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ASSESSMENT OF THE DIFFERENT SUBJECT AREAS IN AN INTERDISCIPLINARY PROJECT

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Abstract

The explored component of this work investigates the influence of formative assessment, interim assessment, participation grading, self and peer assessment, as well as summative assessment on the final results of Project Based Learning (PBL). The samples were 120 students at an American-type of high school divided into two groups of 60. The aim of the study is to check whether the use of these specific assessment methods is applicable for an interdisciplinary project. The effect of having feedback from multiple teachers responsible for different disciplines on the end-result will also be tested. The end-goal is to determine whether the students have control over their projects and method of studying, to an extent where their finished products are created in their own vision. The instruments used to measure the course objectives were checklists corresponding to them. The research is made by observations on project activities: Checks throughout a set period of time, Questions and goals, Peer feedback, Final project report. A comparative analysis of students' academic results, with a sole focus on Mathematics and a multidisciplinary project, was done, to make a more extensive conclusion as to the effectiveness of said methods and their application in an educational setting.

Keywords: *PBL, formative, interim and summative assessment, participation grade, peer feedback.*

1. Introduction

These days, it's almost impossible to have a conversation about education without hearing phrases like "student-centered," "deeper learning," or "project-based." Everywhere, districts, school leaders, and curriculum developers are launching new initiatives to promote instruction that gets students creating, investigating, performing, and experimenting, rather than taking notes and tests (Grossman et al., 2019). Science education is currently going through a process of change globally, which is related to the integration called STEM (Science - Technology - Engineering - Mathematics) (Tihbaut, 2018). It is not a separate program, nor does it replace educational standards, but a didactic approach that removes the traditional barriers between the four disciplines and integrates them into real, serious and relevant learning activities. The tasks of integral learning are best addressed when learning is implemented through the path of discovery, i.e., using the inquiry method. This method is an important part of inquiry-based learning through which new knowledge is constructed. The application of the project method and its variant, PBL, have the potential for conducting integrated learning (Raykova, 2019). Today, however, this approach results in most of the teachers being virtually untrained in how to make interdisciplinary connections. The results of Nikolova et al.'s (2018) study on teacher competencies indicate the need to focus on STEM curricula and teacher training methods, to raise awareness of the role of different stakeholders in the development of teacher competencies, and the role of teacher competencies in the development of the new generation of Bulgarian youth. The lack of tradition and experience in the collaborative implementation of STEM learning logically leads to questions about subsequent evaluation. Not only knowledge should be assessed in project work, because the aim is also to create key skills that should be adequately assessed. The latter implies the careful development of objective criteria and scales on which to base the assessment in question. In this regard, Raykova (2019) recommends the following methods for assessing students' knowledge and skills: testing to measure academic achievement; oral and written questionnaires; diagnostic interview; informal feedback from all groups; personal conversations with each student, etc.

Preparing our students for the future is an unpredictable task. But, with PBL, we can at least prepare our students to be adaptive to any situation they may face. This method doesn't have a particular definition, but for short let's say that PBL is a teaching method in which students are taught through tasks to model real-world situations in what they see as meaningful projects. Students are engaged in exploring

and solving a real-life problem, developing the skills needed to do so. It is meant to help prepare youth for the challenges of the 21st century, in addition to what the traditional curriculum is able to do. *The main goal of developing this approach is to create effective learning opportunities where learners can help each other by working in a group to answer a question, solve a problem, or tackle a challenge that will lead them to create a final product (Bell, 2010).*

Due to the Course syllabus of the American College of Sofia (ASC), the phases of creating an interdisciplinary project include:

Table 1. Syllabus for an interdisciplinary PBL.

WEEK	**TOPIC**	**OUTCOMES**	**TEACHING METHOD**	**ASSIGNMENTS**
1-4	Interdisciplinary PBL start up	-Introduce the goals and work timeline for the PBL -Understand the complexity of the research process -Know what knowledge and skills related to each subject could be included in the project	Videos Discussion Lecture Discussion	Class Work (CW), Participation grade, Mind map (subject teachers Math and Physics)/ Formative Assessment (FA)
5	Creating the project goal	-Initial research on possible topics/questions -Identify, learn, and value interdisciplinary connections in science research.	Students Discussion Teacher feedback (Formative Assessment)	Group work, CW/ Participation grade /Interim Assessment (IA)
6-7	Build a project RoadMap	-Create Project Plan with milestones and timeline. -Reflect and review the project proposal to incorporate teachers' suggestions	Students Discussion Teacher feedback	Group work Project Proposal/ Subject teachers Math/Physics (IA) IT/Informatics/ Entrepreneurship (FA)
8	Analyzing Project requirements	-Students list functional and nonfunctional requirements	Students Discussion Teacher feedback	Submit Requirements/FA
9	Design/ Implementation Phase	Apply and improve all skills of the experimental research	Students driven learning, Teacher using effective questioning techniques	Group and Teacher Communication Group or Peer Evaluation/ FA
10-22	Iterative Implementation Phase	Build/Create/Develop, Test, Evaluate, Revise	Teacher facilitating and supporting enquiries	Video Reflections/ IA (Subject teachers IT and Informatics)
23	High Fidelity prototype (Interim Submission)	Submit Prototype - Self Evaluate Project	Group Work	Prototype and Evaluation result Submission/ IA
24-27	Iterative Implementation Phase	- Improve/Extend/Complete Project Requirements	Self-directed Learning	Group and Teacher Communication/ Participation grade
28-30	Final Project Report, Project Presentation	Final Project Report - Group Presentation Skills - Individual Reflection	Group Presentation Skills	Presentation and project report / Final grade

Not only are the learning method and the intent of its outcomes important, but also the evaluation of their achievement (Friedman, 2000). Such assessment must be an integral part of the teaching-learning process; it should be continuous and not just take part at the end of it, and it should be both summative and formative. Formative assessment is a part of the developmental or ongoing teaching-learning process. It includes delivery of feedback to the student, with the aim of improving teaching, learning and the curriculum. Summative assessment occurs at the end of a term or course and is used primarily to provide information about how much the student has learned and how well the course was taught (Wojtczak, 2002).

2. Materials and methods

PBL is difficult to introduce into classrooms at first, as it requires teachers to find what is interesting to students and work off that. It also requires a completely different way of grading, as it is impossible for an interdisciplinary project to be evaluated the same as a test or quiz, exactly because of the reasons PBL is looked at as better preparing for students – there is never one right answer, but rather numerous ways to solve a problem. Real problems are rarely solved by using knowledge from only a single subject or sphere. In order to construct efficient, working products, or even to reach a beneficial solution, students have to learn to intertwine the different lessons that they learn from the many subjects that they get taught at school. Achieving an objective summative assessment in this case requires very clearly formulated standards in rubrics for the different levels of grading in each subject. As mentioned, PBL projects do not have a single correct answer. In fact, many times they do not have a correct answer at all. For this reason, rubrics are so difficult to create, as they cannot constitute a simple checklist of "yes" or "no," on which to base the students' grades. Numerous factors have to be taken into account, not the least of which the students' engagement in what they are doing, how they have tried to solve the problems they have been given, and how ambitious their project was in the first place. These criteria should help both them and their teacher in determining a grade. Sometimes the most complex part of having an interdisciplinary PBL project is the evaluation, as teachers who are most of the time not used to having to evaluate a common project, are put into a new for them situation. This is where formative assessment is very helpful, as it allows for one of the teachers (whose subject is the predominant), to grade the work at the end. While their colleagues just guide students as to how to improve the project in the required area. This is also possible through common formative assessment where all the teachers evaluate the project throughout the whole year and still give ideas for improvement, relating to their field. The explored component of this work was to investigate the influence of formative assessment, participation grade, self and peer assessment and only "leading teacher" assessment in project-based learning on the learning outcome of students and also to probe the level of reliability and validity of these methods of assessment in project-based learning. For the purpose five types of checklists were developed:

2.1. Assignment in google classroom for weekly report, assigned and graded by the faculty member (formative or interim assessment)

Tutorial sessions ran once a week for three main subjects for an hour and a half in the seven-month course for grade 12th. In this particular case three main disciplines were included – Math, Physics/Entrepreneurship, Information Technologies (IT)/Informatics. The scale for each criterion (weekly communication and report, self and peer assessment and practice presentation) ranged from 0% to 100%. Every assessment type was not assessed weekly; criteria that were considered for each tutorial session depended on the objectives to be covered in that particular session, which were defined in the beginning of the school year, and they also depended on the PBL step the group of students was working on. After each tutorial session the "leading teacher" (Math teacher) of the project assigned each group one grade for participation (interim assessment) that ranged from 0% to 100%, for "weekly communication" criteria. It is very controversial whether participation can be assessed. Jacobs and Chase identify several reasons for not grading class participation: professors generally don't provide instruction on how to improve participation; interpretation of student behavior is difficult and subjective; participation often depends on a student's personality thus disadvantaging shy or introverted students; record-keeping is problematic: participation scores for a given individual are hard to justify if challenged. Despite these objections, Bean and Peterson believe that grading class participation can send positive signals to students about the kind of learning and thinking an instructor values, such as growth in critical thinking, active learning, development of listening and speaking skills needed for career success, and the ability to join a discipline's conversation. Throughout the project, participation had to be assessed regardless of teacher preference as it was one of the only ways to assess student engagement. They were given a rubric for participation with several criteria (workload, participation in surveys and after-class meetings, acceptance, and request for feedback from the teacher) that allowed to better understand (for both teacher

and student) how much is learned during group work. This means that if both parties follow this guide and determine which criteria are met and how, students will be able to self-assess by filling out a Google form and explaining why they deserve a certain grade. Teachers will be able to separate individual performance from group performance and see if the feedback provided is accepted. The papers for each group were also compared against themselves to see if, as students became familiar and comfortable with PBL over the course of the semester, they had become more engaged and motivated. At the end of the month, the "leading teacher" summed the formative grades obtained by each group from all the teachers and entered one average interim grade for "Weekly report" criteria. The last grade of students had both formative and summative value. At the end of the month each subject tutor assessed performance of the roles taken by each student during the classwork (leader or participant). Role assessment served a formative purpose to improve student performance in their future work but had no summative value.

2.2. A self-assessment checklist (formative assessment)

-Making a questionnaire, on which to ask the students, in order to determine whether they are moving correctly and whether they will achieve the goals that they have set. Self-assessment took place at the end of each month.

- Checklist, which contains questions towards the criteria to measure the cognitive outcomes from the study. In this way the students can reflect on their learning outcomes at the end of each semester.

2.3. Peer-assessment checklist (formative assessment)

-Making every group look at another group's project, in order to give feedback or feel motivated to move faster. The peers might also think of things that the teacher might have missed when making their own questionnaires. It helps students to analyze why their classmates assessed their performance in a particular way. Peer assessment took place at the end of each month.

2.4. Final report (summative assessment)

- A definitive questionnaire that gives the students the ability to self-evaluate their final product by giving them questions, concerning how it works, whether it works, whether it follows the goal of the initial plan.

3. Results

The samples were 120 students from the American College of Sofia divided into two groups of 60, taught through two consecutive school years. During the 2019/2020 school year only summative assessment was applied, while in 2020/2021 formative assessment was used as well. The average of students' results in math entry tests for all students are very similar. Table 2 includes a summary of all grades, including the scores received on each of the projects for both the final product and the participation. The grades were determined according to the ACS grading scale. What can be seen from this table is that even though the first project only required knowledge of mathematics and IT and only included one topic, the student performance levels on the interdisciplinary project were higher than the scores of the Group 2019/2020. The author did not expect such a conclusion as the interdisciplinary project was developed under the demands of three teachers. This fact makes the author believe that it's very useful if the formative assessment precedes summative. Even when we did our best to collaborate, sometimes it was not possible to get everyone together and students had to continue to pursue their next goal on their own. The students were also given to fill out a Google Form questionnaire where they had to answer whether their project was what they planned on doing initially. Their answers varied in the detail they provided, but it was found that most students seemed to determine that their projects were sometimes even more sophisticated than they initially planned. That is thought to be because of the guidance of the teachers. Some of the students had to change topics, again deciding that it was better than their initial idea, as it resulted in a more interesting and useful project that developed skills they might need in the future. Given that this case study was conducted with a small group of students from only one school and one class, and the criteria for the participation rubrics were developed by only one teacher, expectations could skew the results of the formative assessments and the results of the study may not be accurate.

Table 2. Results from PBL.

GRADE	**PBL Project Summative (Math) Grade 2019/2020**	**Interdisciplinary PBL Project Formative (Math) Grade 2020/2021**	**Interdisciplinary PBL Project Participation / Peer Grade 2020/2021**	**Interdisciplinary PBL Project Summative Grade 2020/2021**
Poor (<59.5%)	2	2	0	0
Low (59.5% - 70.4%)	0	30	0	0
Average (70.5% - 80.4%)	6	16	0	0
Above the average (80.5%-91.4%)	28	8	14	6
Excellent (≥91.5%)	24	4	46	54

4. Conclusion

Project-based learning is intimidating at first, as it requires a change in the core principles of the school curriculum – from grading and participation to the roles that the students and the teachers have in the classroom. However, those different types of assessment are freeing, as they allow the students to experiment and get more engaged in what they are doing, without the fear of being negatively impacted, as there simply exist no right or wrong answers. However, it also allows the teachers to improve their criteria throughout the school year, depending on what they find to be more valuable, while also allowing different students to be graded fairly, depending not only on the result, but the effort that they put into their projects. PBL develops the so-called "21st century skills," a phrase that combines many skills and abilities that are looked for in the contemporary world – teamwork, problem-solving, ingenuity, and overall independency, creating something from scratch by yourself. As such, the author thinks that it can and should find place in the classroom, despite the many initial difficulties that might be faced when integrating it.

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