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VB2ALGO: An Educational Reverse Engineering Tool to Enhance High School Students' Learning Capacities in Programming

Salem ALMADHUN[1], Mehmet TOYCAN[2], Ahmet ADALIER[3]

Abstract

An educational software assessment tool, VB2ALGO, for a visual programming course has been developed and the effects of it on the high school students' performances, motivation and cognitive skills were explored. The tool inherits algorithm visualization technique together with reverse engineering approach; it takes the visual basic source code as an input and generates pseudocode and flowchart as an output. First, an experimental research methodology was applied, whereby pre-tests and post-tests were conducted to estimate the effect of using the software tool on student performances towards learning visual programming course. Then, the effect of the tool on students' motivation and cognitive skills were measured with students' questionnaires. Finally, teachers' class management skills were investigated with teachers' questionnaires in terms of time-management for better teaching experiences. The experiment was carried out with 294 students from 4 different high schools which had divided into experimental group and control groups. Parametric statistical tests were applied and results showed that the use of software tool reveals better performances for the experimental group as compared to the control group. In addition, the results of the students' questionnaires confirmed an increment in students' motivation and cognitive skills in programming language classes as compared to the traditional class. It also results in the improvement of students' learning capacities and knowledge about programming concepts. Finally, results of the teachers' quantitative analysis

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outlined that use of the software tool encourages teachers to complete more examples inside the classroom with better time management.

Keywords: Algorithm visualization, reverse engineering, ICT, high school education, visual programming, motivation.

Introduction

Information and Communication Technologies (ICT) have shown an enormous growth in the last decade and has a strong impact on the learning process at all education levels (Homiakova, Arras & Kozík, 2017). In accordance, the integration of ICT with education is an important phenomenon which offers educators the necessary tools to enhance the impact of teaching and learning processes as indicated by UNESCO's framework. It was also indicated that the use of ICT technologies in education could support society's penetration towards knowledge-based societies (UNESCO, 2011). The benefits of using digital learning tools in classroom instruction have been proven by many researchers (Hwang & Tsai, 2011; OECD, 2015; Sung, Chang, & Liu, 2016). Hence, it is an essential research objective to study the effects of such tools, and how they can be implemented best in a specific course (Cheung & Slavin, 2013; De Witte, Haelermans, & Rogge, 2015). In general, digital learning tools offer various advantages when compared with traditional learning tools with positive effects on learners' achievements (Cheung & Slavin, 2013). These tools could enhance the opportunities for the students to practice in assignments which adapted towards their learning needs.

Programming is one of the most important skills in today's technological world which is vital for programmable devices, such as smartphones, and tablets, However, it is a difficult and challenging aspect for the students to learn programming languages since the highest level of problem solving skills are required (Başer, 2013; Gomes & Mendes, 2007; Tan, Ting, & Ling, 2009). On the other hand, motivation and attitude against learning are considered important factors which affect the programming success of the students. New students face serious difficulties with learning concepts in programming which can be specified as programming knowledge, programming skills, debugging and understanding semantics of the program, (Ozmen & Altun, 2014). Students often learn what the reference books present or lecturers explain which leads to rigid thinking.

It is well-understood from the previous research studies that course contents and learning environment are important for better learning performances with increased motivation (Verdú, Regueras, Leal, De Castro, & Queirós, 2012; Forte & Guzdial, 2005). It is also quite common for educational institutions to use software tools to enhance students' learning progress. There are differences in the use of technology learning tools. Ross, Morrison, and Lowther (2010) identified

three roles for technology in education; technology as a tutor, technology as a teaching aid and technology as a learning tool. Technology as a tutor refers to computer-assisted technology that provides lessons and practice with respect to the learning needs of the students. Technology as a "teaching aid" refers to the use of multiple media (e.g., including video segments, interactive exercises and multimedia presentations) to enhance teacher-led instruction. Technology as a learning tool refers to student-use of technology to enhance their learning.

The benefits of using technology tools are verified by many educators and researchers (e.g., Chambers *et al.,* 2008; Savage *et al.*, 2013). Algorithm Visualization (AV) is an instructional approach which is used to improve students' programming language learning capabilities by utilizing graphical representations (Kölling, 2010). Different AV environments are created in the previous years in order to enhance beginners learning in computer programming with different interactive and media-rich application characteristics (Shaffer *et al.,* 2010; Maloney *et al.,* 2010).

In a traditional teaching approach of programming languages, teachers or lecturers first introduce a topic during the class hours, then demonstrate its application inside the lab environment and finally assign problems in order to utilize the topic. By solving several problems inside the lab, students could have the chance to become more familiar with the topic and understand better how to apply particular concepts. This is referred to the lower levels of Bloom's taxonomy: knowledge, comprehension, and application. While the students comprehend the concepts of the lecture inside the classroom, a deeper level of understanding could be enhanced by using reverse engineering (Rad, 2012). By using the reverse engineering approach, students could have the chance to learn how a tool or device works from its fundamental parts. Students could work through each individual element contained, while understanding the purpose of use, within the system structure. Along these lines, students could design their own tool or device which performs the same function. For instance, a software developer can learn how a software works by dissecting its functions and program steps with the help of a separate algorithm. After that, a student could understand the dynamics of the software and explain the purpose of each part incorporated into the design while identifying the errors on the program. Reverse engineering technique enhances students' learning capacities to advance to the upper levels of Bloom's taxonomy: design, implementation, and evaluation.

This paper presents the impact of using the VB2ALGO learning tool on high school students. Software tool reveals AV technique together with reverse engineering methodology in their lab hours of the visual programming course. The aim of this paper is twofold. First understanding how the tool impacts students' learning capacities and motivation, second investigating the effect on teachers' classroom management skills.

Literature review

There have been enormous efforts in the last decade by Computer Science Teachers Association (CSTA) to promote computer science education as a regular part of the curriculum in several secondary and high schools (CSTA, 2005; Avancena & Nishihara, 2015). In accordance, it was stated in curriculum report of Association of Computing Machinery (ACM) that use of the algorithm is a good foundation to learn programming and improve the necessary skills accordingly (ACM, 2001). A learning tool is presented in this research work which exploits algorithm visualization (AV) together with the reverse engineering approach. The proposed AV uses graphics, flowcharts and animation of the algorithm processes. AV is a sub-class of software utilization that is used for developing and evaluating the methods to represent the software's structure, execution, and evolution graphically to have a better understanding of the programming course (Diehl, 2007; Shaffer et al., 2010).

It is explored that AV features have a positive influence on the effectiveness of the tool (Rößling, 2009). These factors could be summarized as ease of use, appropriate feedback, state changes, window management, multiple views, user control, canned examples and data input, and pseudocode (Saraiya, 2002).

On the other hand, critical and creative thinking are two of the most important skills in order to solve the problems with the most optimal solutions. While critical thinking considers well-known approaches, creative thinking considers diverging approaches and often different from the accepted principles. It was well-understood from the earlier studies that both skills resemble synergy and produce a greater combined effect than the sum of their separate effects (Conwell, George & Beard, 1993). Critical thinking is developed in a class by applying repetition of problems. On the other hand, it was released from some of the previous studies that creative thinking is not much considered by many educators since it is considered as an intimidating task (Diaz, 1992; Bransford and Stein, 1983). Reverse engineering is an approach that fosters both the critical and creative thinking which improves students' problem-solving skills. It is considered as a supplement for a course in order to enhance deeper and more comprehensive understanding of their field rather than repetition and memorization. Reverse engineering is considered as a redesign process of a product or a tool wherein the working process of the tool is observed, disassembled, analyzed and tested. The main use of this approach is to comprehend and experience the working principles of the tool by reading the solution to a specific task and working backwards to learn about how things were used through the processes. This enhances students' excitement and learning in the courses (O'Brien and Abulencia, 2010).

In addition, students could have the chance to receive feedback immediately after assignments or assessments are completed (Bokhove & Drijvers, 2012b; Pilli & Aksu, 2013; Van der Kleij, Feskens, & Eggen, 2015; Wang, 2014). For instance,

students from programming languages class could have the chance to learn by applying the written codes to the tool in order to achieve a better understanding of the program with improved learning skills. Use of AV together with the reverse engineering approach enrich the students' learning capacities with sensory, visual and active skills.

Purpose of the Study and Hypothesis

The main goal of the study was to test the effectiveness of educational software as a motivating digital formative assessment tool to improve high-school students' learning capabilities for visual basic programming course. In addition, the effect on teachers' time management skills was studied. The implementation model of the conducted research study is illustrated in *Figure 1*.

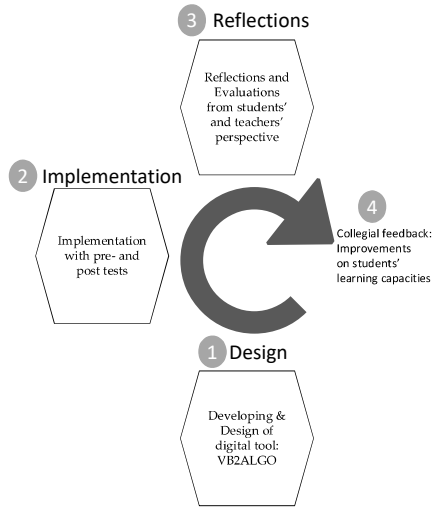


Figure 1: Implementation model of the research study

To explore the model, VB2ALGO software tool has been designed which utilizes algorithm visualization with a reverse engineering approach for the analysis of the written code. The tool displays functions, calls operations as an algorithm so that students could follow the program steps while observing the mistakes on the codes. Learning tool was expected to enhance the students' motivation for the visual programming course while maintaining individual learning and supporting laboratory assignments. Cognitive Constructivism indicates that each individual constructs the knowledge in his/her mind. Each learner establishes the truth by

themselves. In the learning process, students must be active and involved. Thus, the main hypothesizes are:

H1: The use of VB2ALGO tool in high school Labs will have a positive impact on students' performance in VB programing language course.

H2: the use of VB2ALGO tool in high school Labs will increase cognitive skills of students in VB programing language.

A second goal for the study was to explore time-management of the teachers after using the software tool inside the laboratories. Time management is defined as the efficient and maximum use of time for productivity and achievement (Allen, 2001). In accordance, it is an essential skill for the teachers to manage their time efficiently in order to provide quality education for the students. By using the necessary time management strategies, teachers could have the chance to keep up better with the educational needs of the students. For instance, teachers could have the chance to better identify the problem areas where process improvements could make a positive impact to maintain productive learning time for the students. It is quite crucial to plan, implement and evaluate the time by the administrator while utilizing the available school resources in order to increase student performance and motivations towards the course (Ugwulashi, 2011).

We believe that the use of VB2ALGO tool inside the laboratories could enhance improved learning skills which eventually lead the lecturers to instruct the course curriculum on time with productivity. Therefore, the following hypothesis is proposed:

H3: The use of VB2ALGO tool in high schools will help teachers to manage their teaching time for teaching VB programing language.

Methods

Research Design

Libya is one of the largest countries in Africa and the estimated population was reported as 6.75 million in July 2018. The population of the country is young with nearly 42.34 per cent being under the age of twenty-five; the median age of the total population is 29.4 (CIA, 2019). Almargap region is located in the north region of the Libya state. It was stated in the National Report of the Great Libyan Jamahiria (2008) that the majority of Libyans today are educated at university or higher institute level and the CIA report (CIA, 2019) confirms that 91% of the adult population are literate, although there is a difference between males at 96.7% and females at 85.6%. There are three phases in the Libyan education system. First, students attend basic educational schools for nine years: they spend 6 years in a

primary school and 3 years in a general secondary school. Graduated students are awarded a basic education certificate. After that, students continue for the second phase of the secondary school education for 4 years where students could have the chance to choose more specific and specialized areas of study, such as arts and sciences. Upon completion of the second phase of the education system, students could continue to the university level (Abushafa, 2014). After the design of the VB2ALGO tool, three steps research methodology was applied in this study as depicted in *Figure 2*. All the permissions for conducting the quantitative surveys (pre-tests, post-tests, students and teachers' questionnaires) were granted by the Libyan Ministry of Education with the collaboration of the schools' principals.

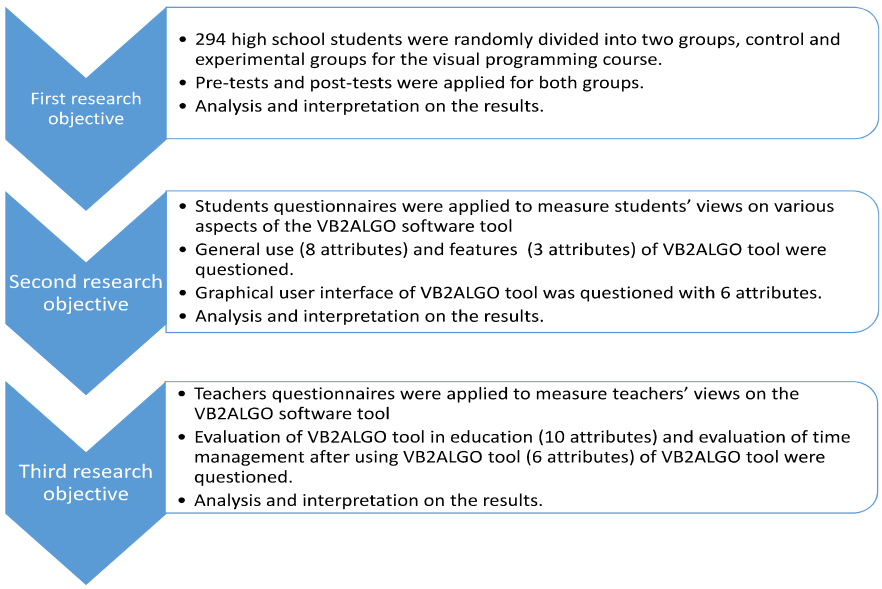


Figure 2: Three steps research methodology

As the first objective of the study, two educational applications were implemented and compared with the students, who were enrolled on the visual basic course, from four different high schools in Almargeb region of Libya State. The students who participated in the study were assigned to two groups, one of which used the VB2ALGO tool (Experimental group) and the other did not (Control group). Groups were identical in terms of learning objectives and course materials during theoretical classes. They differed in the VB2ALGO digital learning tool that they followed during the laboratory hours. Therefore, it could be stated that any differences in learning outcomes could be attributed to the VB2ALGO software tool. The study followed a pretest/posttest experimental design, taking before and after measures of each group, in order to investigate the effect of the application. The students' achievement was measured by a knowledge test on visual basic

programming. In order to actualize the validity of the measuring instrument used for the data collection, the questionnaire was cross-checked by the course teachers. These experts provided corrections and suggestions that result in some modifications of the items in the tests, which ensure its content validity. Pre-tests were conducted both for the control and experiment groups by using quantitative surveys during the mid-term exams. Then, VB2ALGO tool was installed at the laboratories for the experimental groups only. Post-tests were distributed as quantitative surveys both to the control and experimental groups which was just after the final exams.

As the second research objective, students' views on various aspects of the VB2ALGO software tool were measured through a close-ended questionnaire and the participants' responses were analyzed. The questionnaire items were formed by the authors. The first part of the questionnaire survey consists of two items (gender and age) as the demographic information of the students while the second part consists of a total of 17 items that measures the students' views on the general use of the VB2ALGO tool (8 items), their qualifications (3 items) and the graphical user interface (6 items). The survey questions were rated on a 5-point Likert scale, where 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree. The value of the Cronbach's Alpha, reliability analysis, was calculated as ($\alpha = 0.704$).

As the third research objective, teachers' views on the software tool were explored by using a questionnaire in order to reveal the effect of the software tool for teaching approaches. The questionnaire items were formed by the authors. The first part of the questionnaire survey consists of two items (gender and age) as the demographic information of the teachers while the second part consists of a total of 16 items that measures the evaluation of tool in education (10 items) and the evaluation of time-management after using the tool (6 items). The survey questions were rated on a 5-point Likert scale, where 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree. The value of the Cronbach's Alpha, reliability analysis, was calculated as ($\alpha = 0.914$).

Participants

First nine years of education, which is so-called basic education, is compulsory in Libyan educational system (UNESCO, 06/07, p. 9). Later, students study the following three years as a secondary (ages 12-15) school years in which they take several educational and cultural subjects. After successful completion of the secondary school, students enroll in high schools (ages 16-20) of their choice (Alhmali, 2007). The research study was conducted in Almargeb region of Libya where 89 schools were available. The region was divided into four cities where one school was selected randomly from each city in order to reflect the homogeneity of the participants. 294 Students participated in the survey. The gender proportion in the resulting population was 52.7% (155) males, and 47.3% (139) females. Table

1 shows the distribution of the participants according to gender and school while all the high schools are public in the region.

Table 1: Participants who participated in the survey

School Name	Female	Male	Total
School 1: Suq Alkhamis	34	29	63
School 2: Jeel Alghad	41	14	55
School 3: Almanara	27	57	84
School 4: Shuhada' Kaeam	37	55	92
Total	139	155	294

The students were attending the final year of the high school and had been taught the same subject matter relevant to visual basic programming according to the Libyan high school education curriculum. In addition to the theoretical teaching hours, compulsory lab hours were also included in the curriculum in order to enhance the practical experience for the students. They had never used any digital learning tool at the school. In each of the selected schools, all final year students attending the course "Visual Basic Programming" served as subjects for the investigation. Students were randomly assigned in each school to one of the two groups (Control and Experimental). Eight classes from four schools participated: four classes used the VB2ALGO digital learning tool during the laboratory hours and the other four classes used the traditional learning in laboratories. Table 2 (a) and (b) shows the distribution of the participants for the control and the experimental groups respectively.

School Name	Total
School 1: Suq Alkhamis	31
School 2: Jeel Alghad	28
School 3: Almanara	42
School 4: Shuhada' Kaeam	46
Grand Total	147

(a)

School Name	Total
School 1: Suq Alkhamis	32
School 2: Jeel Alghad	27
School 3: Almanara	42
School 4: Shuhada' Kaeam	46
Grand Total	147

(b)

Table 2: (a) Control group participants, (b) Experimental group participants

Table 3 depicts the distribution of the participated teachers according to gender and school. There were 16 teachers available in the schools as visual programming course teachers, while 8 were male, 8 were female.

School Name	Female	Male	Total
School 1: Suq Alkhamis	2	2	4
School 2: Jeel Alghad	3	0	3
School 3: Almanara	2	3	5
School 4: Shuhada' Kaeam	1	3	4
Total	8	8	16

Table 3: Participated teachers for the questionnaire

In order to ensure that students did not use any other external factors rather than VB2ALGO tool, a set of questions were prepared and distributed to the students with the post-test. Students were removed from the analysis who indicated that they used external factors such as the Internet, any other learning tool, or private classes. This is quite crucial in order to conduct the most accurate analysis of the effect of the VB2ALGO tool on students' performances.

The Digital Formative Assessment Tool: VB2ALGO

Participants VB2ALGO is a digital formative assessment tool which uses the reverse engineering approach for the analysis of the code. Software tool shows how the visual basic program instructions are connected together. Functions, calls and operations are displayed as separate algorithms on a screen, also allowing the students to follow the program steps while having the chance to check the wrong steps as well. VB2ALGO tool takes a visual basic code as an input and produces an algorithm (flowchart and pseudocode) as an output. It uses static analysis techniques to extract an algorithm where valid results are produced with for all executions and for all inputs. The tool has been designed in three stages and each stage depends on the preceding. These stages are: loading the source code, analyzing the code and generating pseudocode & drawing the flowchart accordingly. The following algorithm in Figure 3 shows the previous three phases after it was linked in a flowchart. The algorithm starts by loading a Visual Basic Source Code and then the tool analyses the code while dividing it into subroutines and functions. After that, all Subroutines and Functions can be viewed in source file such as *Form1_Activate(), Command1_Click(),Function Rectangle_Pic_1()*, etc. By doing so, any subroutine or function can be viewed separately by clicking on its name. Declarations, headings and comments can be excluded from the chosen

subroutine or function which does not affect the results. Contents of Subroutine or Function can be viewed as a pseudocode after excluding some statements. After that, a flowchart for the subroutine or function can be drawn. Finally, the resulted flowchart can be exported to a printer or an image editor.

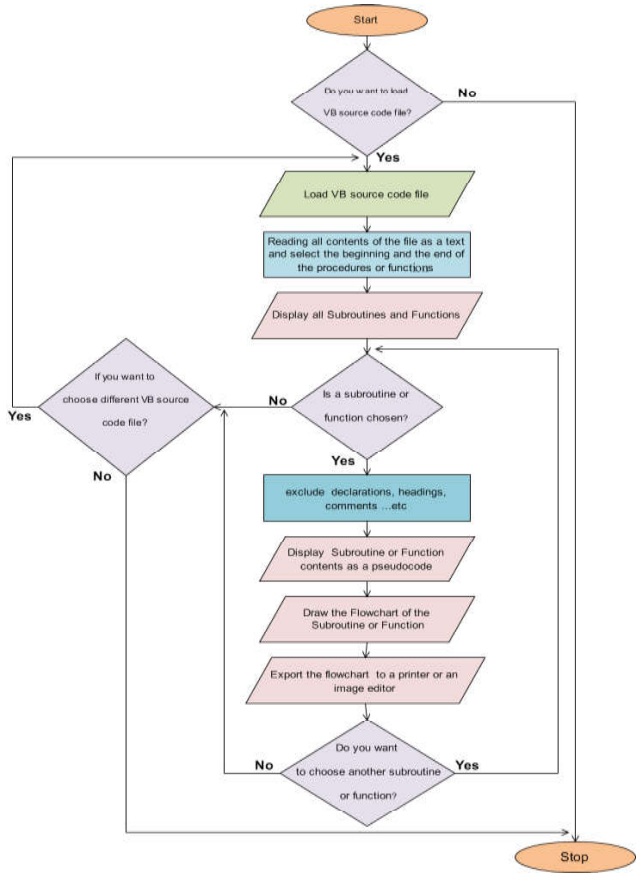
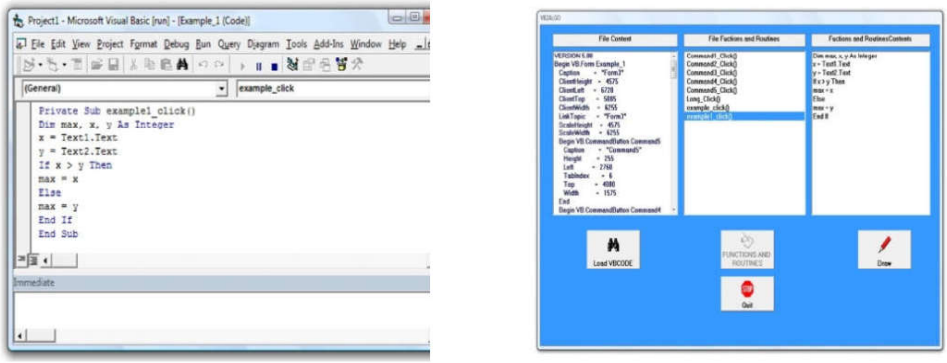


Figure 3: Flowchart of the tool's algorithm

In order to comprehend the operation of VB2ALGO tool, an example for comparing two numbers to find the maximum is considered. Figure 4 (a) and (b) illustrate the code which is written in visual basic language and pseudocode of the example respectively. "File Content", "File Functions and Routines", "Functions and Routines Contents" fragments of the figure 4b represents a list to show the code, the name of subroutines, and the pseudocode respectively.



(a) (b)

Figure 4: (a) Visual Basic code to compare two numbers, (b) Pseudocode of the example which is generated by the tool

After that, a flowchart of the example can be drawn by the tool as shown in *Figure 5*.

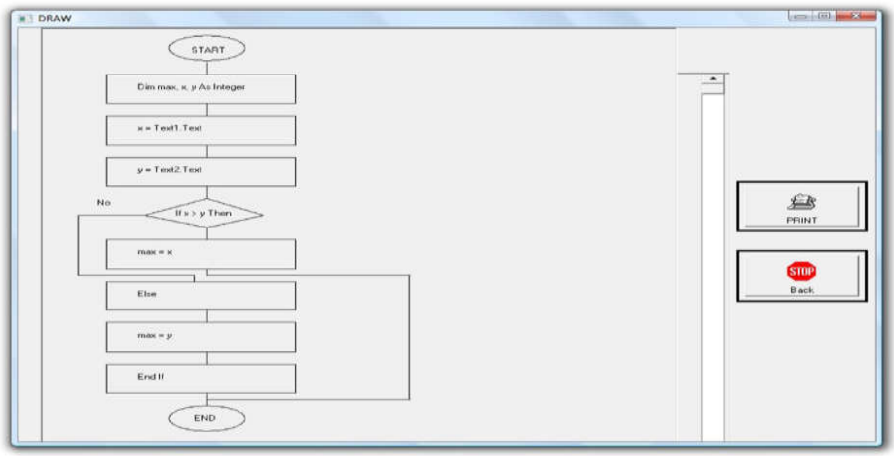


Figure 5: Flowchart of the comparing example

Results

For the first phase of the research analysis, pretests and posttests were applied to both control and experimental groups in order to reveal the impact of VB2ALGO digital learning tool for the students. Statistical comparison was completed after the experimental pre-test and post-test as well as its analysis. Eight students from the controlled group and eleven students from the experimental group are removed from the analysis who indicated that they had used external factors for visual programming such as the internet, any other learning tool, and private classes.

Findings from the first phase of the analysis

The research study is conducted based on the interpretive paradigm to understand human behavior in terms of individual description and interpretation. Experimental analysis, pre-test/post-tests, is used since comparison and quantitative measurement is the classical experiment (Cohen, Manion, and Morrison, 2000). The random experiment has the following objectives: First, the experiment involves a pre-test to assess students' abilities before the intervention, on intervention, and a post-test that measures students' abilities after the intervention. There are control and experimental groups which are formed randomly. The control group allows comparing the abilities between the groups after the intervention. Students have to be randomly selected while forming the control and experimental groups. A t-test is a type of statistical test that is used to compare the means of two groups and is one of the most widely used statistical hypothesis tests in research studies. Subjects are divided into two; control and experimental groups. T-tests can be divided into two types. If the two groups under comparison are independent of each other, the independent samples t–test was used. On the other hand, the paired t-test was used when the groups were dependent on each other in different experimental environments (Kim, 2015). The paired t-test is used in this research study and first the degree of normality was confirmed by applying the Shapiro-Wilk test. Table 4 (a) and (b) present the Normality tests for control and experiment groups accordingly. It could be stated that the samples for both groups satisfy the condition of normality since the P values are greater than 0.05 (Yaratan, 2017). P value can be viewed as a continuous measure of the compatibility between the data and the entire model used to compute it, ranging from 0 for complete incompatibility to 1 for perfect compatibility, and therefore the presented results fit the model with normal distribution (Greenland, Senn, Rothman, Carlin, Poole, Goodman, & Altman, 2016).

Table 4: Normality test for control and experiment groups

	Shapiro-Wilk		
	Statistic	df	Sig.
Pre-test(Cont)	.988	139	.292
Post-test(Cont)	.990	139	.457

(a) Control group

	*(b)*Shapiro-Wilk		
	Statistic	df	Sig.
Pre-test(Expr)	.986	136	.189
Post-test(Expr)	.994	136	.878

(c) Experiment group

The mean scores of the pre-tests for control and experimental groups are quite close to each other (43.6 for control and 42.9 for experimental group). On the other hand, while the mean score of the post-test for the control group is 55.85, the mean score of the post-test for the experimental group is 65.53.

Multivariate normality of the students' performance was checked by examining the Q-Q plot of expected and observed Mahalonobis distance. The plot had a 45-degree line between two variables for pre/post-tests of both control and experimental groups as can be seen in Figure 6. That was the evidence of the multivariate normality of the pre and post-tests of students' marks.

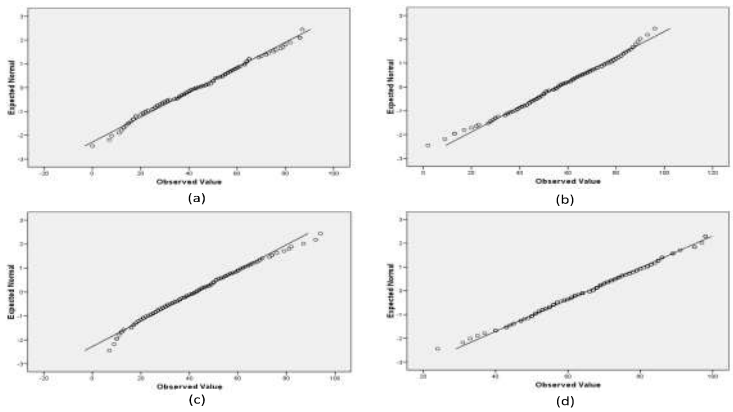


Figure 6: Q-Q plots of (a) pre-test for control group, (b) post-test for control group, (c) pre-test for experimental group, (d) post-test for experimental group

Pre-test and Post-test marks for both control and experimental groups were positively correlated. Pair samples correlation is 0.576 for control group ($p < 0.001$) and 0.664 ($p < 0.001$) for experimental group. The results of the paired sample t-test for control and experimental groups are illustrated in Table 5 (a) and (b) respectively. While the scores of the control group are improved average of 12.252 points from pre-test to post-test, there are 22.625 points average improvement for the experimental group due to the use of VB2ALGO tool in the laboratories. T is the t-test statistic which indicates the difference between the scores of pre and post-tests. As can be seen from Table 5, the t value is -8.240 for the control group and -18.461 for the experimental group. The larger value identifies the difference between the conditions due to the use of VB2ALGO tool. In addition, it could be concluded that there is a smaller probability that this difference occurred by chance. By the Significance level (p=.000<.05), as it can be seen from table 5 (a) and (b), it could be stated that the paired population means are not equal for both control and experimental groups.

Table 5: Paired T-test for (a) control group, (b) experimental group

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre-test(Expr)-Post-test(Expr)	-12.252	17.529	1.487	-15.192	-9.312	-8.240	138	.000

(a)

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre-test(Expr)-Post-test(Expr)	-22.625	14.292	1.226	-25.049	-20.201	-18.461	135	.000

(b)

There are 26 students who have pre-test scores higher than post-test scores for the control group while there only 6 students for the experimental group. It could be concluded that VB2ALGO has a positive impact on students' learning

capacities. Descriptive statistics for both the control and experimental groups are summarized in Table 6 (a) and (b) respectively.

As evident from the Table 6(b); the value of mean, median, mode for post-test are 65.5294, 67, and 68 respectively. The mode is higher than the mean and the median. This indicates that the distribution is negatively skewed indicating high scores. Further the difference between mean, median and mode is marginal indicating that the distribution is near normal. Hence it can be calculated that the selected sample is a representative of the population. The kurtosis of the sample is indicating that the distribution is platykurtic in nature which means that there is a frequency of distribution flatter than the normal. It could also be compared between Table 6 (a) and (b) that minimum and maximum scores of the students are improved after using the VB2ALGO tool inside laboratories.

Table 6: Descriptive statistics for (a) control group, (b) experimental group

Controlled group	Pre-test	Post-test	Experimental group	Pre-test	Post-test
N Valid	139	139	N Valid	136	136
Missing	0	0	Missing	0	0
Mean	43.60	55.85	Mean	42.90	65.53
Median	43.00	56.00	Median	43.00	67.00
Mode	50	50	Mode	36	68
Std. Deviation	19.087	18.971	Std. Deviation	18.833	14.931
Variance	364.329	359.897	Variance	354.665	222.947
Skewness	.094	-.245	Skewness	.320	-.088
Std. Error of Skewness	.206	.206	Std. Error of Skewness	.208	.208
Kurtosis	-.563	-.149	Kurtosis	-.250	-.224
Std. Error of Kurtosis	.408	.408	Std. Error of Kurtosis	.413	.413
Range	87	94	Range	87	74
Minimum	0	2	Minimum	7	224
Maximum	87	96	Maximum	94	98
(a)			(b)		

Findings from the Second and Third phase of the Analysis

As it can be seen from *Table 7*, KMO = 0.604 which indicates that the sample is adequate. For Bartlett's Test of Sphericity test, the level of Significance (α = 0.05) is considered as 95% and the p-value (Sig.) of .000 < 0.05. Therefore, the factor analysis is valid since p < α which the interrelationship between variables are significant.

Table 7: KMO and Bartlett's test for student questionnaire after the post-test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.604
Bartlett's Test of Sphericity	Approx. Chi-Square	961.987
	df	136
	Sig.	.000

From the students' questionnaire analysis; it could be concluded that 82.56% of students agreed that they are satisfied with the tool, 87% thinks that the graphical user interface of VB2ALGO is easy to use, 65.44% of students agreed that the tool gave them the skills and knowledge to complete their exercises better and faster than before, 77.94% of students think that they had a better understanding of programming lectures, 86.03% of students think that they get better to identify programming errors and problems while seen 71.33% of students think that they become more productive after using VB2ALGO tool.

Comparing the answers from the pre and post questionnaires revealed that there was a difference in the time management of lecture. In addition, there was a significant difference for the laboratory time between the controlled and the experimental group. All 16 teachers think that students' skills for programming increased significantly after using the tool. 13 of teachers thinks that the tool helped students to understand the course better than the previous methods 14 of teachers agreed that the level of students' understanding of the fundamentals of programming became better after using of the tool. Also, 14 teachers agreed that the tool can reduce the failure of students in the course of programing language. All the teachers thought that the number of completed examples has increased in the classroom after using the tool with better time management. All agreed that the tool was easy to learn and use for assigned tasks. From this comparison, we noted that the tool contributed to the management of classroom time and management of laboratory time especially in the laboratory.

Conclusions

It was revealed from the experimental analysis of pre- and post-tests that the use of VB2ALGO tool for visual programming course in Libyan high school labs has a positive impact on students' performances with better understanding. Therefore, Hypothesis 1 is supported.

It could be stated from the students' questionnaire that the use of VB2ALGO tool has a positive motivation for the students to learn VB programing language.

It is also concluded from the results of the students' questionnaire analysis that the use of VB2ALGO tool in high school labs has increased cognitive skills for students in VB programing language. Hence, Hypothesis 2 is also supported.

It is revealed from the questionnaire for teachers that the use of VB2ALGO tool in high school labs increases the number of solved programs in VB programing language course class.

It is understood from the pre and post questionnaire results for teachers that the use of VB2ALGO tool in high schools helped teachers to manage their teaching time more efficiently for VB programing language class. Therefore, Hypothesis 3 is supported.

It could also be stated from the teachers' questionnaire results that the use of VB2ALGO tool in high schools made learning process interesting for students.

It is discovered from the teachers' questionnaire that the use of VB2ALGO tool in high schools has a positive contribution to the development of creative thinking among students.

This research discusses the impact of using the VB2ALGO digital tool in the visual programming course. In this study, 294 students from 4 high schools were tested on their comprehension of learning VB language programs. The ability to understand computer programs is the skill that begins to develop in novice programmers and reaches maturity when programmers are expert in programming. This research shows how novice programmers start learning visual computer programing course during their high school study. The degree of association between students' scores before and after using the tool as well as the comparison with the control groups in which traditional teaching methods are studied. It could be concluded from the research analysis that there is a positive correlation between the control and experimental groups before and after using the tool during the lab hours, namely experimental group students got higher marks at the post-tests. The mean score was higher for the experimental group (M=65.5294, SD=14.93142) than for the controlled group (M=55.85, SD=18.971) by 9.6794 points. Quantitative results were analyzed with the t-test. The justification for using t-test is based on the formulation of a hypothesis, which predicts that there will be no significant statistical difference between the learning outcomes of the controlled and experimental group. The t-test indicated a significant difference between the two groups. Based on these results, the tested hypothesis has to be adopted at the

p=0.05 level of significance. The results make it clear that VB2ALGO tool can help students to better understand the programming language and better level of teaching. Also the educational tools will be enjoyable for the students, which make them focus on studying the curriculum. Finally, it was noted from the research study that the VB2ALGO tool contributed to the time management in the classroom and contributed to the time management in the laboratory for teaching VB programing language in high schools.

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