ENHANCING EFL PROFESSION-BASED VOCABULARY ACQUISITION THROUGH 3D ENGINEERING ANIMATION FOR ENGINEERING STUDENTS

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Abstract. Today, a majority of agricultural farms are equipped with a new type of farm machinery, tractors, which require high-quality knowledge, skills and abilities from engineers. Therefore, the ability to describe the objects, mechanisms and working schemes is a priority for future agricultural engineers. Before COVID-19 and the war in Ukraine, most ESP classes were held in specially equipped laboratories, where students could study agricultural machinery and equipment on layouts. Ukrainian educators search for alternative teaching tools to enable effective distance learning of future agricultural engineers. Three-dimensional environments can be very useful to examine agricultural machinery parts. The purpose of this experiment was to test the effectiveness of 3-D engineering animation in improving profession-based vocabulary acquisition. A two-group post-test comparative pedagogical experiment was conducted with the second-year agricultural engineering students ($n = 30$) during the spring semester of the academic year 2022. A series of online 3-D engineering animations was adapted with the students of the experimental group to reinforce the course content and develop vocabulary skills in participants. The achievement profession-based vocabulary test with experimental and control groups was carried out. The number of participants in each group is equal ($n_1 = 15$, $n_2 = 15$), so the boundary value of X_b at a 5%- level of significance for $N = 30$ is 4.88. The statistical interpretation of the test results based on the Van der Waerden criterion shows that $X_{f >} H_b$, respectively, 8.85 > 4.88. The differences in the results obtained are statistically significant ($X = 8.85$ at $P < 0.05$), which allows us to assert the effectiveness of training engaged in the experimental group.

Keywords: 3-D animation; agricultural engineering; ESP; profession-based; vocabulary acquisition.

Introduction

The problem of training highly qualified personnel is still relevant for Ukraine. This is why national stakeholders who participate in designing educational-professional training programmes at technical universities along with technical engineering knowledge indicate the need for acquiring sound ESP skills. In today’s world, potential employers from all over the world seek graduates able to communicate with counterparts across the globe in general and professional contexts, present engineering ideas to decision-makers in presentations, meetings, and reports, and explain complex ideas and new technologies.

Therefore, when studying ESP, the ability to describe a specific device of the object, the working scheme, the interaction of nodes and mechanisms, and to communicate on technical characteristics and features of agricultural machinery and equipment becomes a priority. In the post-COVID and pre-war periods, most ESP classes with engineering students were carried out in specially equipped laboratories, where students could master profession-based foreign language vocabulary; describe the construction and operation of machinery with the help of full-size layouts. In the distance learning setting, foreign language instructors started to explore the virtual tools that could replace natural means (mechanisms and components, devices, tools, samples of parts). In this respect, we believe that utilizing semi-immersive virtual reality, 3D animations and presentations in particular can substitute ESP classes in engineering laboratories and show good achievements compared to using a textbook with illustrations during Zoom classes.One of the possible solutions to promote the functioning of engineering education in the global context is providing 3D animated-based activities (animated presentations, computer animation or digital animation, or computational mimics) in engineering learning. Animation has a potential role in supporting the visualization of dynamic processes, such as those not easily observable in real space and time scales, real processes that are practically impossible to realize in a learning situation, or a process that is not inherently visual [1].

Many types of research have addressed the advantages of three-dimensional (3D) environments in engineering education [2; 3-6]. 3D models have preferences over traditional interactive multimedia environments. They are user-friendly and easy to comprehend to make acquaint students with features

DOI: 10.22616/ERDev.2023.22.TF087

of different shapes and objects [2]. Three-dimensional animation allows learners to observe many phenomena which would be hard or even impossible for them to do so in the real world [7].

Multimedia demonstration of a dynamic system with instructional animation provides the students with more accuracy in the depiction of the system's behaviour [8]. Nazirah and Al-Asmari state that employing 3D animation increases students' learning, especially in grasping a difficult subject such as the engineering subject. They consider the complex details of structural steel joints a difficult topic to comprehend. The scientists conclude that projecting 3D images in a virtual space can be an effective solution for making the study of structures more interesting and interactive [5].

Other interesting aspects of the implementation of 3D animation were disclosed in several studies such as prior knowledge students, segmentation, cueing/signalling, prediction prompts and modality are proven as the effective design principles [9], the effect of static vs. animated presentations on comprehension [10], effects of presentation speed of dynamic visualization on the understanding of a mechanical system [11], segmented-animation presentation [1], roles of mental animations and external animations in understanding mechanical systems [12], dynamic and static visualizations [13], benefits of 3D animation for low and high spatial ability learners [14]. Utilizing 3D animation in teaching engineering disciplines has a beneficial effect on the learning process. The issue is whether 3D animation can be used to promote a profession-based approach to teaching other disciplines with engineering students.

The scientists from a private Colombian Catholic university used the software Moviestorm to create 3D videos in the ESP classroom with students majoring in electronic engineering, computer science, and law. Research results revealed that the development of oral presentation skills allows students to talk about their professions and other topics, facing contexts where they can represent real-life situations [15].

Based on the above-mentioned statements, it is clear that incorporating 3D animation and presentation can assist the positive performance of engineering students in their specialty subjects; however, we failed to examine the research papers that consider the implementation of 3D animation and presentation in ESP classrooms with the engineering students. The present research is conducted in the framework of the confirmed theme of the foreign languages department at the higher educational institution Podillia State University in Ukraine. Previous studies have shown the efficiency of using digital tools in teaching ESP to engineering students [16, 17]. Thus, in this research, we apply the 3D engineering animation app to agricultural machinery context classes with students majoring in agricultural engineering to enhance the students' professional vocabulary learning.

Materials and methods

To evaluate the efficacy of 3D engineering animation in ESP classrooms we used a post-test 1-semester (2022 academic year) experimental design. Second-year agricultural engineering students who graduated from college and received a diploma of junior specialist were employed in the survey. These students passed the diagnostic test at the beginning of their university study and were divided into groups according to their level of EFL proficiency. Two equal groups of students with B1-level of EFL proficiency were chosen as participants in the experiment. So, the first group obtained the status of the experimental (n_e + 15) and the second group participated in the survey as the control group (n_c = 15). The two groups had distance learning ESP classes using Zoom taught by the same teacher and had an equal number of learning hours according to the syllabus in the discipline (18 hours a semester, two periods a week). During the semester the students in both groups covered the following topics: V6 engine, Beam engine, Manual gear transmission and Car steering. Students in the control group worked with texts on the topics, examined machine parts with the help of textbook illustrations, and performed lexical exercises, while the students in the experimental group used a 3D engineering animation application.

The language instructors who experimented explored the functional characteristics of the 3D engineering animation device in advance. All the participants of the experiment (teacher and the students of the experimental group) installed the application on touchscreen phones and computers. The user of 3D engineering animation can download 3D machinery models and control animation speed, graphics quality and rotation sensitivity. Moving the fingers over the 3D model we can view it from different angles, zooming in and out as it is shown in Figure 1.

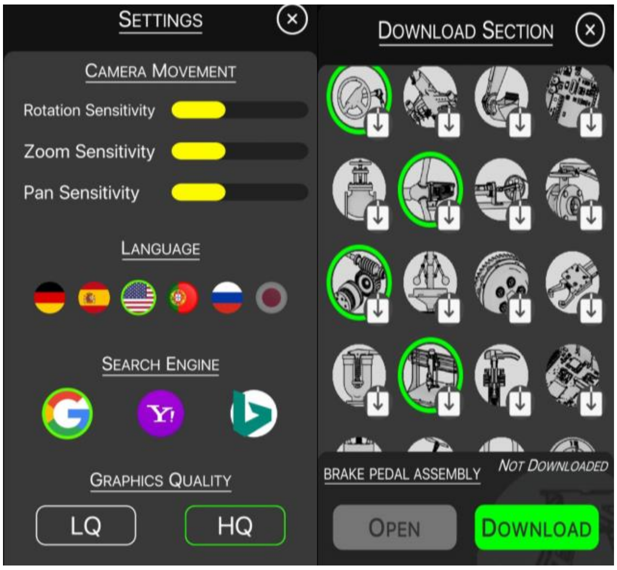

Fig. 1. **Interface of 3D engineering animation device**

There were four phases of 3D engineering animation experimental ESP teaching: 1) Downloading the 3D animation model; 2) Starting the demonstration centring the model on the screen and analyzing the pattern in detail; 3) Clicking different components of the engineering model. For example, when we examined V6 Engine, we pressed its parts (cylinder head, hoses, exhaust manifold, air filter) and each engine part got highlighted by green colour and its name appeared in the upper row. 4) If necessary the users can ask the device for additional information about certain V 6 engine parts in the form of textual support and available information in the search engine (Fig. 2).

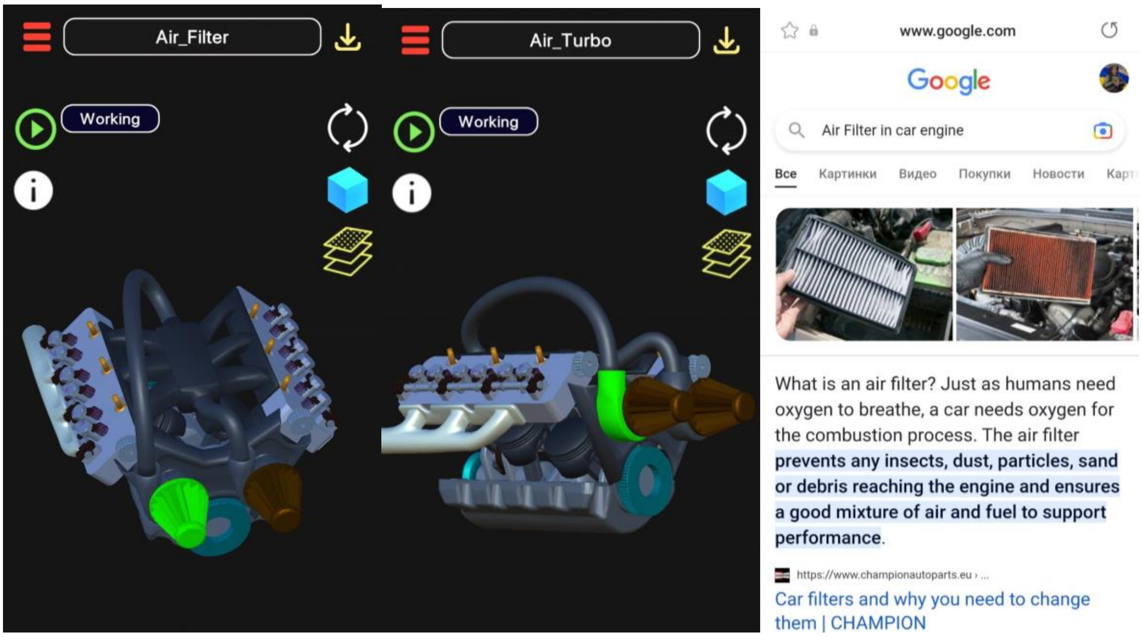

Fig. 2. **3D engineering animation platform capabilities**

Results and discussion

After a semester of teaching, the two groups (experimental and control groups) were tested to verify the learning effect and the results of the experimental teaching method. The post-test consisted of 10 questions with selective answer options. The results are given in Table 1.

Table 1

Comparative results of the final evaluation test

Group	*n*	Number of correct answers out of 10										
		0	1	2	3	4	5	6	7	8	9	10
Experimental	15	-	-	-	-	-	2	4	1	3	2	3
Control	15	-	1	3	3	1	2	3	-	2	-	-

The X – Van der Waerden criterion was used to calculate the reliability of the differences according to the included following steps. First, we prepared a special table for calculation (Table 2).

Table 2

Table for calculating the reliability of differences according to the *X*-test of Van der Waerden

Number (R)	Number of correct answers out of 10		$\frac{R}{N+1}$	$\psi\left\{\frac{R}{N+1}\right\}$
	Experimental group	Control group		
1	-	1	-	-
2	-	2	-	-
3	-	2	-	-
4	-	2	-	-
5	-	3	-	-
6	-	3	-	-
7	-	3	-	-
8	-	4	-	-
9	-	5	-	-
10	-	5	-	-
11	5	-	11:31 = 0.355	-0.37
12	5	-	12:31 = 0.387	-0.29
13	6	-	13:31 = 0.419	-0.20
14	6	-	14:31 = 0.452	-0.12
15	6	-	15:31 = 0.484	-0.04
16	6	-	16:31 = 0.516	0.04
17	-	6	-	-
18	-	6	-	-
19	-	6	-	-
20	7	-	20:31 = 0.645	0.37
21	8	-	20:31 = 0.678	0.46
22	8	-	20:31 = 0.710	0.55
23	8	-	20:31 = 0.742	0.65
24	-	8	-	-
25	-	8	-	-
26	9	-	26:31 = 0.839	0.99
27	9	-	27:31 = 0.871	1.13
28	10	-	28:31 = 0.903	1.30
29	10	-	29:31 = 0.935	1.51
30	10	-	30:31 = 0.968	1.85
	N = 15	N = 15	-	Σ = 8.85

The sequence numbers of all observations in the experimental and control groups (ranks) $R = n_e + n_c = 15 + 15 = 30$ (N) were placed in the first column. Then we entered the results of the experimental and control groups in ascending order in the second and third columns, respectively. Next, we chose the experimental group (although under the equal number of respondents, the type of group has no significance) and inserted the values in the fourth column (separate from dividing the sequence number by a number equal to the sum of the observations in both groups, plus 1):

$$\frac{R}{N+1}$$

where N – total number of observations ($n_e + n_c = 15 + 15 = 30$);
R – sequence numbers.

The next step was to find the values of the function

$$\psi\left\{\frac{R}{N+1}\right\} \text{ for quantities } \frac{R}{N+1}$$

(Values of White's T-test at $P = 0.95$) and place them in the fifth column. Then we calculated the sum of the finite values of the function ψ which would be the value of the calculated (actual) value of the X-test of Van der Waerden.

We compared the obtained value of X_f with the boundary (tabular) value of X_b at the selected level of significance according to a special table (critical values of X criterion of Van der Waerden). In our example X_f is 8.85. The boundary value was taken depending on the number ($N = n_e + n_c$), as well as on the difference (n_e-n_c) between the number of observations in the groups if the groups had a different number of observations (subjects). In our experiment, the number of observations was the same 15 in each group, so the boundary value of X_b at a 5% significance level for $N = 30$ was 4.88. Based on the comparison of the data of H_f and H_b, we formulated statistical and pedagogical conclusions. Statistical conclusion: if the calculated value is greater than the boundary ($X_f > X_b$), then we can talk about the reliability of the differences in the results obtained. In the case where the calculated value of X is less than the boundary value, i.e. ($X_f < X_b$), the differences between the results obtained are considered unreliable. Pedagogical conclusion: when obtaining reliable differences, we can talk about the greater effectiveness of one of the methods of teaching. In the case when the differences are statistically unreliable to assert the advantage of any of the methods used there is no reason. In our example, $X_f > X_b$, respectively, $8.85 > 4.88$, i.e. the differences in the results obtained were statistically significant ($X = 8.85$ at $P < 0.05$), which allowed us to assert greater effectiveness of training engaged in the experimental group.

This research contextualizes the field of English for Specific Purposes, with a particular focus on employing semi-immersive virtual reality in mastering engineering vocabulary. The present study contributes to the "meaningful context" [2], efficacy in "grasping difficult subjects" [5], and the possibility of 3D animation to show the details which would be hard or even impossible to see in the real world [7]. The authors suggest that digital animation can replace or complement the laboratory session in the nearest future [5] and their further research will consider this issue. Our research is fulfilled in profession-based and integrated approaches to ESP teaching. Asef and Kalyvas [4] used animations for explaining to automotive engineering students how multiphysics equations and systems work. We, in turn, used the potential of 3D engineering animation in ESP learning. The results of our study revealed that three-dimensional (3D) environments can replace full-size layouts of machines and their parts and enable providing distance learning ESP classes. 3D engineering animation can serve as a tool for improving profession-based vocabulary with students majoring in engineering.

Conclusions

1. Mastering engineering vocabulary through 3D images can be beneficial for engineering students. The captured data affirm the hypothesis that the students who used 3D engineering animation showed better results than those who worked with ESP textbooks.
2. The implications drawn from the research can be considered by foreign language instructors when dealing with utilizing innovative approaches in ESP vocabulary learning.
3. Using 3D engineering animation provides strong interdisciplinary collaboration since the students acquire not only the new machinery vocabulary but also revise mechanism design and operation. Further research will focus on the communicative aspect of ESP learning through three-dimensional environments.

Author contributions

Conceptualization, O.C.; methodology, V.S. and A.K.; software, O.N.; validation, A.K. and O.N; formal analysis, O.N. and V.S..; investigation, O.C., O.N., V.S. and A.K.; data curation, O.N., V.S.; writing – original draft preparation, O.C.; writing – review and editing, V.S. and A.K.; visualization, O.N. All authors have read and agreed to the published version of the manuscript.

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