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Changes of Project Based Learning Effectiveness due to the COVID-19 Pandemic

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Abstract

Project based learning (PBL) is an effective student-centered method to improve students' understanding. However, most PBL learning techniques rely heavily on a sequence of activities which require interaction with other humans or components and equipment in the laboratory. For many years, this method has proven effective and reliable particularly in STEM education.

During the year when COVID-19 hit the world, PBL based education was implemented in the same exact manner as previous years to teach a course in electronics to senior students in high school. However, remarkable deterioration was observed in students' performance within this STEM course during this unusual year of the pandemic. The only change in educational practices was that all PBL steps were carried out using remote tools and in a social distance setting. The change in results raised many questions regarding the resilience of the used methods and techniques as well as its level of reliance on circumstances as significant factors in its effectiveness. These observations triggered this study where the target was of twofold: First, the study targeted understanding the factors influencing PBL effectiveness reflected by students' performance deterioration and identifying the subgroup of factors which were altered by the COVID-19 situation. Second, based on findings from the first part, the target was to propose corrective strategies that will improve the resilience of current interventions or reduce its dependence on circumstances which might change, such as what occurred during the pandemic. Students' performance was monitored and assessed in an electronics course at a high school during the pandemic using different assessment tools. Results were compared to similar sets collected when the course was conducted before the pandemic time. Results showed that students' performance in PBL decreased as instruction moved from face-to-face to remote mode. Timely interaction was mostly affected by this sudden change within a short time reflecting a need for better preparation, communication, and innovation to improve the independence of PBL from circumstances.

Keywords: Project-based learning, electronics students, COVID-19 pandemic, distance learning

Introduction

Project-based learning (PBL) is a student-centered learning strategy that aims to foster deeper learning through active exploration of real-world problems [1]. PBL enables students to learn by doing, applying ideas, and solving real-world problems [2]. In addition, PBL provides room for individualized learning and achievement while working within a team environment.

Implementing PBL among high school students has shown promising results [3]. PBL resulted in improved students' cognitive ability and problem-solving skills while dealing with complex engineering problems. In light of these findings, PBL was introduced to high school students before the COVID-19 pandemic time in the form of an electrical engineering-based project. The project included dedicated assignments. During the COVID-19 pandemic, the same exercise was carried out by high school students in a remote setting with social distancing. Comparing results from the two experiences provided significant insights which are discussed in this paper.

The following sections include a description of the theoretical framework of the study on which the research is based, thus project-based learning in both face-to-face and remote learning modes. Next, the research questions are formulated, and the research methodology is described to help understand the results of the study. Finally, a conclusion summarizing the findings is provided which could benefit the educators' community, particularly those focusing on engineering education.

Theoretical background

Project-based learning

Using PBL in education extends back to the time of Dewey's experiments with educational strategies at the University of Chicago Laboratory School [4]. PBL is founded on the theoretical background of constructivism in which students are involved in the different components of problem solving within an interdisciplinary curriculum including open questions, hands-on activities, group work and interactive group activities [5], [6]. In fact, PBL is driven by a demand that drives the process which ends with a final product [7]. PBL is used in science education to engage students in research for discovery and solving problems including difficult social challenges [8], [9]. Project topics often arise out of students' interest and spread organically when the students want to know more. Professionals describe PBL as a systematic method of teaching that directs students to acquire basic knowledge and life-enhancing skills through an advanced and student-influenced research process, structured around complex questions, authentic and carefully designed products, and assignments [10]. The ultimate goal of implementing PBL in k-12 education is to achieve deeper understanding, which occurs when students are given scaffolding and formative assessment within social structures [11].

To maximize the effectiveness of PBL, Goodrich et al. [12] suggested that projects be of real interest to provide a natural context for learning. They also suggested having clear goals and steps with enough flexibility to encourage self-direction. In addition, projects targeting PBL should include coaching, modeling, continuous assessment, and teaching of students to think and focus on a learning goal. Finally, PBL is considered one of the most effective techniques in learning when it is designed to generate motivation among students [13]. There are seven standard components expected to be included in any project following the gold standard of PBL. These components are: 1) Challenging problem or question; 2) Sustained inquiry; 3) Authenticity; 4) Students' voice and choice; 5) Reflection; 6) Critique and revision, and 7) Public product [14].

Distance learning during COVID-19 pandemic

Since the outbreak of the COVID-19 pandemic the entire education process changed. This triggered numerous studies to analyze the impact of these changes on students, teachers, and the entire educational system. The analysis focused on different angles such as: the quality of life of students during the pandemic [15], the remote learning process which replaced traditional face-to-face learning [16], the impact on the state of educational institutions [17], and student mobility within higher education [18].

Studies have shown that more than one model for online teaching was implemented. Different platforms and communication media were used while exposing students to a variety of formats that replaced face-to-face classes [19]. Real time video conferencing, A.K.A. synchronous mode, was the most widespread form of distance learning with tools such as Microsoft Teams, Zoom, or similar. The next most widespread form of was the asynchronous mode where recorded lectures or presentations were placed online for students to watch at their own convenience. Different forms of follow up were also implemented such as open fora and chats [20]. On the one hand, the variety of methods used in the teaching process during the COVID-19 pandemic has been problematic not only for students but also for teachers. Challenges in computer skills among teachers caused difficulty to prepare and conduct online teaching [21]. On the other hand, one of the positive consequences of online education for teachers was that many of them managed to develop their digital skills [22].

Lack of contact with students, especially in primary and secondary schools, has distracted teachers from motivation issues. Studies have shown a strong correlation between the effectiveness of online learning with factors such as material design and preparation, teacher engagement and the possibility of teacher-student or student-student interaction. These elements and many others such as the quality of communication between teachers and students and the increased time of preparation needed for teaching materials, in comparison to face-to-face delivery mode, have all emerged as challenges in education during the pandemic [19], [23], [24].

At the core of PBL, where hands-on and experiential learning constitute a major pilar, schools and colleges have faced more complex situations during the COVID-19 pandemic, especially when in need of special equipment, laboratories, or face-to-face interaction. More specifically, online learning proved to be challenging for classes where lab attendance is required, such as electronics, chemistry, and drawing [25].

Meanwhile, the effect of the pandemic was most prominent among students. In a study conducted recently by the authors of this paper, and confirmed by others, results have shown that students' study-load became greater than what it was before the pandemic, and that their academic performance deteriorated due to many related reasons such as: lack of a quiet place to study, lack of adequate access to course materials and instructors, lack of digital skills, and lack of access to a reliable internet connection, among others [26]. Aristovnik et al., analyzed questionnaires of 30,383 students from 62 countries and concluded that students' emotional distress was one of the significant consequences of the epidemic leading to performance deterioration [20]. Another study conducted in Bangladesh in May 2020 showed that feelings of increased anxiety have become relatively common among students as a consequence of the pandemic [27]. When it comes to motivation, studies have shown that students' motivation is related to both involvement with, and connection to, the university [28]. Therefore, there are differences in motivation between a student who has been transferred to distance learning and another student who has started studying online from the beginning of their university career [28]. Researchers argue that the need to adapt to different learning conditions in a short period of time, as well as the lack of experience in online learning, may have resulted in a reduction in involvement in the learning process [28].

Research goal and questions

The purpose of this study is to investigate the effect of the COVID-19 pandemic on PBL effectiveness as reflected by twelfth grade electronics students' performance, and to propose strategies targeting improving the resilience of current practices by reducing its dependence on circumstances.

The following research questions were formulated:

1. Did the COVID-19 pandemic change the effectiveness of PBL, as reflected by students' performance, and to what extent?
2. Which components of PBL were mainly affected by the COVID-19 pandemic?

Methodology

Participants

The study involved 69 twelfth-grade students studying electronics at a high school, divided into two groups. The first group consisted of 36 students. This group carried out electronics projects in a face-to-face mode during year 2019 (before the pandemic). The second group consisted of 33 students. This group carried out electronics projects in a remote learning mode online, during year 2021 while the COVID-19 pandemic was taking place. The two groups of students' characteristics were like those of any twelfth-grade students majoring in electronics.

Intervention

In both groups, teams submitted a project proposal at the beginning of the school year and the final report at the end. During the school year, students carried out their final project in teams of two students and under the guidance of an experienced teacher. For the face-to-face groups the challenging problem was to design and implement a system combining hardware and software as a final product based on an Arduino micro-controller board (programmable device). The product included components, such as sensors, motors and displays, and was tested with equipment (e.g., oscilloscopes and multi-meters). Figure 1 shows an example of the final project which is a baby formula-milk preparation system.

Figure 1: Prototype of baby formula-milk preparation system.

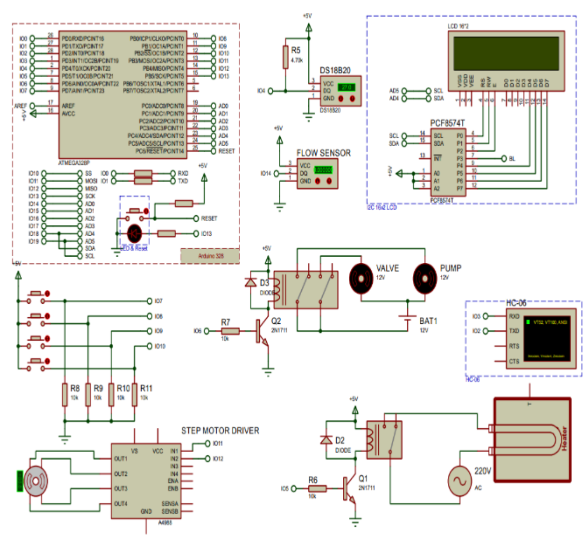

Figure 2: Electrical simulation of a baby formula-milk preparation system

For the online groups, the challenging problem was to design and implement a system combining virtual hardware and software that includes virtual products (electrical simulations) based on an Arduino micro-controller. The project was performed using PROTEUS simulation. In addition, the virtual products (simulated using PROTEUS) included virtual hardware components, such as sensors, motors and displays, as well as virtual measuring equipment (e.g., oscilloscopes and multi-meters). Figure 2 shows an example of a final virtual project (simulation) of a baby formula-milk preparation system. During the year, 14 dedicated assignments based on PBL elements and teaching practices were integrated into the curriculum (i.e., the project-based learning described above). These dedicated assignments focused on the cognitive skills within PBL, Table 1 displays a listing of the assignments and the corresponding components of PBL they covered. As can be seen from the table, each assignment group covered at least four of the seven components of PBL.

Procedure

The study included mixed methods drawing from instruments collecting both quantitative and qualitative data. Students executed projects during two different semesters that combined hardware and software. One group was in face-to-face mode and the other was in online mode. Fourteen dedicated assignments focused on PBL's seven major elements were integrated into the curriculum for each group. At the end of the school year, students took an achievement test (multiple-choice test). This achievement test was designed to evaluate students' cognitive skills corresponding to PBL components as in table 1. At the end of the year, students presented their projects and submitted final reports. The quantitative data were analyzed using an independent samples T-test between the populations of the two groups. In addition, two experts in engineering education coded the qualitative data (final reports and observations on performance and presentations) and classified them into categories using directed content analysis [29]. The analysis was based on the cognitive skills of PBL adapted for high-school electronics students. Results are shown in table 3.

Tools

An achievement test to measure students' attainment of the knowledge and skills targeted by the projects was carried out at the end of the school year. The test focused on analysis of an electronic system opening and closing a parking lot gate. This system was not part of any final project carried out by any of the teams. However, this project was within the same frame of knowledge encapsulating all projects carried out by the students. The test included 23 multiple-choice questions (one correct answer and three distractors). The questions were of equal value. The test time was limited to one-hour. Two experts in engineering education validated the test. The internal consistency of the achievement test questions (Cronbach's α =0.758) was acceptable. Two sample questions are shown in Appendix.

Another assessment tool was used, which is the collection of observations and remarks from the instructor during the experiences, particularly the final presentation and reports, as well as the remarks from students' reflections in the final reports. The reflection part was a required open category in each report where students wrote freely about their experience and the challenges they faced. Once data was collected, a statistical analysis was conducted to find out if there was any difference in performance between the two groups. IRB approval was obtained and kept on file.

Findings

Table 2 shows students' mean score *M* (ranging between 0 and 100) and standard deviation SD in both, face-to-face group and online group.

Table 1: List of assignments targeting cognitive skills in the projects vs. components of PBL

No.	Assignment / Activity / skill	Challenging Problem	Sustained inquiry	Authenticity	'Students	Reflection	Criticuqe and Rivision	Pubilic Product
1	Request for proposal within a defined frame	X	X		X		X	
2	Formulating general solution	X	X	X	X	X		
3	Formulating requirements: Students are required to formulate project requirements		X	X	X		X	
4	Suggesting several alternatives for implementing the project and choosing the optimal alternative: Each group of students offers at least 3 solutions (alternatives) for implementing the project. Then, the students in each group compare the alternatives and choose the optimal alternative.	X	X	X	X	X	X	
5	Build a block diagram and analyze the principle of operating system chosen for implementation: Students are required to build a block diagram of the proposed system and analyze the principle of the selected system of operation for implementation.		X	X	X	X	X	
6	Build the data flow diagram (DFD): Students are required to build a software data flow diagram (DFD) and describe in their words the input information, information processing, and output information of the system.		X	X	X	X	X	
7	Build the structure chart of the software: Students are required to build a structure chart of the software (describe the purpose of the modules, routines, and their relations)		X	X	X	X	X	
8	Defining the functional structure of software modules	X	X		X	X	X	
9	Build flow charts			X	X		X	
10	Writing codes	X	X	X	X		X	
11	Hardware and software knowledge	X	X	X	X	X	X	
12	Problems solving in implementing the solution	X	X	X	X	X	X	
13	Abstraction: Switching between abstraction levels (description of the software at different levels of detail), description of the software at			X	X	X		X

No.	Assignment / Activity / skill	Challenging Problem	Sustained inquiry	Authenticity	'Students	Reflection	Criticuqe and Rivision	Pubilic Product
	a detailed level and analysis of the software from different points of view (e.g. different points of view of users, analogy to another software)							
14	Final presentation and report			X	X	X		X

An independent samples T-test was carried out for all categories of skills, excluding the first and last category, between the two groups of students. The independent sample T-test revealed a significant difference in students' performance scores between the face-to-face group (hands-on) and the online group in the overall performance $t(67) = 6.41$, $p < 0.001$. Looking at the skill categories closely, as shown in table 2, there was a significant difference in students' performance scores between the face-to-face group and online group in 7 of the 12 tested categories as follows: 1) Formulating general solution; 2) Building a block diagram and analyze the principle of operating system chosen for implementation; 3) Building the data flow diagram (DFD); 4) Building the structure chart of the software; 5) Defining the functional structure of software modules; 6) Writing codes; 7) Problems solving in implementing the solution. The categories of skills for which the independent T-test did not reveal a significant difference included: 1) Formulating requirements: Students are required to formulate project requirements; 2) Suggesting several alternatives for implementing the project and choosing the optimal alternative; 3) Building flow charts; 4) Hardware and software knowledge; 5) Abstraction.

Table 2: Descriptive statistics of students' performance scores

Assignment No.	Question No.	Score	Face-to-face group (*N*=36)		Virtual group (*N*=33)		Independent samples T-test
			M	***SD***	***M***	***SD***	
2	1	4.35	4.23	0.72	1.98	2.20	$t(38.34) = 5.61, p < 0.001$
3	2,3,4,5	17.4	11.48	4.18	9.25	5.43	$t(67) = 1.98, p > 0.05$
4	6,7	8.7	6.04	2.39	5.27	3.03	$t(67) = 1.18, p > 0.05$
5	8,9,10	13.05	8.58	3.82	3.56	3.99	$t(67) = 5.34, p < 0.001$
6	11,12	8.7	6.52	2.85	4.35	3.44	$t(67) = 2.87, p < 0.01$
7	13	4.35	4.35	0.00	2.64	2.16	$t(32) = 4.56, p < 0.001$
8	14	4.35	3.02	2.03	0.79	1.70	$t(66.49) = 4.95, p < 0.001$
9	15	4.35	1.57	2.12	1.19	1.97	$t(67) = 0.78, p > 0.05$
10	18,19	8.7	5.07	3.03	3.16	3.13	$t(67) = 2.58, p < 0.05$
11	16	4.35	1.93	2.19	1.32	2.03	$t(67) = 1.21, p > 0.05$
12	17,20,21	13.05	9.67	3.62	6.46	3.63	$t(67) = 3.67, p < 0.001$

Assignment No.	Question No.	Score	Face-to-face group (*N*=36)		Virtual group (*N*=33)		Independent samples T-test
			M	***SD***	***M***	***SD***	
13	22,23	8.7	4.11	2.31	3.82	3.03	t(59.73) = 0.44, p > 0.05
Total	**23**	**100**	**66.58**	**13.02**	**43.79**	**16.34**	**t(67) = 6.41, p < 0.001**

As was mentioned, during these projects, including final presentation and reports, instructor's observations, and remarks were collected. In addition, students' remarks from the reflection part of the reports were collected as well. All these qualitative entries were grouped and categorized in relation to the assignments or cognitive skills targeted by the projects as shown by table 3.

Table 3: Observations and remarks summary from instructor and students during PBL

No.	Assignment / Skill	Summary of observations and remarks
1	Request proposals	N/A
2	Formulate general solution	Most students asked instructor for help in this part
3	Formulate requirements	Students usually work on this part individually, collect the work as a team and seek instructor input
4	Suggest alternatives	Students usually research and think about this part individually
5	Build a block diagram and analyze the operating system for implementation	- Most students asked instructor for help in building block diagram. - Most students had difficulties in analyzing the principle of operating system chosen for implementation
6	Build the data flow diagram (DFD) of the software	- Most students asked instructor for help in building the DFD of the software. - Most students had difficulties to explain the DFD of the software
7	Build the structure chart of the software	- Most students had difficulties in building the structure chart of the software and corrected the charts after the teacher's help - Most students had difficulty to explain the structure chart
8	Define functional structure of software modules	Most groups needed to consult with the instructor on this part
9	Build flow charts	Most students had difficulties in building the structure chart of the software
10	Writing codes	- We encountered some problems and difficulties related to the components of PROTEUS - It was so difficult to run the project through simulation because the components were not compatible with the practical components
11	Hardware and software knowledge	I faced many problems on hardware in PROTEUS and couldn't solve them

12	Problems solving in implementing the solution	I Always asked my instructor for helping me to figure the problems out
13	Abstraction	Most groups needed to consult with the instructor on this part
14	Final presentation and report	- It is hard to work on the project by zoom because of the bad connection - The internet connection is bad - It's hard to make tasks online with the partner - My partner does not help me with the project tasks because he claims he does not have internet at home - Some students do not respond when the instructor asks them probably because they are asleep - Most students do not agree to open cameras and some claim they do not have microphones" - It's boring to work on the project by simulation without hands-on components - In the Proteus simulation, some components were missing

Discussion

The investigation described in this paper examined whether students' performance scores (cognitive skills), targeted by PBL, were affected by the COVID-19 pandemic, which consequently indicates changes in the level of PBL effectiveness. This is particularly significant as education had to move from face-to-face into remote or online mode of delivery, causing many challenges over a short period of time to all parties involved and to the educational process itself. Therefore, performances of two groups of students, where one experienced face-to-face PBL and the other experienced remote PBL, were compared using mixed method. Moreover, an attempt was made to identify cognitive skills which were mostly affected by the pandemic, and the corresponding components of PBL. This was to be used in suggesting strategies for improving performance related to the components which were challenged. Data revealed that a significant difference, showing as retraction, in students' performance has occurred during online delivery of PBL, when compared to face-to-face experiences. This confirmed observations expressed by many educators, including the authors of this paper, from actual field data.

Results from the direct assessment method, summarized by table 1, showed that the largest difference in performance between the two groups was revealed by the independent T-test to be in the overall or combination category (last line in the table).

Investigating each category separately, the highest difference, or retraction, showed in students' performance in the following skills categories, listed by order from highest to lowest retraction levels: Category 2) Formulate general solution, Category 5) Building a block diagram and analyze the principle of operating system chosen for implementation; Category 8) Defining the functional structure of software modules; Category 7) Building the structure chart of the software; and Category 12) Problems solving in implementing the solution. Checking for the common PBL components among these five categories reveals that it is: Sustained inquiry, Students' voice and choice, Reflection, and Critique and Revision. These four PBL components require a significant amount of timely consultation, re-iteration, and discussion. In fact, this is the part of the project where challenges arise and the ability to provide a safe environment for trial and error by the instructor so students can learn effectively becomes vital to raising the level of motivation and challenge among the young minds working on the project. It is also when thrust builds up and innovative ideas start formulating. During the pandemic, and as the entire experience was moved online, students did not lose this type of environment completely, but it became more cumbersome, time and effort demanding, and dependent on external elements, to have an opportunity for fast and efficient interaction close or similar to the environment provided during face-to-face delivery mode. Moreover, the external elements were sometimes the deciding factor in building or destroying thrust and motivation in performing the projects tasks, considering that they included continuous access to reliable internet connections and efficient equipment as well as reduced distractions while working outside the classroom or school laboratory. It is worth noting that these external elements are connected to socio-economic factors which are usually brought close to equality in a school environment. These findings are supported fully by the results from observations by both instructors and students, and from students' reflections in the final reports, as shown by table 3. These indirect assessment results confirm and support the finding from the direct assessment process where the same categories of cognitive skills in table 1 are being hindered by the online experience.

In addition, analysis of the qualitative data (final reports and observations) displays that the online group had more skills' difficulties in PBL assignments because of rapid change to modes of instruction without sufficient preparation or training time by the students or instructors during the COVID-19 pandemic (Table 3).

Collectively, results revealed that students are not capable of adapting to change in instruction modes if not given a significant increase in support and communication that will generate an environment equivalent to the one in the face-to-face situation. This was impossible when the pandemic started due to schools and instructors being at capacity in terms of resources and being unprepared for change in such a short notice. Logically speaking, it is expected that repeating the remote experience might actually show improvement in performance because instructors and their schools have lessons to learn from leading to better mitigation of previous pitfalls. This expected improvement would be proportional to the response at the school and organizational level where access to advanced equipment and technological availability would be improved, combined with instructors' preparation and potentially innovation in methods of delivery. Ultimately this can bring flexibility and resilience to STEM education that is dependent on experiential learning such as PBL.

It is to be noted that students expressed dissatisfaction with the loss of interaction with colleagues and instructors. Therefore, remote communication might help ease some of these challenges, but it will not completely solve the problem unless improved and updated. Observations from the students indicate that the motivation of the students decreased, and the impact was in direct proportion to their performance and achievements, which is a direct result of time and capabilities challenges in interaction. Once timely interaction is lost, especially between students and the instructor, distractions increase, and thrust and motivation decrease, causing a vicious negative cycle to start and take over.

Conclusions

This study was set out to explore the impact of changes to students' performance and (cognitive skills) influenced by the COVID-19 pandemic and its relation to experiential learning, especially PBL effectiveness. An attempt was made to use mixed methods in finding out the change and identifying components of PBL which could be influenced the most by the change in delivery mode from face-to-face mode to remote mode. Results were to be used in making recommendations on how to overcome the challenges created by this change over a short period of time.

Results from different sources showed a deterioration in students' performance during PBL as instruction moved from face-to-face into remote mode. Components of PBL requiring significant interactions, timely response, re-iteration, and discussion were challenged the most. Capitalizing on knowledge of remote learning issues and challenges, some of the negative effects from these issues could be alleviated but not eliminated completely. The sudden change over a short period of time revealed a lack of preparation for such calamities in exiting education systems and the need for further considerations and development. Other areas in need of most attention were also partially revealed by this investigation which includes investment in infrastructure such as internet access, capacity, and equipment, as well as in teacher training. Constant communication and versatility in using remote delivery tools can help as well. Innovative methods relying on new technology such as AI and VR are desperately needed to revolutionize education on the long run, but for now, access seems to be a pressing issue in both the technical and social sides.

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Appendix – Achievement test

The multiple-choice test mentioned in the Tools Section for the purpose of evaluating students' performance in cognitive skills consisted of 23 questions. As described below, the test was given at the end of the school year. The aim was to analyze a system that integrates hardware and software:

> In one school, the principal requested that a mobile phone be used to open and close the parking lot gate. Whenever a member of the school staff wanted to open the parking lot gate, they could dial a certain number and the gate would operate by a 24V DC motor. If the gate opens, the system waits for 12 seconds, and if a proximity sensor detects no one goes through, the gate automatically closes. The gate would be equipped with two position sensors. One sensor would indicate that the gate was completely closed, and the other would indicate that it was completely open.

There are four secondary functions called by the main function:

1. Car_Gate - This function evaluates if a vehicle crossed the gate;
2. Order_Gate - This function evaluates if a gateway request is received;
3. Con_Gate - This function determines whether the gate is fully open, closed, or partially open; and
4. Open_CloseGate - This function opens/closes the gate.

Following are two sample questions:

1. What change needs to be made in the system when we are interested in rotating the DC motor at different speeds?
   A. Replacing AC driver instead of DC driver.
   B. Connect the driver to outputs that behave as analog outputs using the PWM method.
   C. Connect an AC amplifier instead of the driver.
   D. Connect Relay instead of the driver.
2. Which line has a syntax error in the software code as shown in figure 3?
   A. 8
   B. 24
   C. 10
   D. 11

```
1. int val = 0;
2. int Car_Gate();
3. void Open_CloseGate();
4. void setup() {
5.   pinMode(4, OUTPUT);
6.   pinMode(5, OUTPUT);
7. }
8. void loop () {

17.   }
18.   else if(st==0) {
19.     digitalWrite(4, LOW);
20.     digitalWrite(5, HIGH);
21.     delay(10000);
22.   }
23. }
```

```
  Open_CloseGate();
}
void Open_CloseGate() {
  int st = Car_Gate();
  if(st==1) {
    digitalwrite(4, 0);
    digitalwrite(5, 1);
    delay(10000);
```

```
Car_Gate() {
  int s;
  val = analogRead(A0);
  if(val>200)
    s = 1;
  else
    s = 0;
  return s;
}
```

Figure 3: Software code