Impacts of IT-related group tasks on capacity building of young scholars

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ABSTRACT

Preparing, assessing group tasks and dividing them among students are challenging issues as efficiency of group-based learning may differ from one field of study to another. Therefore, managing group works in classes and assigning roles to each learner may be specific for each discipline. Moreover, as information-communication technology is being implemented and constructively used in almost all the areas of industry, teaching methods should include IT-based tasks to assure quality learning. In fact, group works should also target computer literacy of students. In this context, this paper presents implemented methodology and achieved results in introducing IT-related group works intended for students of Young Scholars' Council of higher educational institution. Group tasks were prepared in a way that each task required technical background of each member. Because the main goal of the research was to analyze the effects of both computer-based group tasks and backgrounds of students on the IT-related capacity building, knowledge and skill development of each another. Young scholars were selected from various engineering disciplines among distinguished students.

CCS CONCEPTS

• **Computer Uses in Education;**; • **General;**;

KEYWORDS

IT-based group works, project-based learning of young scholars, capacity-building tasks

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1 INTRODUCTION

Creating a scientific environment or medium for students where they can develop new skills and deepen their knowledge by practicing as a group is one of the most important inputs to the education. Because, in this way students learn how to learn, work as a group, develop their capacity, use their potential, find out solutions and search new information. These abilities or skills can be determined as the main goals which undergraduate education aims at. Moreover, gaining computer or digital literacy of engineers is one of the main job market demands as IT solutions are being implemented in all industrial sectors including engineering fields [1]. In this regards, in many universities all over the world there exist student organizations, scientific teams and groups of young scholars. Similarly, by the initiative of the Esteemed President of Turkmenistan, in 2017 there was created a Center of Young Scholars near the Academy of Sciences of Turkmenistan and the Central Council of the Youth Organization of Turkmenistan named after Makhtumkuli. Moreover, at each higher educational and scientific institution of the country, there were established Young Scholars' Council (hereinafter, the Council) in order to create the scientific environment for the reasons mentioned above.

The Council serves as a place where young scholars work together on scientific projects, work out software and develop smart solutions. In order to collect necessary information and deliver announcements, there exist a web page of the Council. Therefore, selection of young scholars to the membership of the Council at State Energy Institute of Turkmenistan is carried out by analyzing their backgrounds, cumulative GPA and project proposals after candidates apply for the membership through the web page.

As there are various disciplines at the institute such as information technology, power engineering, electronics, automation and electro-mechanics, members of the Council consists of undergraduates with different technical backgrounds. Therefore, taking this integration as an advantage, the research aimed at improving the IT-based capacities of young scholars by assigning them IT-related group tasks, solutions of which were only possible by the help or contribution of each group member. Implemented POWER (preparation-orientation-watching-evaluation-rearrangement) methodology and achieved results of the research are presented at this paper.

2 LITERATURE REVIEW

In a group learning, the strategy of dividing the task among group members and therefore individual assessment plays an important role. Therefore, as an author of an article [2] suggests that while evaluating the results of group work, instructor or teacher should decide what to evaluate, process or result, and how to evaluate. In this regards, problem-based learning, a type of group learning, was found out to be more effective for long-term duration [3]. Therefore, it is better to use ICT-related group works out of the class activities. In our case, this point was also taken into account and group tasks were carried out in the Council. Moreover, as authors of the paper [4] point out, individual accountability is significant in order to increase members' contributions to the group tasks and make each student a stronger individual. They also underline that a method called Learning Together, which fosters input of each individual, is more constructive than individualistic and competitive learning. Although students learning in a group may increase their capacities such as knowledge development, social interaction skills and course comprehension [5], it is not easy for teachers or instructors to choose an appropriate type of group-based learning for IT-related tasks. Therefore, several researches have been carried out which are dedicated for ICT integration of undergraduate curricula. For instance, in the paper [6], there was developed a curriculum that aimed at not only topic comprehension but also gaining computer skills through ICT-based individual works. Similarly, authors of the paper [7] worked out computer-assisted exercises for students to develop their creativity. On the other hand, research results in [8] indicate that achieving course objectives becomes more efficient if the course is integrated with computer-assisted project-based teaching. Moreover, in the dissertation work [9], the results of the research on computer-assisted instruction using PLATO (Programmed Logic for Automated Teaching Operations) software showed the advantages of IT-based group learning over traditional instruction in Business Education course. However, the PLATO did not consider knowledge levels of students, in fact, authors did not sort students by their backgrounds. Likewise, in the paper [1], there was carried out a research on the efficiency of programming-based group assignments prepared for the students of the same field. Unfortunately, still there are few scientific works about group-based learning on the effect of IT-related tasks for distinguished students or young scholars with different engineering backgrounds. Therefore, within the research being presented in this paper, young scholars from various technical disciplines were selected as group members and they were assigned IT-related or computer-aided group tasks. By doing so, capacity-building skills of young scholars were improved through newly developed appropriate instructional tool which is called POWER methodology.

3 DESCRIPTION OF THE METHODOLOGY

Selected young scholars were already expected to have solid background in their specialty, however they were still lacking IT-related skills which are compulsory factors for each specialist to withstand in digital era. Therefore, the POWER methodology was developed in 2021 by the Council of our institute to assess and foster young scholars' computer-related capacity-building skills in regards with the learner-centered multidisciplinary group tasks and knowledge exchange of group members. As this methodology is learner-centered one and it is intended for distinguished young scholars, it gives students enough freedom by excluding lecturer interruption in task completion stage so that students can improve their IT-related

Figure 1: Stages of POWER methodology

capabilities by doing, searching, applying, discussing and experiencing trial-errors. Therefore, the main tasks of lecturer in POWER methodology are to select appropriate young scholars, prepare IT-related interdisciplinary group tasks and develop valid assessment tools.

The underlying concept of the proposed and tested POWER methodology or cycle consists of five phases:

I. Preparation: preparing IT-related group tasks or projects which require integration of various engineering capabilities. This phase demands interdisciplinary skills from lecturers as project tasks are expected to contain both engineering knowledge and IT competencies. Here, skills-table can be worked out for each task and member in accordance with his/her engineering background;
II. Orientation: selecting young scholars from different engineering fields in accordance with the group tasks and creating groups consisting of one member from each discipline. Each group is given clear instructions and necessary materials to carry out the task;
III. Watching: delivering tasks and necessary materials to groups, observing attentively how group members perform the tasks. After instructions are given and the group starts carrying out the tasks, the lecturer is isolated from the group and his/her role in this stage includes taking notes on how group members contribute, and monitor the process. That is why this step is called "watching";
IV. Evaluation: evaluating results and assessing each individual's capacity-building, especially IT skills. In this stage, feedbacks of group members are also taken into account using tools such as Google Forms. Moreover, the completed IT-related tasks are graded according to quiz or essay results and previously prepared reference sheet. In other words, computer-based capacity development of young scholars in relation with the group tasks and group members are evaluated;
V. Rearrangement: interchanging group members or assigning different tasks to groups and repeating the cycle. This phase is optional. If necessary to monitor and assess performance of young scholars repeatedly in order to guarantee validity, new groups can be created with different group members.

As it can be seen from the stages of methodology which are listed above and shown in Figure 1, the role of the instructor differs in each stage.

Table 1: IT-based group tasks and distribution of duties among group members

Task name	Task description	IT-related common objectives of the tasks	Expected common inputs (contributions) from each group member
Working out gas alarm system	Developing a project for detecting gas leakages by the help of gas sensor, and preventing possible disasters	to understand basics of programming; to build an algorithm of the project; to assign variables in programming; to use software libraries; to work out a software of the project; to carry out mathematical operations in programming; to draw 3D model of the project.	ACTS students select necessary sensors, modules, and build the hardware; CMIS students develop programming part; MSD students build the circuit model and select necessary microprocessor; EM students deal with electrical part and power maintenance issues.
Designing a plot-clock	Working out a construction of a plot-clock using 3D printer and other necessary tools		
Projecting a solar tracker	Designing a solar tracker for obtaining efficient power output from solar panel		
Printing a logo of the institute using CNC machine	Building a CNC machine to draw the logo of the institute on a paper		

The reference sheet used to grade members is prepared in accordance with the intended IT objectives. Thus, in order to assure reliability, the sheet and quiz must contain points on specific IT skills. This methodology is challenging for both lecturers and students as it serves as an encouragement to improve life-long learning abilities of students. Therefore, the result of the methodology is expected to yield fruitful results in terms of improved IT-skills and self-esteem of young scholars.

4 TESTING

The POWER methodology was implemented and tested in the fall semester of 2021-2022 academic year among the undergraduate students from different engineering fields. Firstly, in the Preparation and Orientation stages, in order to encourage participation of young scholars in the teamwork, among engineering students, there were announced the conditions of the group tasks and a prize for the best group, carrying out those IT-related tasks. Then, by the help of the website of the Council, information about the candidates and their achievements was collected. In total, from 4 different disciplines, 20 students were selected to the membership of the Council and they were divided into 4 groups, each consisting one student from each discipline. In fact, young scholars were selected from the following specialties:

1st discipline: "Automation and control in technical systems", abbreviated as ACTS;
2nd discipline: "Complex maintenance of information security of automated systems", abbreviated as CMIS;
3rd discipline: "Microelectronics and semiconducting devices", abbreviated as MSD;
4th discipline: "Electrical maintenance", abbreviated as EM.

Afterwards, in accordance with the engineering backgrounds of the students, four different tasks, aiming at IT-based capacity building of young scholars, were worked out as shown in Table 1.

Then, in the Watching stage, all four groups were delivered the IT-related tasks, given instructions on what to do exactly, and time limit to complete the task was set. As shown in Figure 2, young scholars were left to do the tasks by themselves, i.e. lecturer's role in this phase was to take notes and observe attendance of each member, after maintaining them with the set of equipment, course books and supplementary computer programs to develop the software part of the projects. Moreover, in order to develop their problem-solving and capacity-building skills, access of students to the internet, in the place where the projects are being carried out, was also denied throughout the task completion process. Therefore, in theory, each group had the same opportunity and enough material to complete the task.

At the end of the project-based IT-related tasks, in fact at the Evaluation stage, project results were analyzed and each member was expected to explain the working principles and software of the task in order to grade their programming or IT-based capacity-building skills. Moreover, Google Forms was used to assess the efficiency of the POWER methodology. In this regards, Moodle platform was also used for essay-type and multiple choice questions. Surprisingly, after the tasks were completed, young scholars themselves wanted to change their groups so that they can deepen their knowledge on computer sciences by exchanging experience and performing other tasks. Therefore, by rearranging groups, the cycle was repeated.

5 RESULTS

In order to assess validity level and efficiency of the POWER methodology, young scholars' IT-based knowledge, especially those related to the objectives indicated in Table 1, was tested prior to and after the task completion with different but identical questions. The results of Google Forms and quizzes, carried out using Moodle platform, showed that the POWER methodology is an efficient tool to encourage young scholars to learn by themselves and gain IT-related capabilities. Because the average result of the quizzes increased by 35%. In fact, pre-task result was 53% while post-task result was around 88%. Moreover, participants anonymously wrote constructive feedbacks in the form. Some of them are as listed below:

Figure 2: Task completion process – Watching stage of the POWER cycle: a) CMIS student dealing with the programming part, b) MSD student modelling the circuit of the project, c) ACTS student printing the components of the plot-clock using 3D printer, d) connecting the elements (duty of EM student)

The task was interesting and it helped me to learn printing 3D models and generating ".gcodes";
As young scholar, I was satisfied with this project because it taught me learn by doing;
This project was like puzzle, necessary materials were accessible and we build the project by using them;
It made me to learn the computer or software part of my major;
While trying to complete the task with my group members, I learned how to develop software of our project and upload it to the micro-controller;
This method of studying the out-of-the-class tasks was helpful for me to exchange experience, and learn from books and from my group-mates.

The comments on the form obviously showed the willingness of young scholars to deal with IT-related multidisciplinary and complex projects. As shown in Figure 3, each group managed to complete their tasks but within different time interval.

While performing above-mentioned tasks and building the devices shown in Figure 3, young scholars also managed to print some components using 3D printer. Considering the functionality of the device, quiz results, lecturer notes and level of comprehended IT objectives, second group which designed the plot-clock was selected as a best group and each group member was awarded with individual prizes.

6 CONCLUSION

As mentioned before, the aim of the methodology was to develop an instructional tool that can be used in directing young scholars to develop their IT competencies through multidisciplinary project-based learning. As instructional methods and scientific papers intended for distinguished students are few although indispensable, this methodology is important to guide and foster young scholars to self-learning. Testing or implementing the methodology yielded fruitful results. Therefore, the POWER cycle can be used in other fields in order to guide young scholars, teach them learning by doing, and improve their IT-related competencies.

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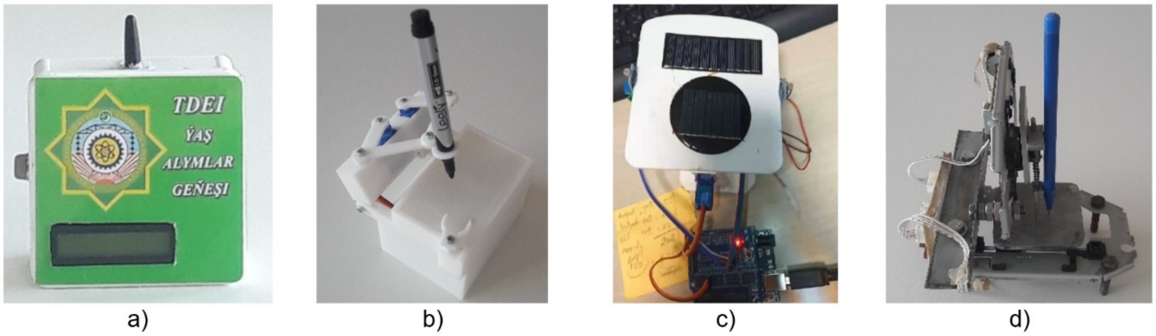

Figure 3: Completed tasks: a) gas alarm device, b) plot-clock, c) solar tracker, d) CNC machine

Central Asia through new technologies (HiEdTec)". The research was carried out at the IET center.

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