Experience in Evaluating the Educational Results Obtained by Students Carrying out an Educational Group Project

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Abstract: We have established that one of the main problems in the adaptation of graduates is the problem associated with the collective nature of future work, and the lack of appropriate competencies among young specialists. Also, we have developed and tested an assessment methodology an individual work of students in an educational group project, using web-service Trello based on the subject "Fundamentals of collaboration in IT". Unlike others, the described assessment methodology allowed to increase the objectivity of the mid-term and final test results of both the students' work and the group work. Also, it allowed to track and direct students' activities to such an educational group project result that harmonizes their capabilities with requirements. Web-service Trello used for a group project allowed to quickly identify problems at all its stages, deploy resources rationally, avoid the "emergencies", complete tasks on time, and organize constant feedback among all members of the group and the tutor. The tutor's ability to track all the activities of each student and the group as a whole is one more benefit of using web-service Trello. As a result of the students' educational group project, they have developed the ability to work in a team.

Keywords: *an educational group project; assessment methodology; «soft skills»; Software Engineering; web-service Trello.*

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1. Introduction

Nowadays, employers need specialists with work experience and an existing range of professional knowledge with developed “soft skills” that significantly increase labor efficiency. Recent labor market research by Kautz et al. (2014) reflects a notable trend of significant employer interest in “soft skills” in those seeking a job. Most employers consider them as important as professional knowledge and skills. The study by Ivanova & Skornyakova (2018) shows about 16 thousand specialists in the field of information technology graduate from Ukrainian educational institutions annually

Software engineering has a special place in the list of IT majors. Experts say that one of the main problems of young software developers in IT companies is the problem associated with the collective nature of software development and almost complete lack of skills and knowledge they need for working in a multidisciplinary team. So, the modern educational paradigm encourages us to search for new teaching methods and tools that would provide an appropriate level of mobility for a specialist in mastering both «hard skills» and «soft skills». According to the recommendations on teaching software engineering (SE, 2014), education should be conducted using appropriate modern methods and tools, even if these tools are not the purpose of training. In our opinion, these issues can be resolved through the introduction of group training using modern project management software, in particular, an educational group project with web-service Trello (Trello).

2. Literature overview

The idea of project-based learning suggests organizing education on an active basis, through the student's interest in gaining certain knowledge to achieve the goal. A group project is an active form of learning, where practical activities help understand the subject under study Polat (2007). Theoretical and applied research on group learning shows that it increases students' mental activity and deepens their field of knowledge (Entwistle et al. 1988; Fearon et al. 2012; Huff, 2014) students quickly adapt to the specifics of the profession (Normane et al. 2004; Jackling et al. 2009), they learn based on experience and co-education (Mahenthiran et al. 2000; Barron, 2003), develop group work skills (Ballantine et al. 2007; Hannaford, 2017). Despite of all the advantages of group work, there is a number of problems that impede its introduction into the educational process of universities, among which is low motivation of students and tutors (Morgan,

2002), free-riding (Strong et al. 1990; Brooks et al. 2003; Maiden et al. 2011), unpreparedness of tutors and students (Norman et al. 2004; Davies, 2009), the vague logic of achieving goals; poor relations between the activities, tasks, and goals of the project; lack of a schedule for the project activities and tasks; determination of necessary resources “by eye”; lack of resources distribution according to time and tasks; non-use of objective criteria for the plan implementation (Lazarev, 2011); the lack of objective metrics for measuring the group project results because a visual overview of intermediate results is often unavailable (Tucci, 2008; Volkov et al. 2015). It's difficult for the tutors to control the students' progress of the project. But it is especially difficult to evaluate the contribution of each group member to the final result.

Bublik, Aphonin & Borozeni (2008) in their article considered the problem of coordination of the group and individual education forms in the process of future software developers training. The authors propose a model for group work evaluation, which is based on the requirement for all performers to work efficiently, creatively and responsibly. The resulting student assessment in a team may depend on the results of cooperative activities, mutual evaluation, time worked, and each participant's relationship in a common matter. To assess the “good faith”, the authors propose using coefficients that, in their opinion, will increase the objectivity of the assessment.

Conway et al. (1993) offer an approach in which students freely evaluate the individual contribution of team members, and then these estimates are taken into account when calculating an individual student score. Additionally, the author proposes to ensure the anonymity of the team members' assessment, which leads to greater objectivity and does not compensate for the low rating of an individual student at the expense of other students.

Brooks et al. (2003) offer a time-consuming technique for assessing the individual work of students, in which students anonymously evaluate their group members in accordance with the instructions given on a prearranged assessment sheet template. They conduct such an expert assessment every four weeks; the total grade is averaged. Instructor's grade was averaged according to the group average. As a result, students receive grades from their group members and tutors. Davies (2009) modifies the technique by Brooks et al. (2003) and proposes a one-time expert assessment instead. According to his method, students assign a percentage grade to their

group members; if its value is lower than 90% a meeting is held between the group and the tutor where they reach consensus on the grades given. This method allows one to increase the evaluating objectivity of the student activities in the group. The study conducted by Sridharan et al. (2019) indicates a significant bias in the grades of group mates when they give the final grades themselves. This fact raises a question about the appropriateness of using peer-to-peer ratings for a final assessment. However, the students' evaluating their group member activities allows them to develop soft skills and evaluative judgement ability.

Rainsbury et al. (1998). propose an approach in which a group project is evaluated by a student, employer, and research advisor. Upon completion of the project, the three parties meet to agree on a final evaluation of the project. It can be noted that the use of such a rating system for large teams may not be very effective since the relationship between personal contribution and the final result of joint work is leveled out by numerous intermediate links.

Published work analysis on the implementation of the group project method in the educational process and personal experience revealed that one of the limiting factors for an objective assessment of a group project is the four-mark grading system ("excellent", "good", "satisfactory", "unsatisfactory") that is adopted in the Ukrainian higher education system. On the one hand, the four-mark grading system has some obvious advantages: intuitiveness, ease of use, methodological mastering, psychological familiarity, relative accuracy. On the other hand, it lacks quantitative criteria and has insufficient differentiation of activity levels in a group project. The lack of quantitative assessment criteria leads to the fact that the grades are relative and do not correspond to different levels of student activity. Therefore, in modern conditions, the qualimetric approach, which reduces the degree of subjectivity of assessment, is becoming increasingly relevant.

The second limiting factor is the tutor's lack of ability to evaluate each student's contribution in the overall result. To achieve the goals in the framework of design planning decisions in production, special project management tools are used, the main functions of which are the placement and tracking of tasks, as well as the distribution of resources within the project.

Therefore, for the educational group project organization in the field of engineering a variety of information technologies are used. The study

conducted by Prevedello et al. (2018) shows the experience of using a virtual environment to monitor students' group projects where they are taught the basics of electronics design. A virtual environment allows one to systematically monitor activities in mail archives, wikis and file sharing systems; it provides the basis for a detailed visual and quantitative analysis of the students' activities. Grytsenko et al. (2014), showed practical experience in using the version control system Git for the thesis proper organization and fulfilment within the framework of a more complex project.

Maněna et al. (2014) carried out a comparative analysis of modern means of organizing group projects. The testing analysis showed that the Trello met the requirements set by the researchers most fully. The work of Naik, Jenkins & Newell (2019) demonstrated the experience of applying the Agile Scrum methodology with the implementation of the Trello not only for teaching and learning but also for the development of real projects. An experimental report on the use of the Trello to support the Scrum process and the Kanban board for the professional development of teachers was demonstrated in operation by Parsons et al. (2018).

Given the above, **the purpose of the research** is to develop and tested an assessment methodology an individual work of students in an educational group project using Trello based on the subject "Fundamentals of collaboration in IT".

3. Research methodology

The object of the study is the student performance as a result of the educational group project completion using Trello. The purpose of the study is to evaluate students' activities in an educational group project within the framework of the subject "Fundamentals of collaboration in IT" using the capabilities of the Trello.

An educational group project is based on the subject "Fundamentals of collaboration in IT", which first-year students majoring in 121 "Software Engineering" study in the second semester according to the educational program. The educational objectives of the project stem from the educational program and are reflected in the subject syllabus. Comprehensive goals include the ability to apply knowledge in practical situations; the ability to learn and master modern knowledge; the ability to search, process and analyze information from various sources; the ability to work in teams. Professional learning objectives include the ability to algorithmic and logical thinking, the ability to possess knowledge and apply

the necessary tools to raise awareness; training and sustainable development; the ability to act creatively developing applications and choosing appropriate technical solutions; the ability to make informed decisions in emotionally stressful situations choosing the appropriate actions necessary to minimize the working impact. The research involved first-year students studying C++ and C# and having experience in developing Windows applications in Microsoft VS 2015. The experiment was being conducted for 3 years from 2017 to 2019. The total number of students participating in the experiment is 102 students, 85 students of whom are boys, 17 students are girls. The first limiting factor in experimenting lied in students' different training levels. For team members to have different skills, previously all participants were grouped into three groups based on expected performance. The average score based on the exam results for the first semester was used as a selection criterion. There were students with an average score of 90-100 in the first group, students with an average score of 75-89 in the second group, and students with an average score of 60-70 in the third group. As a result, teams that were uniform in performance were formed (the total number of students was 102). It was not possible to form teams homogeneous by gender and ethnicity due to the small number of girls (16.6%) and students from neighboring countries (5%). Nevertheless, girls and foreign students were distributed in the project throughout different teams.

Before conducting the study, all the students were informed that they could refuse to participate in the study without any consequences for their academic status in accordance with the provisions on academic goodwill of Kharkiv National Aerospace University (2019).

The second limiting factor was the timing of the project. An educational group project was implemented within the frameworks of the subject "Fundamentals of collaboration in IT", which is taught in the 1st year, the second semester according to the curriculum of bachelors majoring in 121 "Software Engineering". Project implementation time is one week.

To assess the students' individual activities, we determined the criteria for their assessment based on the qualimetric approach, which is described below. Next, to assess the students' academic performance, we determined the students' performance rating using the following scale: low level (0.6-0.74); middle level (0.75 - 0.89); high level (0.9 - 1) (Chernovol-Tkachenko, 2013).

Each group in the project had to develop a "Crossword" Windows application. Students used VS 2015, C# programming language. To develop

a thematic crossword puzzle, students were asked to use scientific terms that are the names of some concepts in the field of software engineering and were mastered by them in the first semester when studying such subjects as “Fundamentals of programming”, “Fundamentals of software engineering”. For organization, communication and monitoring of students’ group work Trello web service was used. During the project, all participants worked individually on a personal computer or laptop with Microsoft VS 2015 installed. All computers had Internet access. Students were previously registered in the Trello system.

Testing of the assessment methodology of the students' individual activities in an educational group project includes the following stages. 1) The students get acquainted with the purpose of the group project, its main tasks, timing, recommendations regarding the distribution of roles in the group, individual and group activity planning. Also, the students get to know the evaluation criteria of their individual activities using LMS Mentor (2019). The students carry out a group project during the week in accordance with the given requirements. 3) The tutor monitors the activities of the students individually and in groups using the capabilities of the Trello web service, providing feedback to the students if necessary. Also, the tutor evaluates the interim students’ individual activity in accordance with the developed criteria and indicators in the Trello web service (2019). 4) In accordance with the schedule of the group project, the presentation of the project results takes place in the presence of other groups. 5) The results of the students’ individual work are exported to an electronic journal of the students’ academic performance using LMS Mentor (2019). 6) The tutor analyzes the students’ learning outcomes and adjusts his/her activities related to the organization of the educational group project.

To register all the data necessary for the students’ individual activities assessment, we developed a MS Excel template in accordance with the interim activities criteria and the final assessment of a group project. In the template, the columns of the table contained information about the students whose individual activity was evaluated, the name and the importance of the factors being assessed, and the criteria indicators in the Trello web service. The template allowed us to automate the calculation of the student’s individual assessment. The grades generated in the MS Excel were exported to an electronic journal of the students’ academic performance using LMS Mentor (2019).

Research methods were the following: methods of qualimetry; pedagogical experiment carried out in the laboratory under the tutor's supervision; interviewing of the students. To assess the students' work in a group project we used the final grade, which was calculated by the assessment methodology; absolute performance (Aas), as well as the quality of performance (Qas) which are determined using the formulas described in «The Regulation on the students' profound knowledge assessment" (2019):

$$Aas = ((N - N_2) / N) \cdot 100\% \quad (1)$$

$$Qas = ((N_4 + N_5) / N) \cdot 100\%, \quad (2)$$

where:

N is the total number of grades;

N₄ - the number of "good" grades;

N₅ - the number of "excellent" grades .

To identify the main difficulties in the group project implementation as well as its positive aspects, we developed a questionnaire in the Mentor system, which we use in the educational process (2019).

4. Students' individual activity assessment methodology in the educational group project

The result of an educational group project should be attributed to complex multidimensional objects, to assess the quality of which comprehensive assessments should be applied. To obtain information on the qualitative state of any object, it is necessary to have its quantitative characteristics. We can obtain such a characteristic based on the qualimetric approach (Garry et al. 2015).

A qualimetric approach involves the division of complex, multicomponent phenomena into their main components (factors). These factors, in turn, were represented by a set of simpler indicators (criteria) that will be quantified. For the students' individual activity assessment in a group project we selected some factors on the basis of the activity formula developed by Bespalko (1995) who focused on the scientific research of Davidov et al. (1996). These are the following: 1) factors by which we accept students' activities in a group project according to the educational objectives of the project; 2) the criteria by which we adopt a set of simpler educational actions for the fulfillment of the educational task, and which are subject to quantification; 3) criteria indicators, which are displayed in the Trello web service interface and allow to determine the degree of the criterion used.

According to the purpose of an educational project, we have selected factors that unfold the parameter. We selected a total of 5 factors, and 16 criteria detailing these factors. When choosing the factors and criteria, we focused on the fact that one of the most significant indicators should be the student effectiveness in the group as well as the group productivity as a whole. The next step was to determine the significance of each indicator. We applied the method of expert assessments for it Garry et al. (2015). We invited tutors from the Software Engineering Department as experts. A formed expert group of 10 tutors took part in the examination of the basic set of factors and criteria using the “strict ranking” method (Raikhman, & Azgaldov, 1974). Accepted peer review assumptions: experts are isolated from each other; there is no feedback. As a result of the examination we obtained weighting coefficients of each factor and criterion. The degree of agreement among experts was evaluated by the Kendall coefficient. The coefficient value equal to 0.81 indicates that the degree of agreement among the experts is high (Katrenko, Pasichnik, & Pasko, 2009, p. 13). The rating of each factor is defined as the rating sum of products for each criterion and corresponding weighting coefficients. It was developed five factors: the “Group creation” ($M_1=0.07$), the “Group communication” ($M_2=0.28$), the “Program Development” ($M_3=0.32$), the “Crossword development” ($M_4=0.19$), the “Project presentation” ($M_5=0.14$). The rating of an educational group project result is defined as the sum of parameter ratings. A comprehensive rating comprises the weighted arithmetic dependence Chernovol-Tkachenko (2013, p. 44).

$$F = M_1 (V_1K_1 + V_2K_2 + V_3K_3 + V_4K_4) + M_2 (V_5K_5 + \dots + V_9K_9) + \dots + M_5 (V_{15}K_{15} + V_{16}K_{16}), \quad (3)$$

where:

$M_1, \dots, M_5$ – weighting of factors as a decimal quantity;

$V_1, \dots, V_{16}$ – weighting of criterion as a decimal quantity;

$K_1, \dots, K_{16}$ – the degree of the criterion development in the activity evaluated.

High level. *The “Group creation” factor.* The student is actively involved in choosing the group name, selects an avatar, creates a Trello board. He independently rationalizes and selects tasks to achieve the project goals, creates cards with tasks in accordance with the requirements. Also, he independently plans monitoring activities in the group; defines functional roles in a software developers group.

The “Group communication” factor. The student independently clearly and logically expresses his thoughts. He autonomously makes informed decisions in emotionally stressful situations choosing the appropriate actions necessary to minimize the working impact, and convinces other team members of the correctness of the decision. The student expresses positive expectations from the teamwork and trusts other team members. He does not ignore the opinion of other group members, respects the opinions of others and tries to take it into account. The student adapts to the rhythm of the team according to the planned deadlines for the tasks and the project in general. Also, he actively participates in all daily meetings and the final meeting, in the discussion of problems. The student independently creates repositories in the form of intermediate results personalized catalog on Google disk, and places links to access the catalog on the activity card. He demonstrates effective work in a group and manages conflicts in the process of software product development.

The “Program Development” factor. The student is not limiting himself to the scope of the program and textbook. He applies a wide range of knowledge from additional scientific and technical sources in the process of the program code development. The student independently determines the input/output data and each command in the algorithm as the only possible action of the executor. The student independently sets a name for the function, explains the meaning of the function, as well as the order and meaning of the arguments. He implements the separation of commands and requests, as well as the handling of exceptional situations. The student independently develops informative comments. He develops test specifications and documents them; implements code testing. The student documents the test results and independently refactors the code in case of error. *The “Crossword development” factor.* The student independently searches, processes and analyzes information from various sources. He selects terms from the software engineering field and creates information source links. The student independently formulates instructions for guesses, eliminating the possibility of ambiguous interpretation. *The “Project presentation” factor.* The student independently demonstrates professional and ethical responsibility for engineering decisions. The student independently determines the goals and objectives of the presentation. He determines the structure, content, and duration of the presentation. The student designs each slide and defines the animation of the slide elements as well as their transitions. He takes an active part in the presentation rehearsal. The student takes part in the project

presentation. During the presentation, the student behaves naturally and gains mutual understanding with the audience. He answers the questions from the audience correctly.

Middle level. *The “Group creation” factor.* The student selects the group name, and an avatar; creates a Trello board but not always independently. He justifies and selects tasks to achieve the project goals on his own with the help of more educated group members; creates cards with tasks in accordance with the requirements; tries to independently plan monitoring activities in the group. With the help of other group members, he determines the functional roles in the software developers group. *The “Group communication” factor.* The student tries to clearly and logically express his thoughts and convince other team members of the decision correctness, expresses positive expectations from the teamwork and trusts other team members. He does not ignore the opinions of other group members, respects the opinions of others, but does not always try to take them into account. In general, the student tries to adapt to the rhythm of the team according to the planned deadlines for the tasks and the project, but not always independently. He tries to control his emotions and understand the emotions of others, but not always successfully. He tries to identify his mistakes and takes into account different points of view of the group members. The student tries to confirm his opinion with arguments, but not always successfully.

He doesn't make independent decisions in emotionally stressful situations but relies on the appropriate actions of more educated group members that are necessary to minimize the working impact. He tries to participate in all daily meetings and the final meeting, and the problem discussions. The student is not always able to anticipate the consequences of his influence on the project outcome. He creates repositories in the form of intermediate results personalized catalog on Google disk and places links to access the catalog on the activity card. He demonstrates the prevention and resolution of conflict situations.

The “Program Development” factor. The student independently develops an algorithm according to requirements. He develops the program code based on the teaching aids, methodological recommendations and additional sources of information. The student tries to independently set a name for the function, explain the meaning of the function, as well as the order and meaning of the arguments. He implements the separation of commands and requests as well as the handling of exceptional situations. The student

independently develops informative comments on educational and methodological recommendations. He develops test specifications and documents them; implements code testing. The student tries to document the test results and independently perform code refactoring in case of error. The student sees the flaws in the program code, but not always independently. *The “Crossword development” factor.* The student searches, processes and analyzes information from limited sources focusing either on the average level of the entire group or on individual student categories. He selects terms from the software engineering field and creates information sources links, limiting himself to the curriculum and textbooks. The student attempts to briefly formulate instructions for guesses, eliminating the possibility of ambiguous interpretation, but not always successfully. *The “Project presentation” factor.* The student demonstrates professional and ethical responsibility for engineering decisions. The student is trying to independently determine the goals, objectives, structure, and content of the presentation as well as its duration. The student designs each slide and defines the animation of the slide elements, and their transitions, but sometimes with the help of more educated students. He participates in the presentation rehearsal, but he is not always ready. The student takes part in the project presentation. During the presentation, the student tries to behave naturally and gains a mutual understanding with the audience. He answers the questions from the audience, but not always independently.

Low level. *The “Group creation” factor.* The student formally takes part in the choice of a group name, avatar, and the creation of a Trello board. He does not justify and choose tasks for achieving the project goals but creates cards strictly according to the instructions and requirements. *The “Group communication” factor.* The student does not express his opinion and does not convince other team members of the decision correctness. He ignores the opinion of other group members and does not try to take it into account. The student does not try to adjust to the rhythm of the team according to the planned deadlines for the tasks and the project. As a rule, the student performs tasks with constant external control. He does not focus on the consequences of his actions in different situations. He does not make informed decisions in emotionally stressful situations and does not see the need to confirm his opinion with arguments, and does not take into account the opinions of other team members. The student does not analyze his actions, mainly due to the lack of a conscious need for self-reflection. The stereotype of his rightness prevails in the student’s consciousness. He

predominantly acts autonomously, and does not establish contact with other group members, but does not participate in daily meetings. With the tutor's help, the student creates repositories in the form of intermediate results personalized catalog on Google disk and places links to access the catalog on the activity card. *The "Program development" factor.* The student develops a program code based on the teaching aids and methodological recommendations with the tutor's help. He develops an algorithm according to the instructions and requirements. The student creates a program code and comments on the code by copying information from other group members. He formally implements code testing and code refactoring in case of error. The student does not see the flaws in the program code and does not listen to criticism from other group members. *The "Crossword development" factor.* The student searches for information in limited sources. He selects terms from the software engineering field, but does not make references to information sources; he limits himself. He does not try to concisely formulate instructions for guesses. *The "Project presentation" factor.* The student does not participate in the discussion and determination of goal, task, structure, content of the presentation, but uses ready-made solutions created by other group members. The student designs each slide and defines the animation of the slide elements as well as their transitions using specific instructions. The student does not consider it necessary to take part in the rehearsal of the presentation. During the presentation, the student behaves autonomously and does not gain mutual understanding with the audience. He does not try to answer the questions.

The developed factors, criteria, and indicators in the Trello web service are presented in Table 1.

Table 1. Quantitative indicators of students' individual activity in the educational group project

Criterion	Vi	Criterion indicator in the Trello web service
1	2	3
1.1 Group identification.	0,11	Trello board, Trello lists.
1.2 Definition of all tasks within the project.	0,32	Trello cards, card commenting system.
1.3 Project duration determination as a whole.	0,38	Calendar extension, color task progress indicators, card commenting system.
1.4 Planning of the group	0,19	The list of scheduled meetings

monitoring activities.		attached as a file to the card, cards commenting system.
2.1 Assistance to the other group members.	0,13	Slack messenger, card commenting system, email.
2.2 General activity.	0,23	Progress indicator of the task intermediate steps, list of activities on the board.
2.3 Conflict prevention.	0,32	Slack messenger, card commenting system; an alert mechanism for selected participants.
2.4 Participation in scheduled meetings.	0,25	Slack messenger, card commenting system, board activity list, an alert mechanism for selected participants.
2.5 Documenting the mid-term project results.	0,07	Google Drive file repository.

Table 1. Continue

1	2	3
3.1 Analysis and choice of terms in the crossword puzzle.	0,37	Reference to a file containing text with terms and instructions, a card commenting system.
3.2 Creating instructions for guessing terms in a crossword puzzle.	0,63	Reference to a file containing text with terms and instructions, a card commenting system.
4.1 Algorithm of the function work.	0,43	Reference to a file containing a flowchart of the function algorithm.
4.2 Quality of the function program code.	0,41	Reference to a file containing the function code.
4.3 Program testing	0,16	Reference to files containing test specification, test results.
5.1 Presentation preparation.	0,36	Reference to file containing presentation plan, card commenting system.
5.2 Project results presentation	0,64	Project results presentation.

5. Testing of the student individual activity assessment methodology in the educational group project

During the research, we tested in the educational group project within the framework of the discipline "Fundamentals of teamwork in IT" using the possibilities of the Trello web service (2019).

Successful application of an educational group project in the educational process requires student team preliminary preparation and the tutor's solving of several methodological problems. These are the following: the formation of positive motivation for educational activities in the group project, formation of the group optimal composition, coordination and control of the group work, and assessment of the students' activities in the group. Therefore, at the previous stage of the study, we informed the students about the goals of the project and its main tasks; project deadlines; distribution of responsibilities in a team; activity planning throughout the project; requirements and basic functions of the Trello; Windows application basic requirements; requirements for the project presentation. Also we explained the students' assessment criteria of their activities in the group.

One of the means of increasing students' motivation for learning and achieving their cognitive activity is didactic games, in particular thematic crosswords. A crossword puzzle contains a game task (solving or compiling a crossword puzzle), and a training task (mastering certain knowledge, skills) that students do not get explicitly, but through the content of the game. Crosswords have a special quality that generates interest in the learning process and contributes to the search and creative abilities development of students to apply their knowledge. With this in mind, we chose the theme of the group project, which is "Development of the Windows application "Crossword".

To achieve the goals within the project, special project management tools are used, the main functions of which are the placement and tracking of tasks as well as the distribution of resources within the project. As part of the training project, we used the Trello, which helps organize teamwork with projects and tasks as well as visualize this work Trello Software Review (Delos Santos, 2019). The main advantages of using Trello in a group project are the ability to organize student group work and coordinate the project by the tutor.

The first task for students in the project was to create a team and plan a project schedule. As part of the activity, each team creates its board and assigns a group name to it. Also, it gives access to this board for all team

members and the tutor. Next, the team adds a background image to the board for its visual recognition. The team chooses a leader to coordinate teamwork. Each group places three mandatory lists of tasks on the board: "To do", "In progress", "Done", which must be completed to achieve the project goals. Students determine tasks in the form of cards according to the program requirements and place them in the "To do" list in the order of their priority. For each card, students set the required attributes: a color label that visualizes the type of assignment; information about the tasks and assignment results; the last name of the student (or students) who is responsible for completing the assignment; the deadline by which the task should be completed; the student's profile picture. Indicators for assessing this activity are shown in Table1.

Group work is an activity planned within the project framework to solve assigned tasks. Within the framework of the project, the tasks of each student in the group were clearly stated, and the degree of the student's responsibility for his part of work was established. Students used the standard "Calendar" extension to plan the work schedule for the project. The "Calendar" provided a visual representation of tasks for seven days. It also informed each student when the deadline for the task was ending with the help of messages. Such work planning allowed students to systematically complete work on time. The students separated the difficult tasks into separate stages, implementation of each can be displayed independently from each other using a list of target achievements function. The progress of the task intermediate stages was displayed on the map as a percentage. A visual representation of certain stages completion of the assignment allowed both students and the tutor to quickly assess progress in all the main stages at once in real-time on one screen.

The "In Progress" list contains cards that are at the stage of active development. One student has the right to perform only one task. Students attached colored labels to the cards, which visually informed all group members about the status of the task: completed, error, assembly etc. When the student considers the task completed, the group checks if the card works. A tutor can also be involved in this process. If the group decides that the task has not been completed, they mark it with the appropriate label and leave it in the "In Progress" list. When the student cannot solve the problem on his/her own, he/she adds a new card with the label "Problem" to the list and other group members help him solve this problem. A group discussion of the problem allows finding a wider range of alternatives, including innovative solutions, and finding the most optimal solutions.

The student stores the intermediate workable result of the assignment in a repository, which is organized as a personalized catalog of intermediate results on Google Drive. The student notes links to access the directory on the card. Such an organization of storing intermediate results, on the one hand, allowed students to have access to the intermediate results of all group members. They could view the results, leave their comments; use them in the future, for example, when compiling a program; edit if necessary, with the consent of the author. On the other hand, the tutor could evaluate the work result of each student in the group as well as coordinate their work. For example, the catalog contained files with deadlines for the crossword puzzle, crossword puzzle structure, program algorithms, and individual methods, program structure, program interface diagram, input/output specifications, code of individual components, test samples, the finished program, project presentation, etc. The student moved the assignment to the "Done" list. The tutor could see each student's actions to solve the problem on the back of the card, in the profile or on the menu.

The exchange of ideas and joint work in the project was carried out through a card commenting system, files with inserts, hyperlinks, a notification mechanism for selected participants. Besides, students used e-mail, which allowed them and the tutor to receive notifications of any actions on the Trello board and send descriptive cards that were automatically placed in the corresponding list on the board.

The result of the students' project activities was a public project presentation in the classroom in the presence of the tutor and students. Students presented their work carried out within the framework of the project. They analyzed their activities, proposed a way to solve the project problems using self-reflection techniques. At this stage, students develop the ability to logically build their thoughts, summarize them; they also form public speaking skills. Such an organization of the educational project made it possible to achieve certain learning outcomes within the framework of the subject "Organization of collaboration in IT". Students learned to demonstrate the importance of software developer groups; influence individual group members and the group as a whole aiming at the qualitative performance of role functions; evaluate the group activities to increase its effectiveness; maintain interaction and communication; find common interests with the team members; understand someone else's point of view; quickly respond to the statements of the team members; build a system of evidence; effectively make presentations using computer and network communication tools; develop documentation. The results of student performance at three levels from 2017 to 2019, as well as indicators of

absolute performance and quality of education (according to the Ukrainian system of the education quality assessment), are presented in Table 2.

The analysis of Table 2 shows that the education quality parameters correspond to the requirements of the Ukrainian student performance assessment system (absolute performance should be at least 95%, and the quality of performance should be 50%). The highest quality indicator was found in 2019, and the lowest in 2017. It happens because during these three years the tutors developed teaching materials for organizing and evaluating educational group projects. Also tutors were trained to use group projects in the educational process.

Table 2. Student success results in 2017–2019

Year	Total, number of students	Low level, number of students	Middle level, number of students	High level, number of students	Absolute performance (A_{as}), %	Quality of study (Q_{as}), %
2017	33	8	21	4	100	75,7
2018	34	5	19	10	100	85,2
2019	35	3	17	15	100	91,4

Interviews with tutors and students revealed the main difficulties in implementing the educational group project. The students attributed the following factors to the main difficulties in a group project: uneven distribution of responsibility and tasks between team members (68%), which is because first-year students are not able to plan their activities and the activities of their group members; the sole appointment of those responsible for the assignment by one of the group members without discussion with the other group members (22%); the dominance of some students in both discussion and decision-making (35%); the opportunity for some students to solve their problems arising in the course of the project at the expense of more proactive group members (15%). The students attributed the following factors to the advantages of group project: the ability to perform tasks online (95%); the ability to visually save resources and create relevant documents in the Trello (85%); see their plans (65%); see the result of teamwork (74%); show the result of their work to other groups (54%).

The tutors consider that the main factors impeding the introduction of a group project into the educational process are the following: in the year 2017 it was due to lack of methodological literature (86.3%), tutors not trained (77%), students not trained (45%); great complexity of a group project organization (95%). The tutors attributed the use of the Trello web-service to the advantages of an educational group project, which allowed to monitor all student activities controlling their completion time and authorship (90%); creating comments not only for the whole project but also for certain activities while solving a specific problem (85%); ability to point out shortcomings in performing activities and placing instructions for tasks (85%); automatic receiving of activity verification messages and tutor comments by the students (87%); ability to evaluate student activity online (92%).

So, from the experience of organizing group work on project management, we can make the following conclusions and recommendations. In conditions of teamwork, first-year students are not ready enough to engage in group work, which requires the responsible and systematic work of the tutor. It is very important to have formulated requirements for the implementation of all tasks within the group project. The tasks within the group project are for the most part interconnected and carried out sequentially. It is very important to document and save as result files of all student activities. The tutor needs to systematically check student activity and create relevant comments. If the group deviates from the given topic in the process of discussion, the tutor must re-set the same goal, redistribute additional questions to the group members, and submit them for a separate discussion. The tutor should organize students' independent activities based on dialogue, creative interaction, and cooperation.

6. Conclusion

During the research, we assessed the outcomes student group project. Unlike the others, the used model made it possible to evaluate the contribution of each participant according to the following factors: group creation, communication in a group, developing a crossword puzzle, developing a program, and project presenting.

Within the subject "Fundamentals of collaboration in IT", an educational group project with the Trello made it possible to simultaneously solve, on the one hand, the problems of professional knowledge forming,

skills related to collective software development. On the other hand, it helped solve problems related to the content of the subject.

Using the developed methodology allowed to increase the objectivity of the mid-term and final exam assessment of both individual student's work and the group as a whole; to track and direct students' activities to the result of an educational group project; to combine their capabilities with requirements; to reduce problems associated with free-rider and sucker-effect.

Using the Trello to manage a group project allowed to quickly identify problems at all stages of the project; use the resources rationally; avoid the "emergencies" and complete tasks on time; organize constant feedback among all members of the group and the tutor; track all the activity of each student and group as a whole by the tutor; document and store intermediate results of students' activities; demonstrate the results of a group educational project.

The described experience can be transferred to other subjects in the educational sector. This research does not exhaust all aspects of the problems being studied. Redmine, Git, GitHub, Eclipse and other information systems platforms used in an educational group project to monitor its implementation require further study.

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