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Teachers' Accountability for Adaptive Project-Based Learning

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Abstract In this paper, we propose an approach to determining accountability of teachers for organizing an adaptive project-based learning (PBL) environment. The environment enables customization on performance of students. The certain phases of teacher accountability are determined. Teachers would be accountable for preparing instructional material, teaching a subject through a relevant sample-project, guiding collaborative performance of group projects, and defining course study results. The first phase associated with holding teachers accountable for preparing instructional materials for teaching of subject while performance of a sample-project by every student and performing group projects and comprises: specification of a subject, specification of the sample-project and group projects, setting initial assessments of studying of a subject. The second phase aimed at holding teachers accountable for promoting development of subject-relevant knowledge during the sample-project performance and fostering adoption of specificity of adaptive PBL by students and comprises: submitting subject material while performance of the sample-project; facilitating learning by doing, assessing of students' knowledge after completion of the sample-project. The third phase aimed at holding teachers accountable for inducing development of higher-order knowledge and collaborative skills of students and comprises: fostering self-formation of knowledge heterogeneous collaborative groups; assigning projects of different complexity levels for collaborative groups; support of forming a structure of project tasks; setting adaptive assessments of knowledge and the fixed assessment of the collaborative skill. The fourth phase pertains to teachers' accountability for defining results of the adaptive PBL, and includes: assessing student knowledge after completing the sample-project and group projects; assessing collaborative skills; defining complex summative assessment of students.

Keywords: *adaptive project-based learning, teachers' accountability, adaptive assessment*

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1. Introduction

Project-Based Learning (PBL) is a central teaching strategy. It promotes effective learning through projects that the students carry out, and exercises teaching and learning designed to engage students in the investigation of real-world problems to create meaningful and relevant educational experiences [1,2,3,4,5]. PBL has been found to improve the use of technology, the ability to reach consensual decisions, critical thinking, problem solving, effective communication, collaboration, negotiation skills, and independent learning.

A PBL environment can be characterized as student-centered, knowledge and skill-centered, community-centered, assessment-centered, and focused on assuming responsibility by the students [6,7,8,9,10].

The knowledge and skill-centered characteristic refers to the teacher's concentration on students' development of knowledge and soft skills (i.e., communications, collaboration and learning to learn). Knowledge can be represented on four levels: know-what, know-how, know-why, and care-why [11,12]. The knowledge levels have their defined roles in education, so that the know-what level represents cognitive knowledge; the know-how level involves a synthesis of knowledge to deal with real-world problems; the know-why level refers to an understanding of complex cause-and-effect relationships; and the care-why level represents self-motivated creativity. Know-why and care-why knowledge levels promote development of a higher order of thinking.

The student-centered characteristic refers to students' independent learning by doing, combining individual and collaborative learning, encouraging student interest in problem solving and critical thinking, teacher's monitoring of the development of students' knowledge and skills and adaptability to each student [7,8,9,13].

The community-centered characteristic refers to group work in an online learning environment to acquire knowledge and develop skills collaboratively. The students are responsible for one another's learning as well as their own, which assumes group interdependence, motivation, compatibility and sociability [14,15].

The assessment-centered characteristic refers to a high quantity and quality of assessments while maintaining the learners' motivation to develop their hard and soft skills. An assessment should promote responsibility for the

learning results, and be a guided and adaptive process [16,17].

The student-centered accountability characteristic refers to the focus on the progress of individual students rather than on averages of large groups, whose members do not share similar learning needs, as a means of improving teaching and learning [7].

The central role in organization of a PBL adaptive environment with the abovementioned characteristics is assigned to a teacher. Adaptability of the PBL environment provides customization on student achievement. It behaves the teacher to become accountable for organizing an adaptive PBL environment, which encourages students' acquisition of knowledge and development of collaborative skills.

The goal of the proposed approach is to determine the scope of teacher accountability for organizing an adaptive PBL environment as an incentive to inculcating school subject matter.

2. Related Research

In the following section some approaches, methods and tools are reviewed in terms of their potential contribution to determining various aspects of the accountability of teachers for organizing an adaptive PBL environment, such as determining students' accountability, creating productive collaboration, forming constructive assessment and providing adaptive support.

2.1. Determining Accountability

Bergsteiner developed an accountability theory that describes and explains the process of accountability, factors that influence it and constructs of accountability that are associated with the process. He designed a decision tree model for building of goal-oriented accountability [18].

Shavelson propounded the need to provide mutual adjustment of formative function of accountability, conducive to changing the organization of teaching and learning, and the summative function of accountability directed towards determining its extent. He emphasized that improvement of teaching and learning can be attained by coordinating the systems of assessment and accountability [10].

Samuel & Chiche described a personal accountability model that enhances realization of the intention to become accountable. The model is based on determining accountability as an action that is consistent with the teacher's desired outcomes [19]. Brundrett & Rhodes maintain that by creating accountability you engender a culture of quality that ensures an improvement in the standard of teaching and learning [20].

Ballard & Bates substantiated the need for holding teachers accountable for students' performance on the basis of standardized achievement tests reflecting the quality of instruction students receive from their teachers [21].

An approach developed by Abu-Hussain, Essawi & Tilchin focuses on creating accountability for learning results. The Project-Based Collaborative Learning (PBCL) model was built specifically for this approach. It outlines a process of creating accountability for learning results, with specific direction for forming collaborative groups of pupils and a flexible assessment system [22].

Mergendoller, Markham, Ravitz & Larmer developed a "pervasive" four stage management approach to guide students effectively through the PBL process. The stages are - project planning, project launch, guided inquiry and product creation, and lastly project conclusion. Management activities guiding and facilitating students' PBL are determined relative to each stage [23].

2.2. Creating Productive Collaboration

Markham suggests an approach to specific management of project performance directed towards building higher-order knowledge through collaboration [24]. Maltese affirms collaborative learning is both the strategy and the goal of PBCL [25]. It serves as a means of student engagement in creative problem solving, and learning to work together. Graham & Misanchuk define the principal stages of organizing collaborative learning: structuring of learning activities, creating groups and facilitating inter- and intra-group interactions [26]. Orvis Kara & Lassiter address dynamic management of group organization [27]. Stanton & Fairfax suggest an approach to creating a PBCL environment with a view to facilitating interaction between students. Composition of the collaborative groups is left according to their approach to students' discretion [28]. Stanton & Fairfax have defined a productive collaborative environment as one in which there is interdependence of the students on a project, on face-to-face interaction and on development of collaborative skills [28].

2.3. Forming Constructive Assessment

Knight pointed to the need for a systematic approach to the assessment of students' learning that would be reliable, valid and usable [29]. Moallem discusses three stages of evaluation: initial, progress and product assessments [30]. Tillema contends that the function of formative assessment is to promote learning [31]. Lovie-Kitchin claims assessment methods should be congruent with the PBL process [32]. Macdonald & Savin-Baden stress the need for specific methods of assessment for PBL that would reflect its practical orientation [33].

William describes strategies of formative assessment: clarifying, sharing, and understanding learning intentions and criteria for success; creating effective discussions and project tasks that promote learning; providing feedback as an impetus for learning; and activating individual and collaborative learning [17]. Ellis & Hafner propose that PBCL assessment of a student should be based on an evaluation of the work of his team and his individual work both personal and as a member of the team [34].

2.4. Providing Adaptive Support

Burgos, Tattersall & Koper propose different types of adaptive learning support including problem-solving support, information filtering, and collaborative grouping of students, adaptive testing and real-time course modifications by the instructor to meet the specific needs of students [35]. Soller describes various tools of adaptive support for collaborative learning to best promote facilitation of interactions, motivation for knowledge

sharing, and collaboration management [36]. Mennin explores a PBL group as a complex adaptive system. A student group is complex and it is adaptive in that the participants individually and in a group are altered [37]. Brusilovsky & Peylo consider adaptive group formation using knowledge about collaborating peers, and adaptive collaboration support providing an interactive support of a collaboration process assisting an individual student in solving a problem [38]. Papanastasiou defined adaptive assessment as one that is specific for each student and takes into account that student's previous performance, thus making it more accurate in terms of individual ability [39].

The sample of publications discussed above indicates that no comprehensive approach exists by which to define a teacher's accountability for organizing an adaptive PBL environment that would enhance subject study. The proposed complex approach will promote effective PBL due to:

- Dividing teachers' accountability for organizing the adaptive PBL into defined phases
- Designing a complete plan for the adaptive PBL
- Promoting development of subject-relevant knowledge
- Adopting specificity of the adaptive PBL environment
- Guiding formation of knowledge heterogeneous collaborative groups
- Inducing development of higher-order knowledge and collaborative skills
- Realizing adaptive assessments of knowledge
- Adjusting projects and control tests to knowledge dynamics
- Determining the adaptive PBL issues.

3. Accountability of Teachers for Adaptive PBL

The proposed complex approach aims to hold teachers accountable for organizing an adaptive PBL environment. Its complexity lies in the aggregate of teacher accountability phases, making this accountability complete. The particularity of the approach that we propound consists in taking into account specific characteristics of the extensive and comprehensive PBL environment, organizing the adaptive PBL environment, and realizing adaptive PBL as the two-stage process.

An adaptive PBL environment provides customization on student achievement and balances between individual and collaborative learning. Adaptability is expressed by changes in teacher assessments based upon knowledge dynamics, flexible choice of control tests for students and assigning projects of different complexity for different collaborative groups, and forming collaborative groups comprising heterogeneous knowledge levels of members. All these are an impetus for students to acquire knowledge and develop collaborative skills.

During the first stage of the adaptive PBL process a teacher teaches a subject just in time performing the tasks of a sample-project by the class. The teacher's main attention at this stage is devoted to creation of subject-relevant knowledge, fostering adoption of specificity of PBL environment, and facilitating acquisition of learning experience by students in this environment. Then, the knowledge of each student is examined relative to the various knowledge levels through personal control questions based on subject material. It is resulted by assessment of knowledge development. Next, adaptive formation of collaborative groups is realized by taking into account the individual assessment of each student.

At the second stage of the adaptive PBL process, the teacher's main attention is devoted to developing higher order knowledge and students' collaborative skills. The self-formed collaborative groups of students perform projects of different complexity during this stage. Then, their knowledge is assessed by control tests.

Teachers' accountability for organizing a two-stage process of the adaptive PBL can be divided into phases. The phases are:

- Preparing instructional material
- Teaching a subject through a sample project
- Guiding collaborative performance of group projects
- Determining a course study results

Each phase follows prescribed directions.

3.1. Preparing of instructional material

Preparing instructional material aims to hold teachers accountable for preparing teaching matter that would enable them to teach a subject synchronously with students' work on a personal sample-project and engagement in work on group projects. This involves: specification of a subject, a personal sample-project and group projects, and setting initial assessments of studying of a subject.

Specification of a subject involves: requirements for a student. After studying a subject, a student is expected to know the concepts relevant to it, be able to apply the theoretical knowledge introduced by the subject, explain cause-and-effect relationships, and to develop a collaborative skill; list the subject topics; subject-relevant knowledge. It is an aggregate of topic-relevant knowledge, which is required knowledge of know-what (k^1), know-how (k^2), know-why (k^3), and care-why (k^4) levels related to a subject topic. Knowledge relevant j topic is $K_j = <k_j^1, k_j^2, k_j^3, k_j^4>$, where j=1,…, n; n is the quantity of subject topics. If each subject topic corresponds with one project task, then n is the quantity of project tasks; control tests for examination of students' subject-relevant knowledge after completion of a sample-project.

Specification of a sample project involves: correlating a subject for study with a sample project. Sample project-relevant knowledge (the knowledge required in order to carry out the project) should be equal to the subject-relevant knowledge; determining a set of project tasks and the order of performing them. A set of project tasks should correspond to a set of subject topics. In other words, one task or more of a sample-project should correspond to each subject topic. The order of performing the project tasks must conform to the order of studying the corresponding subject topics; determining task-relevant knowledge (the knowledge required in order to perform a project task); determining correspondence between topic-relevant knowledge and task- relevant knowledge.

Setting initial assessments of studying of a subject involves: setting initial assessments of students' knowledge for different knowledge levels, with more assessment value for know-what and know-how levels, with an aim to motivate students to learn the subject matter through doing; setting initial assessments of students' knowledge regarding the subject topics and the sample-project tasks.

Example1: The initial assessments for studying of a subject regarding knowledge levels are represented in Table 1.

Table 1. The initial assessments for studying of a subject

The knowledge level name	Knowledge assessments %
know-what (k^1)	30
know-how (k^2)	40
know-why (k^3)	20
care-why (k^4)	10

If a subject includes 5 subject topics, then the fixed assessments of topic-relevant knowledge of a student regarding the knowledge levels (Table 1) are equal to 6%, 8%, 4%, and 2% accordingly. If each task of a sample project corresponds with one subject topic, then fixed assessments of task-relevant knowledge (knowledge needed for performance of each project task) regarding the knowledge levels are equal to 6%, 8%, 4%, and 2%, accordingly.

Specification of group projects involves describing the various projects, each at its own level of complexity, with the more complex requiring a higher grade of knowledge to handle. As regards teachers' accountability, this also means determining knowledge needed for performing each group project; forming a list of control tests of different complexity to examine the knowledge gained by each individual student in each collaborative group after completion of the group project; developing students' collaborative skills during work on the group projects.

3.2. Teaching a Subject through a Sample Project

The phase of teaching a subject through a sample-project, with regard to teacher's accountability, consists of teaching synchronously with students' work on a sample project by every student of a study group. The work on the sample project thus becomes the means of studying the subject. This phase requires submitting subject material while students' work on their sample project; inducing adoption of learning by doing, assessing knowledge acquired by the students after completion of the sample project.

The subject material is submitted in synchrony with the performance of sample project tasks since educational material of each subject topic corresponds to one or more of these tasks.

Inducing adoption of learning by doing consists in fostering comprehension of specificity of PBL environment, and facilitating acquisition of students' learning experience in this environment.

The teacher evaluates a student's knowledge acquired while working on his sample project through control questions regarding the various knowledge levels. Correct answers at a certain knowledge level indicate that he has acquired knowledge at that level. That means that he has met the initial assessment set for this knowledge level. If his answers are not entirely correct then the corresponding assessment is marked. Lastly, the sum of formative assessments of each student's knowledge for all knowledge levels is calculated and that is his total formative assessment of knowledge.

Example 2: The knowledge built by students while performance of a sample project is represented in Table 2. Row names correspond to knowledge levels relative to project tasks (topics). Lower and upper indices denote task numbers and knowledge levels accordingly. Initial assessments of knowledge levels are shown. Column names correspond to student IDs. Knowledge of a certain level built by a student is marked at the intersection of a row and a column.

Table 2. Formative assessments of student knowledge after completion of a sample project

Knowledge levels regarding subject topics(tasks)	The students					
	S_1	S_2	S_3	S_4	S_5	S_6
K_1^1(6%)	5	6	5	5	4	4
K_1^2(8%)	6	7	4	6	3	5
K_1^3(4%)	2	3	1	2	1	3
K_1^4 (2%)	1	2	2	2	1	1
K_1^1(6%)	6	5	6	6	5	5
K_1^2(8%)	4	6	7	6	4	4
K_1^3(4%)	3	3	1	3	2	1
K_1^4 (2%)	1	2	1	2	1	1
K_1^1(6%)	5	6	3	5	4	4
K_1^2(8%)	8	8	4	7	5	6
K_1^3(4%)	3	4	2	2	1	3
K_1^4 (2%)	2	1	1	1	1	2
K_1^1(6%)	4	5	5	4	6	6
K_1^2(8%)	5	8	6	6	5	7
K_1^3(4%)	2	3	2	2	1	2
K_1^4 (2%)	1	2	2	2	1	1
K_1^1(6%)	6	6	4	6	5	5
K_1^2(8%)	7	8	5	5	4	4
K_1^3(4%)	3	4	1	2	2	1
K_1^4 (2%)	1	1	1	1	1	1

Table 3 represents formative assessments of student knowledge regarding knowledge levels. The last row of Table 3 contains the total formative assessments of student knowledge.

Table 3. Formative assessments of student knowledge regarding knowledge levels

The formative assessments of knowledge regarding knowledge levels	The students					
	S_1	S_2	S_3	S_4	S_5	S_6
know-what	26	28	23	25	24	24
know-how	30	37	26	35	21	26
know-why	13	17	7	11	7	10
care-why	6	8	7	8	5	6
The total formative assessments	75	90	63	79	57	66

3.3. Guiding Collaborative Performance of Group Projects

The teacher accountability phase of guiding collaborative performance of group projects includes promoting self-formation of knowledge heterogeneous collaborative

groups of students; assigning projects for collaborative groups; setting adaptive assessments of knowledge and the fixed assessment of the collaborative skills.

Promoting self-formation of knowledge heterogeneous collaborative groups is achieved by the requirements for forming collaborative groups and support of self-forming collaborative groups.

The requirements induce students to collaboration and conduce to knowledge development during work on group projects through collaborative interactions among students, which compensate for any possible lack of personal knowledge. The requirements are:

- Maximum mutual supplementation of knowledge of students inside a collaborative group. It promotes performing group projects owing to intra-group interactions
- Taking into account personal characteristics of students. It provides compatibility of students
- Maximal allowed quantity of students of a collaborative group is fixed. It encourages intensive collaboration of students.

Support of self-forming collaborative groups consists in facilitation and stimulation of mutual choice by students of suitable peers for collaboration and following coordination, and adjustment among all students of study group. The mutual choice, coordination, and adjustment are guided by the knowledge assessments received by students as a result of the sample project performance, and the requirements for forming the collaborative groups.

Example 3: According to the requirements for forming collaborative group and the formative assessments of student knowledge (Table 2), two collaborative groups are self-formed. The first collaborative group includes the student's s_1, s_3, and s_5. The second collaborative group includes the student's s_2, s_4, and s_6.

Assigning projects for collaborative groups consists in assessing group-relevant knowledge, and choice of a project of suitable complexity level for a collaborative group.

Group-relevant knowledge is cumulative knowledge of students belonging to a collaborative group. This knowledge characterizes ability of a group to perform a project of corresponding complexity level. Group-relevant knowledge is assessed by total formative assessment of a collaborative group. This assessment is sum of total formative assessments of knowledge of students from a group.

Choice of the project of suitable complexity level for the collaborative group of students is realized through comparison between complexity levels of projects and formative assessments of knowledge of collaborative groups. A project with the higher level of complexity is selected for a collaborative group with the more total formative assessment of knowledge.

Example 4: On the basis of data from Table 3, the total formative assessments of the first and the second collaborative groups are 195, and 235, accordingly. Hence, a project of the higher complexity level is assigned for the second collaborative group.

Since at the second stage of adaptive PBL the teacher's main attention is devoted to developing higher order knowledge, adaptive assessments of student knowledge regarding know-why and care-why levels should be higher compared to adaptive assessments regarding know –what and know-how levels.

Adaptive assessments of knowledge for a collaborative group are set by taking into account of the total formative assessment of a collaborative group. According to that, the more adaptive assessments of knowledge regarding know-why and care-why levels are set for students from a collaborative group having the more total formative assessment of knowledge.

Example 5: An adaptive assessment of knowledge regarding to all knowledge levels is set equal to 80%. The total formative assessments of knowledge of the first and the second collaborative groups are 195, and 235, accordingly (Example 4). Hence, the adaptive assessments of knowledge of the collaborative groups regarding know-why and care-why knowledge levels is set equal 50% and 60%, accordingly. Then, the adaptive assessments of knowledge of the collaborative groups regarding know-what and know-how knowledge levels is set equal 30% and 20%, accordingly.

Comparison of built knowledge of different levels can be realized by a relative formative assessment of a collaborative group regarding a knowledge level. This assessment is determined by using a formula:

$$\delta(k_i) = \left(g(k_i) - g^b(k_i)\right) / g^b(k_i), -1 < \delta(k_i) \le 0 \quad (1)$$

Where

$g(k_i)$ is a formative assessment of a collaborative group regarding k_i knowledge level, i=1,2, 3, 4

$g^b(k_i)$ is an initial (basic) group assessment regarding k_i knowledge level.

If the relative formative assessment of knowledge of some knowledge level received by the collaborative group students is lower, then adaptive assessment regarding this knowledge level is set by higher. It motivates a student to gain lacking knowledge through his collaborative work on a group project.

Example 6: The initial group assessments regarding know-what, know-how, know-why, and care-why knowledge levels are 90, 120, 60, and 30, accordingly (Table 1).

The formative assessments of the first collaborative group regarding the knowledge levels are 73, 77, 27, and18, accordingly. The formative assessments of the second collaborative group regarding the knowledge levels are 77, 98, 38, and 22, accordingly. Then the relative formative assessments of the first collaborative group regarding the knowledge levels determined by formula (1) are -0.19, -0.36, -0.55, and -0.40, accordingly. The relative formative assessments of second collaborative group regarding the knowledge levels are -0.14, - 0.18, -0.37, and -0.60, accordingly.

The relative formative assessments of the first collaborative group regarding know-what and care-why levels are higher then corresponding assessments of their knowledge regarding know-how and know-why levels. Hence, the adaptive assessments of knowledge regarding know-what and care-why levels for students from this collaborative group are set lower compared to the adaptive assessments of knowledge are set regarding know-how and know-why levels. The adaptive assessments of knowledge for students of the second collaborative group are set analogously.

Table 4 represents adaptive assessments of knowledge set for students from corresponding collaborative groups.

Table 4. Adaptive assessments of knowledge for the collaborative group students

knowledge levels	adaptive assessments of students	
	first group	second group
know-what	14	8
know-how	16	12
know-why	26	32
care-why	24	28

Setting the fixed assessments of the collaborative skills and requirement of participation of every student in performance all project tasks induce students in the group to collaborate. A fixed assessment of collaborative skills is set equal to 20%.

3.4. Determining Course Study Results

Determining course study results includes: assessing students' knowledge after completion of group projects, assessing their collaborative skills, and defining summative assessment of each student.

The teacher's assessment of the knowledge gained by each student in each collaborative group after completion of a group project is derived on the basis of the control tests of different complexity regarding the various knowledge levels. A student who passes the control tests is considered to have mastered the corresponding knowledge. Then assessment of a student equals the adaptive assessment as set for the student from a collaborative group. If a student doesn't answer the control tests correctly or completely, then the corresponding assessment is marked.

Example 7: Assessments received by students as a result of PBCL are represented by Table 5. The knowledge assessments of students regarding all knowledge levels are shown in the last row of Table 5.

Table 5. The student assessments after completion of group projects

Adaptive assessments regarding knowledge levels (%)	Knowledge assessments of the first group students			Adaptive assessments regarding knowledge levels (%)	Knowledge assessments of the second group students		
	S_1	S_3	S_5		S_2	S_4	S_6
know-what(14)	12	9	8	know-what(8)	8	7	6
know-how(16)	15	11	12	know-how(12)	11	10	9
know-why(26)	20	16	15	know-why(32)	30	28	24
care-why(24)	18	14	9	care-why(28)	25	23	20
Knowledge assessments	65	50	44	Knowledge assessments	75	68	59

Assessment of the collaborative skill is based on an analysis of the knowledge assessments of collaborative group students received after completion of the group projects. The objective of the analysis is to determine the student (or students) who obtained a maximal assessment. This assessment is the result of the student's acquisition of knowledge through his collaborative performance of project tasks. It can serve as a measure of success of a student's collaboration with other students. Hence, a student with a maximal assessment of knowledge possesses the best collaborative skill. Assessments of the collaborative skill of study group students are calculated proportionally to the assessments of their knowledge on the basis of a fixed assessment of the collaborative skill.

Example 8: The fixed assessment of collaborative skills is 20%. This assessment is obtained by the student s_2 since the knowledge assessment of this student is maximal and equals 75 (Table 5). A student s_5 has the worst collaborative skills since the knowledge assessment of this student is minimal and equals 44 (Table 5). Assessment of collaborative skills of the student s_5 equals 11%. Assessments of collaborative skills of remaining students are calculated analogously. The results of calculations are shown in the third row of Table 6.

The summative assessment characterizes outcome of adaptive PBL. This assessment includes the knowledge assessments of a student after completion of the sample project (Table 3) and the group-projects (Table 5), and assessment of his (her) collaborative skills (Example 8). The results of calculating the combined assessments of students are represented by the last but one row of Table 6. The summative assessments are represented by the last row of Table 6.

Table 6. The summative assessment

	The first group			The second group		
The assessment type	**S1**	**S3**	**S5**	**S2**	**S4**	**S6**
The knowledge assessments after completion of the sample-project	75	63	57	90	79	66
The knowledge assessments after completion of the group projects	65	50	44	75	68	59
Assessments of collaborative skills	17	13	11	20	18	15
The combined assessments	157	126	112	185	165	140
The summative assessments	78	63	56	92	82	70

4. Conclusion

The proposed complex approach aims to hold teachers accountable for organizing an adaptive PBL environment. Its complexity lies in the aggregate of teacher accountability phases, making this accountability complete.

The main differences between the approach that we propound and classical PBL consist in taking into account specific characteristics of the extensive and comprehensive PBL environment, organizing the adaptive PBL environment, and realizing PBL as the two-stage process.

The adaptive PBL environment provides customization on performance of students. Its adaptability is expressed by the dynamic nature of the teacher's assessments to correspond with the knowledge dynamics, a flexible choice of control tests for students and projects for collaborative groups, and adaptive self-formation of the knowledge heterogeneous collaborative groups. It induces the students to acquire knowledge and develop collaborative skills.

Effectiveness of the approach is attained due to: organizing adaptive PBL, fostering adoption of specificity of the adaptive PBL environment, ensuring a balance between individual and collaborative learning, guiding collaborative performance of group projects, promoting acquisition of knowledge and development of collaborative skills, complexity of student knowledge evaluation.

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