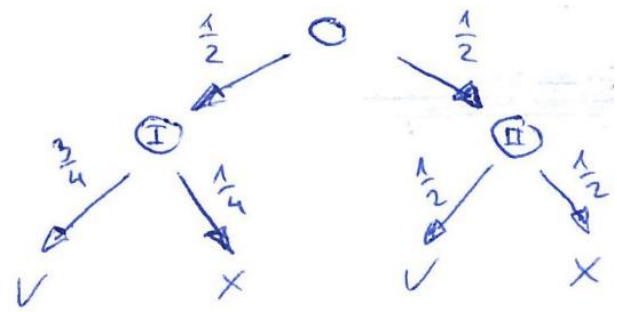

Figure 5 Student's tree diagram for solving the auxiliary task

Three students inappropriately used the addition rule instead of the multiplication rule in solving tasks in the interactive worksheet. The reason for this mistake is the misconception of a misunderstanding of the concept of basic rules (Batanero, Navarro-Pelayo & Godino, 1997). Being aware of this mistake after the brief explanations provided in the automatic feedback, such a mistake was no longer present in solving the tasks in the printed worksheet.

Visualization in solving Problem 2 was most related to distribution of marbles into bags. Several students plotted only one distribution of the marbles and formulated premature incorrect conclusions. Figure 6 shows a picture that was a part of the incorrect student solution.

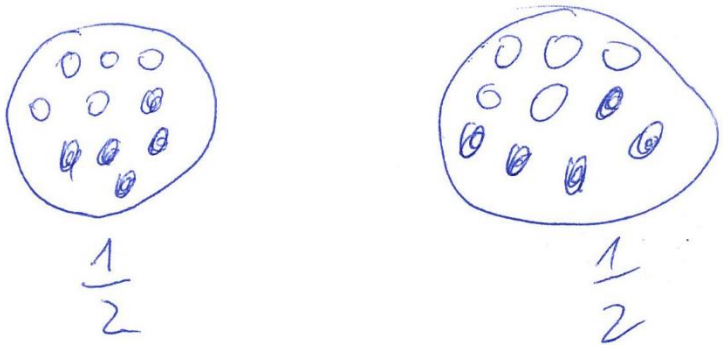

Figure 6 Student's illustration of one distribution of the marbles into the bags in the Problem 2

Three students created pictures, which only illustrated the situation described in the Problem 2. These students did not solve the problem correctly. As stated by Boonen, van Wesel, Jolles, and van der Schoot (2014), concentrating on the sketch of insignificant details can divert the students' attention in the wrong direction, and in many cases does not lead to a correct task solution. For example, we have selected one picture of this type (see Figure 7).

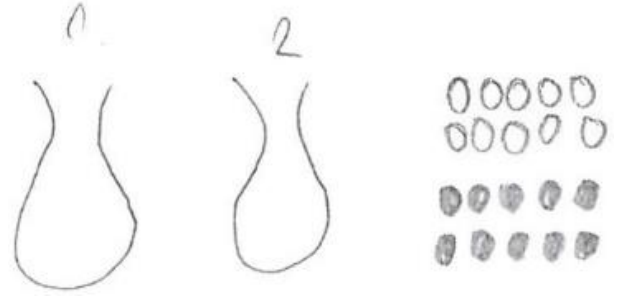

Figure 7 Student's illustration in solving the Problem 2

Analysis of students' solutions and ways of using visualization in problem solving can provide useful information for creating assessment tools that can be used for purposes of the formative assessment. Selected probability problems and misconceptions of students in their solutions can provide to mathematics teachers a basis for understanding student strategies of problem solving and providing feedback for effective student learning.

CONCLUSION

If students are not lead by a teacher to use the appropriate visualization forms, then their visualization often involves drawing the details of the subjects described in the problem. An illustration of unimportant information diverts the students' attention from the analysis and representation of the important relationships described in the problem. A tree diagram can be used appropriately in teaching of several topics in school mathematics. This type of a diagram allows illustrating clearly and systematically the various possibilities or cases that need to be analysed during problem solving. However, other forms of visualization may be used for solving different types of problems. The small research sample does not allow us to formulate general recommendations and conclusions. In view of our results and the conclusions of other studies, the use of various forms of visualization forms in the teaching of probability may be recommended to mathematics teachers.

We plan to continue in our research focused on the use of visualization in solving probability tasks. Based on described results, we replace the first task in the interactive worksheet with more difficult task to use the multiplication rule in calculating the probability of random events. We plan to extend the explanatory part with the example in which we will explain the use of the tree diagram and the unit square in solving the probability tasks. In our opinion, tangrams are appropriate for understanding and applying the multiplication rule in solving probability problems. Mathematics teachers at all levels of schools should consider which forms of visualization can help students to understand the problem solving strategy and how to integrate them into teaching of mathematics.

ACKNOWLEDGEMENTS

The paper was created with support of the VEGA project no. 1/0265/17: Formative assessment in science, mathematics and informatics.

REFERENCES

Ang, L. H., Shahrill, M. (2014). Identifying Students' Specific Misconceptions in Learning Probability. *International Journal of Probability and Statistics,* 2(3), 23-29. ISSN 2168-4863.

Arcavi, A. (2003). The role of visual representations in the learning of mathematics. *Educational Studies in Mathematics,* 3(52), 215-241. ISSN 1573-0816.

Batanero, C., Navarro-Pelayo, V. & Godino, J., D. (1997). Effect of the implicit combinatorial model on combinatorial reasoning in secondary school students. *Educational Studies in Mathematics*, 32, 181-199. ISSN 1573-0816.

Boonen, A., J., H., Van Wesel, F., Jolles, J. & Van Der Schoot, M. (2014).The role of visual representation type, spatial ability, and reading comprehension in word problem solving: An item-level analysis in elementary school children. *International Journal of Educational Research,* 68, 15-26. ISSN 0883-0355.

De Hevia, M. D., Spelke, E. S. (2009). Spontaneous mapping of number and space in adults and young children. *Cognition*, 2(110), 189–207. ISSN 0010-0277.

Edens, K., Potter, E. (2008). How students "unpack" the structure of a word problem: Graphic representations and problem solving. *School Science and Mathematics*, 5(108), 184–196. ISSN 1949-8594.

Fischbein, E., Schnarch, D. (1997). The Evolution with Age of Probabilistic: Intuitively Based Misconceptions. *Journal for Research in Mathematics Education*, 1(28), 96-105. ISSN 2238-0345.

Güler, G., Çiltaş, A. (2011). The visual representation usage levels of mathematics teachers and students in solving verbal problems. *International Journal of Humanities and Social Science*, 1(11), 145-154. ISSN 2221-0989.

Hähkiöniemi, M. (2013).Teacher's reflections on experimenting with technology-enriched inquiry-based mathematics teaching with a preplanned teaching unit. *Journal of Mathematical Behaviour,* 3(32), 295-308. ISSN 0732-3123.

Keeley, P., Tobey, Ch., R. (2011). *Mathematics Formative Assessment*. Corwin a Sage Company, 234 p. ISBN 978-1-4129-6812-6.

Knejpová, E., Vrábelová, M. (2009). *Prieskum vyučovania pravdepodobnosti na ZŠ, SOŠ a gymnáziách*. In ACTA MATHEMATICA 12, 2009, 299-304. ISBN 978-80-8094-614-2.

Madsen, R. W. (1995). Secondary Students' Concepts of Probability. *Teaching Statistics*, 3(17), 90-92. ISSN 1467-9639.

Novick, L., Hmelo, C. (1994). Transferring symbolic representations across nonisomorphic problems. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 6(20), 1296–1321. ISSN 0278-7393.

Peard, R. (1996). Problems with Probability. *Teaching Mathematics*, 1(21), 20-24. ISSN 1589-7389.

Płocki, A. (2007). *Pravdepodobnosť okolo nás: stochastika v úlohách a problémoch*. Ružomberok: Katolícka univerzita v Ružomberku. ISBN 978-8-08084-260-4.

Presmeg, N. C. (1986). Visualisation in High School Mathematics. *For the Learning of Mathematics*, 3(6), 42-46. ISSN 0228-0671.

Presmeg, N. C. (2006). *Research on visualization in learning and teaching mathematics.* In Á. Gutiérrez, P. Boero, Handbook of research on the psychology of mathematics education, 205–236. Rotterdam: Sense. ISBN 978-9-0778-7419-6.

Simon, J., Atkinson, D., Shevokas, C. (1976). Probability and Statistics: Experimental results of a radically different teaching method. *American Mathematical Monthly*, 1(83), 733-739. ISSN 0002-9890.

Shaughnessy, J. M. (1977). Misconceptions of probability: An experiment with a small-group activity-based, model building approach to introductory probability at the college level. *Education Studies in Mathematics*, 3(8), 285-316. ISSN 1573-0816.

Shaughnessy, J. M. (1981). *Misconceptions of probability: From systematic errors to systematic experiments and decisions*. In A. P. Schulte (Ed.), Teaching statistics and probability, 90-100. Reston: National Council of Teachers of Mathematics, Reston. ISBN 978-0-87353-170-1.

Shaughnessy, J. M. (1992). *Research in probability and statistics: Reflections and directions.* Handbook of Research on Mathematics Teaching and Learning, D.A. Grouws (Ed.), 465-494. New York: Macmillan. ISBN 978-0-02922-381-9.

Tversky, A., Kahneman, D. (1982). *Judgement under uncertainty: Heuristics and biases*. In Kahneman, D., Slovic, P., Tversky, A. (Eds.), Judgement under uncertainty: Heuristics and biases, 3-22. Cambridge: Cambridge University Press. ISBN 978-0-52128-414-1.

Uesaka, Y., Manalo, E., Ichikawa, S. (2007). What kinds of perceptions and daily learning behaviours promote students' use of diagrams in mathematics problem solving? *Learning and Instruction*, 3(17), 322–335. ISSN 0959-4752.

Weissglass, J., Curnmings, D. (1991). *Dynamic visual experiments with random phenomena*. In W. Zimmermann and S. Cunningham (eds.), Visualization in Teaching and Learning Mathematics, 215-223. Washington, DC: Mathematical Association of America. ISBN 978-0-88385-071-8.

Zahner, D., Corter, J. E. (2010). The Process of Probability Problem Solving: Use of External Visual Representations. *Mathematical Thinking and Learning*, 2(12), 177–204. ISSN 1532-7833.

Zimmermann, W., Cunningham, S. (1991). *Editor's introduction: What is mathematical visualization?* In W. Zimmermann and S. Cunningham (eds.), Visualization in Teaching and Learning Mathematics, 1-8. Washington, DC: Mathematical Association of America. ISBN 978-0-88385-071-8.