

Development of Student Accountability in a Project-based Learning Environment

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Abstract In this paper, we propose an approach to development of student accountability for study of a subject in a PBL environment through its specific organization by a teacher. It allows to include process of developing accountability of students for PBL to accountability area of a teacher. Accountability of the students for PBL is developed by a seven-step process for the specific organization of the PBL environment. The steps are preparing the sample-project, setting initial knowledge assessments, ensuring study of a subject by a class through performance of the sample-project, promoting self-formation of collaborative student groups for performing projects of different levels of complexity, adapting PBL to knowledge dynamics of students by setting the adaptive assessments of knowledge, sustaining collaborative performance of the project tasks, and measuring student accountability. The stages of development of student accountability for PBL conformed to the steps of organizing the PBL environment are determined. The stages are engendering concern about the need to take accountability for studying the subject matter in the PBL environment, motivating students to take accountability for acquiring the subject-relevant knowledge while performance of the sample-project, the habituation of students to take accountability for study of a subject through performing a sample-project, inducing and guiding of students to take accountability for collaborative performance of projects of different levels of complexity, stimulating students to hold accountability for collaborative performance of the projects, reinforcing student accountability for collaborative performance of the project tasks, and evaluating development of student accountability and a level of accountability skills.

Keywords: *accountability of students, project-based learning*

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1. Introduction

A modern knowledge-based society requires developing progressive approaches to education. It causes the need of formation of a student –centered learning environment. The environment promotes independent, active, individual and collaborative learning by doing of students; involves students in what they are studying; encourages their interest in problem solving and critical thinking; allows teacher's monitoring of the development of students' knowledge and skills; and provides adaptability to each student [4,8,11,14,28].

A central teaching strategy fostering formation of the student –centered learning environment is Project-Based Learning (PBL). The strategy encourages independent and effective learning through performance of projects by students, improves ability to reach consensual decisions, and favors acquiring critical thinking, problem solving, learning to learn, communication, collaboration, and accountability skills [1,6,7,22,27,29,34,36].

The student –centered PBL environment assumes taking accountability by students for learning while performance of project tasks by them. Accountability is

“the willingness to accept responsibility for one’s actions” [25]. Willingness of a student for performance of project tasks incorporates his (her) ability and desire to perform the tasks. Hence, accountability of a student for learning in the student –centered PBL environment can be determined as his (her) ability and desire to accept responsibility for performing the project tasks.

A teacher should be accountable for encouragement of students’ willingness to learn in the student –centered PBL environment [2]. It causes accountability of a teacher for specific organization of teaching, collaborative learning, and assessment inducing students to take accountability for their learning in the PBL environment.

The ability of a student to perform a project task can be revealed by comparison of his (her) knowledge with task-relevant knowledge (knowledge needed for performance of task). There are four knowledge levels according to their determined roles in education. Thus, the know-what level represents cognitive knowledge; the know-how level deals with practical problems of design based on a synthesis of knowledge; the know-why level refers to deep knowledge of complex cause-and-effect relationships; and the care-why level represents self-motivated creativity [37].

The desire of a student to perform a project task can be motivated by perception of PBL as a convenient learning

environment. It is attained by adaptive assessment of students' knowledge, habituation of PBL, and opportunity of productive collaboration.

The proposed approach is aimed at development of student accountability for PBL through specific organization of the student-centered PBL environment by a teacher.

2. Related Research

In the following section some approaches, methods, and tools are reviewed in terms of their potential contribution to development of students' accountability for PBL, such as determining student accountability, improving student assessment, organizing student collaboration.

Determining student accountability

Schoof [31] examined relation between student-centered learning and student accountability. The author concluded that student accountability is caused by student-centered learning. Samuel & Chiche [30] described a personal accountability model, which enhances the intention to become accountable. The model is based on determining accountability as an action that is consistent with the student's desired outcomes.

Shavelson [32] propounded the need of mutual adjustment the between formative function of accountability, conducive to change 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 coordination of assessment activities with accountability.

An approach developed by Abu-Hussain, Essawi & Tilchin [1] promotes creating accountability for learning results, sharing accountability among students, and acquiring accountability skills in the PBL environment. The corresponding model was built for realizing the approach.

Improving student assessment

Hassel & Lourey [17] claimed that the improper mechanism of assessment used by instructor doesn't allow to change behavior of students towards taking accountability for learning. Frye [16] revealed the relationships among accountability, assessment, and student learning. The author showed the constructive role of assessment in improving student learning.

Lovie-Kitchin [20] claimed that assessment methods should be congruent with the PBL process. Macdonald & Savin-Baden [21] stressed the need in assessment methods taking into account the practical orientation of PBL. Ellis & Hafner [12] affirmed that assessment of a student in the PBL environment should be based on evaluation of the work of his team and his individual work both personal and as a member of the team.

Papanastasiou [26] defined adaptive assessment as one that is specific for each student and based on his (her) previous performance, thus making it more accurate in terms of individual ability. Aguilar & Kaijiri [3] developed an adaptive computer-based assessment system, which provides initial, formative, and summative assessments. The system generates questions adapted to the student knowledge. Lazarinis, Green & Pearson [18] created computerized adaptive testing system, which adapts based on student performance, instructional goals, and testing of knowledge of the subject matter.

Organizing student collaboration

Bell [6] concluded that interdependence of students in a collaborative group creates a situation in which each student has to do his (her) part of work while performance of project tasks. It causes accountability to peers and more motivation for students than if they were only responsible to the instructor.

Markham [23] suggested an approach to specific management of project performance directed towards building collective knowledge through collaboration. Stanton & Fairfax [35] 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. Various methods and means of facilitation of group interactions are suggested in works [5,10,13,15,19,38].

Soller [33] described various tools of adaptive support for collaborative learning to promote facilitation of interactions, motivation for knowledge sharing, and collaboration management. Brusilovsky & Peylo [9] considered adaptive group formation using knowledge about collaborating peers.

The publications discussed above indicate that no comprehensive approach exists to developing student accountability by specific organizing of the PBL environment that would improve study of a subject. The proposed comprehensive approach will promote development of student accountability due to:

- Ensuring study of a subject through sequential performance of the sample-project and the group projects
- Accustoming students to take accountability for study of a subject in the PBL environment
- Promoting self-assessment of student knowledge
- Inducing self-formation of the collaborative groups through self-assessment of students' willingness to take accountability for performing the project tasks
- Setting performance-based assessments of student knowledge
- Sustaining collaborative performance of the project tasks
- Adjusting projects and control tests to knowledge dynamics of students
- Measuring accountability development of students for performing the project tasks
- Determining a level of accountability skills acquired by students

3. Development of Student Accountability in the PBL Environment

The goal of the proposed approach is development of student accountability for study of a subject in the PBL environment through its specific organization by a teacher. Hence, development of student accountability for PBL is the accountability area of the teacher.

The basis of the approach is the comprehensive assessment process. It includes setting initial knowledge assessments, student self-assessment of knowledge after completion of a sample-project, setting adaptive (performance-based) knowledge assessments, and teacher

assessment of student knowledge while performance of the group projects.

Student accountability for PBL is developed by a suggested seven-step process of the specific organization of the PBL environment. The steps are preparing the sample-project, setting initial knowledge assessments, ensuring study of a subject by a class through performance of the sample-project, promoting self-formation of collaborative student groups for performing projects of different levels of complexity, adapting PBL to knowledge dynamics of students by setting the adaptive assessments of knowledge, sustaining collaborative performance of the project tasks, and measuring student accountability. The stages of developing student accountability for PBL correspond with the steps of organizing the PBL environment.

The step 1: Preparing the sample-project

The aim is engendering concern about the need to take accountability for studying the subject matter in the PBL environment.

A sample-project is prepared for the class so as to induce students' interest to learning the subject matter through project activity, and foster adoption of PBL specificity.

The sample-project contains a set of interrelated project tasks. Sample project-relevant knowledge (the knowledge required in order to carry out the sample-project) is set equal to the subject-relevant knowledge. Due to that, a set of the tasks corresponds to a set of subject topics. It means that one task or more than one task correspond to each subject topic, the order of the tasks' performance conforms to the order of studying the corresponding subject topics, and task-relevant knowledge (the knowledge required in order to perform a task) corresponds topic-relevant knowledge [1,2].

The step 2: Setting initial knowledge assessments

The aim is motivating students to take accountability for acquiring the subject-relevant knowledge while performance of the sample-project. For that, the initial assessments of student knowledge corresponding with different knowledge levels are set by the teacher.

The values of assessment are set according to ordered sequence of knowledge levels. The sequence is know-how, know-what, know-why, and care-why. The most value of assessment is set for know-how level. It is caused by the need to motivate students to learn by doing. The initial assessments of student knowledge corresponding with the subject topics and the sample-project tasks are set by dividing the initial knowledge assessments of the corresponding knowledge levels.

The step 3: Ensuring study of a subject by a class through performance of a sample-project

The aim is the habituation of students to take accountability for study of a subject through performing a sample-project. The aim is attained by facilitation and stimulation of acquiring subject-relevant knowledge and PBL experience by students since the subject matter is

submitted by a teacher in synchrony with the performance of the sample project tasks, and a project performance process fosters adoption of specificity of PBL.

The teacher suggests control questions for student self-assessment of knowledge corresponding with the various knowledge levels. Each student assesses his (her) knowledge acquired while performance of the sample-project tasks by answers to the control questions.

The assessment process is adjusted by the initial assessments of task-relevant knowledge of the corresponding knowledge levels. According to that, the knowledge self-assessments corresponding with the knowledge levels and the total self-assessment of knowledge are determined. The total self-assessment is the sum of the knowledge self-assessments for all knowledge levels.

The step 4: Promoting self-formation of collaborative student groups for performing projects of different levels of complexity

The aim is inducing and guiding of students to take accountability for collaborative performance of projects of different levels of complexity.

The descriptions of the projects of different complexity levels and the requirements to self-formation of collaborative groups are used for attaining the aim.

The project description includes the level of project complexity, the sequence of typical project tasks caused by their relationship, the task-relevant knowledge, and a bonus (addition to assessment) which can be gained by students as a result of a successful project performance. The project with a higher level of complexity has the more number of the project tasks which are the more complicated tasks. Existence of higher-order task relevant knowledge is required for their performance.

Example 1. The project description includes two projects of different levels of complexity, the sequence of tasks for each project, the task-relevant knowledge of all knowledge levels, and the bonus corresponding with each project. The project descriptions are represented by Table 1.

The requirements to self-formation of collaborative groups are set by a teacher. The requirements are

- The maximal number of students in the collaborative group is set. It fosters knowledge transfer through intensive intra-group interactions.
- Each project task should have a student who is accountable for task performance. It induces sharing accountability.
- Every student should hold accountability for performing the fixed number of project tasks related with different subject topics. It engenders diversity of accountability relations.
- One member of a collaborative group may be accountable for performing a project task. It personalizes accountability of students for qualitative and timely performance of a task.

Table 1. Description of the projects of different complexity levels

The level of project complexity	The sequence of typical project tasks	Task-relevant knowledge	The bonus
1	z_1, z_2, \dots, z_5	$k(z_1), k(z_2), \dots, k(z_5)$	5
2	z_1, z_2, \dots, z_6	$k(z_1), k(z_2), \dots, k(z_6)$	10

- The members of a collaborative group should be accountable for performance all project tasks. It engenders completeness of accountability.
- Providing compatibility of students by coordination of their personal characteristics. It promotes collaboration of students.
- The students of a collaborative group should participate in performance of all project tasks. It reinforces student accountability for task performance.

Attaining of the aim on this step of the specific organization of the PBL is provided by a process of self-formation of the collaborative student groups. At first, each student from the class chooses the project of determined level of complexity on the basis of comparison of student self-assessments of knowledge carried out after completion of the sample-project with the project descriptions (Table 1). It induces the students to take accountability for performing tasks of a project of the determined complexity level. Owing to that, the class is divided on the groups according to the project complexity levels.

Then, a student who chose the project of the determined complexity level evaluates of his (her) willingness to take accountability for performance of the determined project tasks. The willingness to be accountable is resulted by self-assessment of personal knowledge needed for performance of a task and the desire to take accountability, which is guided by the above requirements.

The results of students' self-evaluation can be represented in the table. The rows of the table correspond to the students. The columns of the table correspond to the subject topics and the project tasks related with the topics. The intersection of a row and a column contains the result of self-evaluation. The student's willingness to take accountability for performing a task is marked by symbol "A" in the intersection.

Example 2. Six students from the class chose the project of the second level of complexity. The sequence of typical project tasks is z_1, z_2, \dots, z_6 (Table 1). The maximal number of students in the collaborative group is set equal to three. Then, the number of collaborative groups is equal to two. The course includes five subject topics. Each collaborative group will perform separate project of the second level of complexity.

According the aforementioned requirements each student should take accountability for performance of two project tasks related to the different subject topics. The self-evaluation outcomes are represented in Table 2. Thus, the student s_1 makes decision to take accountability for the results of performing the tasks z_1 and z_2 , corresponding with the first and the second subject topic, accordingly.

Table 2. The self-evaluation outcomes

The students	The subject topics and the typical project tasks					
	t_1	t_2	t_3	t_4	t_5	t_6
	z_1	z_2	z_3	z_4	z_5	z_6
s_1	A	A				
s_2				A		A
s_3		A		A		
s_4	←			A	A	
s_5			A		←	A
s_6			A			A

Self-formation of the collaborative groups is realized through coordination of the self-evaluation outcomes of students guided by the aforementioned requirements. Coordination is realized through discussion of students with participation of an instructor. While the coordination each student compares the tasks for performance of which he (she) prefers being accountable with the tasks chosen by peers. The tasks chosen earlier by the student can be replaced by other tasks due to coordination with the peers.

Example 3. The student s_1 is incompatible with the student s_3 . The student s_2 is incompatible with the student s_4 . It means that the student s_1 may not be in the same collaborative group with the student s_3 . Analogically, the student s_2 may not be in the same collaborative group with the student s_4 . The coordination of the self-evaluation outcomes (Table 2) allows to form the two collaborative groups. Three students' s_1, s_2 and s_5 are included in the first group. Three students' s_3, s_4 and s_6 are included in the second group.

The student s_2 compete with the student s_5 for taking accountability for performing the task z_6 and there is lack of accountability for performance of the task z_5 . As a result of coordination the student s_5 takes accountability for performing the task z_5 instead of the task z_6 .

The student s_3 compete with the student s_4 for taking accountability for performing the task z_4 and there is lack of accountability for performance of the task z_1 . As a result of coordination, the student s_4 takes accountability for performing the task z_1 instead of the task z_4 .

The performed changes correspond with the above mentioned requirements to self-formation of the first and the second groups. The changes are shown by the arrows in Table 2.

The step 5: Adapting PBL to knowledge dynamics of students by setting the adaptive assessments of knowledge

The aim is to stimulate students to hold accountability for collaborative performance of the projects. Holding accountability for performance of the determined project tasks induces students to develop higher-order knowledge and leads to acquiring by them accountability skills. It requires setting more adaptive assessments of student knowledge regarding know-why and care-why levels then adaptive assessments regarding know-what and know-how levels.

Moreover, the adaptive knowledge assessment set for the collaborative group depends from the total knowledge assessment received after completion of the sample-project by summation of the individual self-assessments of knowledge of each group member. According to that, the more adaptive assessment of knowledge regarding know-why and care-why levels is set for the collaborative group having the more total knowledge assessment. It induces the students of such collaborative group to aspire to receiving the best learning results.

Example 4. An adaptive knowledge assessment for all knowledge levels is set equal to 100%. The total knowledge self-assessments of students of the first, and the second collaborative groups after completion of the sample project are 210 and 230, accordingly. Hence, the more adaptive knowledge assessment of both know-why and care-why levels is set for second group. The adaptive knowledge assessments set for students from the corresponding collaborative groups regarding the knowledge level pairs are represented by Table 3.

Table 3. The adaptive knowledge assessments of the collaborative groups

The knowledge levels	The adaptive knowledge assessments for the first group	The adaptive knowledge assessments for the second group
know-what and know-how	42	36
know-why and care-why	58	64

The adaptive knowledge assessments of the collaborative group students regarding the separate knowledge levels are set on the basis of the student self-assessment of knowledge after completion of the sample project. These assessments stimulate students to hold accountability for collaborative performance of the projects by developing higher-order knowledge.

Example 5. Knowledge development of the first group students after completion of the sample project regarding know-what level is higher than their knowledge development regarding know-how level. Hence, the adaptive knowledge assessment regarding know-what level for this group is set lower than the adaptive assessment regarding know-how level.

The knowledge development of the first group students regarding know-why level is higher than the knowledge development regarding care-why level. Consequently, the adaptive knowledge assessment regarding know-why level is set lower than the adaptive assessment regarding care-why level. The adaptive knowledge assessments for students of the second collaborative groups are set on the basis of similar inferences.

The adaptive knowledge assessments regarding the knowledge levels of students of these collaborative groups for performance by them the group projects are represented by Table 4.

Table 4. The adaptive knowledge assessments of the collaborative group students

The knowledge levels	The adaptive knowledge assessments	
	the first group	the second group
know-what(k_1)	15	12
know-how (k_2)	27	24
know-why(k_3)	18	22
care-why (k_4)	40	42

Since the project chosen by the collaborative group students includes six tasks, then the adaptive knowledge assessments of students regarding know-what, know-how, know-why, and care-why levels for each task are determined by dividing of the corresponding adaptive knowledge assessments of the collaborative group students for performing the project (Table 4). As a result of that, the task oriented adaptive knowledge assessments regarding the knowledge levels for students of the first group are equal to 2.5%, 4.5%, 3.0%, and 6.67%, accordingly. The adaptive assessments for students of the second group are equal to 2%, 4%, 3.7%, and 7%, accordingly.

The step 6: Sustaining collaborative performance of the project tasks

The aim is to reinforce students' accountability for collaborative performance of the project tasks. Collaborative performance of the project tasks is sustained

by the teacher's control and the possibility of use of the sample-project as a guide to performance of similar project tasks.

Project performance control is realized by setting the control points all of which are correspond with the fixed number of the project tasks, and assessing the task-relevant knowledge regarding the various knowledge levels gained by each student of collaborative group through testing in a control point.

If a student passed the control test then his (her) assessment is equal to the corresponding adaptive assessment. If a student didn't pass the control test correctly or completely, then the corresponding assessment is marked.

Control of student knowledge during project performance promotes concentration of the students' attention on performance of the project tasks that causes reinforcement of their accountability for collaborative performance of the tasks.

Example 6. The two control points are set. The tasks z_1 , z_2 , and z_3 correspond with the first point. The tasks z_4 , z_5 , and z_6 correspond with the second point. Results of the teacher assessment of the task-relevant knowledge gained by students of two collaborative groups in these control points are represented by Table 5.

The step 7: Measuring student accountability

The aim is to evaluate development of student accountability and a level of accountability skills.

Personal accountability for performance of the determined project task taken by a student motivates him (her) to search creative extraordinary solutions while task performance. It induces a student to develop knowledge of the care-why level. Hence, the assessment of student knowledge of the care-why level can serve as measure his (her) personal accountability for task performance.

The personal accountability measure can be reinforced by knowledge assessment of the care-why level others students of the group. It incites the student to energize others group students to achieving the best task performance. For this, the student favors effective collaboration of the group students aimed at developing their knowledge of the care-why level. Owing to that, an additional accountability measure is determined by summation of knowledge assessments of the care-why level of the group students. It allows to determine the reinforced accountability measure for performance of the task by summation of the personal and additional accountability measures.

The integrated accountability measure of the student is equal to sum of the personal accountability measures. The integrated reinforced accountability measure of the student is determined as a sum of the reinforced accountability measures. The integrated reinforced accountability measure for project performance is equal to sum of the

integrated reinforced accountability measure of all group students.

Example 7. The personal accountability measures of the student s_1 for performance of the tasks z_1 , and the z_2 are equal to 6.4%, and 6.5%, accordingly (Table 5). Then, the integrated personal accountability measure of the student s_1 is equal to 12.9 %.

The additional accountability measure of the student s_1 for performance of the task z_1 is determined as a sum of the knowledge assessments of the care-why level of the students' s_2 and s_5 . These assessments are equal to 4%, and 3.5%, accordingly (Table 5). Then, the additional measure of accountability is equal to 7.5%. The additional

accountability measure of the student s_1 for performance of the task z_2 is determined similarly. It is equal to 6.8%.

The reinforced accountability measures of the student s_1 for performance of the task z_1 and the task z_2 are equal to 13.9%, and 13.3%, accordingly. Then, the reinforced accountability measure of the student s_1 is equal 27.2%. The measures of student accountability for task performance for second collaborative group are determined similarly. The integrated reinforced measure of accountability for project performance by first and second collaborative group is equal to 74%, and 78%, accordingly. The measures of student accountability are represented by Table 6.

Table 5. The student assessments after completion of the group projects

The sequence of the project tasks	The adaptive knowledge assessments of the first group students regarding knowledge levels	The received knowledge assessments of the first group students			The adaptive knowledge assessments of the second group students regarding knowledge levels	The received knowledge assessments of the second group students		
		s_1	s_2	s_5		s_3	s_4	s_6
z_1	$k_1(2.5)$	2.4	2.0	1.9	$k_1(2)$	1.7	1.6	1.5
	$k_2(4.5)$	4.3	3.9	3.6	$k_2(4)$	3.5	3.7	3.2
	$k_3(3)$	2.6	2	1.8	$k_3(3.7)$	3.1	3.3	3.0
	$k_4(6.67)$	6.4	4	3.5	$k_4(7)$	3.4	6.3	3.1
z_2	$k_1(2.5)$	2.2	1.8	1.6	$k_1(2)$	1.7	1.6	1.8
	$k_2(4.5)$	4.1	3.6	3.4	$k_2(4)$	3.7	3.5	3.0
	$k_3(3)$	2.7	1.5	1.2	$k_3(3.7)$	3.2	3.1	3.4
	$k_4(6.67)$	6.5	3.6	3.2	$k_4(7)$	6.8	3.6	3.7
z_3	$k_1(2.5)$	2.4	2.0	2.3	$k_1(2)$	1.7	2.0	1.8
	$k_2(4.5)$	3.8	3.5	4.0	$k_2(4)$	3.6	3.2	3.5
	$k_3(3)$	1.8	1.5	2.2	$k_3(3.7)$	2.8	3.0	3.2
	$k_4(6.67)$	3.1	2.7	6.0	$k_4(7)$	3.0	3.3	6.0
z_4	$k_1(2.5)$	2.4	2.3	2.0	$k_1(2)$	1.8	2.0	1.6
	$k_2(4.5)$	4.2	4.0	3.8	$k_2(4)$	3.5	3.6	3.2
	$k_3(3)$	2.3	2.5	2.0	$k_3(3.7)$	3.2	2.8	2.6
	$k_4(6.67)$	3.5	6.2	3.0	$k_4(7)$	6.6	3.8	3.6
z_5	$k_1(2.5)$	2.0	1.8	2.2	$k_1(2)$	1.6	1.8	2.0
	$k_2(4.5)$	3.6	3.4	4.2	$k_2(4)$	3.4	3.6	3.7
	$k_3(3)$	1.6	1.4	2.0	$k_3(3.7)$	2.8	3.0	2.5
	$k_4(6.67)$	2.8	2.5	5.8	$k_4(7)$	3.2	6.2	3.6
z_6	$k_1(2.5)$	2.3	2.2	1.9	$k_1(2)$	1.5	1.8	1.7
	$k_2(4.5)$	4.0	3.9	3.6	$k_2(4)$	3.3	3.6	3.3
	$k_3(3)$	2.0	2.2	1.8	$k_3(3.7)$	3.0	3.2	3.5
	$k_4(6.67)$	3.1	6.0	2.8	$k_4(7)$	3.2	2.8	5.8

Table 6. The measures of student accountability

The accountability measures of students	The first collaborative group						The second collaborative group					
	s_1		s_2		s_5		s_3		s_4		s_6	
	z_1	z_2	z_4	z_6	z_3	z_5	z_2	z_4	z_1	z_5	z_3	z_6
The personal accountability measure	6.4	6.5	6.2	6.0	6.0	5.8	6.8	6.6	6.3	6.2	6.0	5.8
The additional accountability measure	7.5	6.8	6.5	5.9	5.8	5.3	7.3	7.4	6.5	6.8	6.3	6.0
The reinforced accountability measure	13.9	13.3	12.7	11.9	11.8	11.1	14.1	14.0	12.8	13.0	12.3	11.8
The integrated personal accountability measure	12.9		12.2		11.8		13.4		12.5		11.8	
The integrated additional accountability measure	14.3		12.4		11.1		14.7		13.3		12.3	
The integrated reinforced accountability measure	27.2		24.6		22.9		28.1		25.8		24.1	
The integrated reinforced accountability measure for project performance	74						78					

Table 7. The conformity between the specific organization of a PBL environment and development of student accountability for PBL

N	The steps of the specific organization of a PBL environment	The stages of development of student accountability for PBL
1	Preparing a sample-project	Engendering concern about the need to take accountability for studying the subject matter in the PBL environment
2	Setting initial knowledge assessments	Motivating students to take accountability for acquiring the subject-relevant knowledge while performance of the sample-project
3	Ensuring study of a subject by a class through performance of a sample-project	The habituation of students to take accountability for study of a subject through performing a sample-project
4	Promoting self-formation of collaborative student groups for performing projects of different levels of complexity	Inducing and guiding of students to take accountability for collaborative performance of projects of different levels of complexity
5	Adapting PBL to knowledge dynamics of students by setting the adaptive assessments of knowledge	Stimulating students to hold accountability for collaborative performance of the projects.
6	Sustaining collaborative performance of the project tasks	Reinforcing student accountability for collaborative performance of the project tasks.
7	Measuring student accountability	Evaluating development of student accountability and a level of accountability skills.

Example 8. The integrated personal accountability measure of the student s_1 is more than the integrated personal accountability measures of the students s_2 and s_5 (Table 6). It means that knowledge of care-why level of the student s_1 allows him to perform the project tasks for which he (she) is accountable more qualitatively.

The integrated additional accountability measure of the student s_1 is also more than the integrated additional accountability measures of the students s_2 and s_5 (Table 6). It means, that the student s_1 could energize the students' s_2 and s_5 to be more creative while performance of the project tasks for which the student s_1 is accountable. Hence, the integrated reinforced accountability measure of the student s_1 is more than the integrated reinforced accountability measures of the students' s_2 and s_5 . Comparison of the accountability measures for performance of the project tasks by students from second collaborative group is realized similarly.

The integrated reinforced accountability measure for project performance by the second collaborative group is more than the integrated reinforced accountability measure for project performance by the first collaborative group. It means that students of the second collaborative group performed the project tasks for which they are accountable more qualitatively. Furthermore, the students of the second group are more stimulated by higher adaptive assessments set for higher-order knowledge than the students of the first group (Table 4).

Accountability skill of a student is ability to hold self and others accountable for project task performance. Owing to that a level of accountability skills characterizes quality of task performance caused by creative decisions depending on care-why knowledge level. Hence, the accountability measure can determine a level of accountability skills. If the accountability measure is more, then the level of accountability skills is higher.

Example 9. The accountability measure of the student s_2 is more than the accountability measure of the students s_2 and s_5 (Table 6). Owing to that, the level of accountability skills of the student s_1 is higher than the level of accountability skills of the students' s_2 and s_5 .

4. Conformity between the Specific Organization of a PBL Environment and Development of Student Accountability for PBL

The fulfilled exploration sets conformity between the steps of the specific organization of a PBL environment and the stages of development of student accountability for PBL. The conformity is represented by Table 7.

5. Conclusion

The approach to development of student accountability for study of a subject in the PBL environment through a seven-step process of its specific organization realized by a teacher is proposed. Conformity between the steps of organizing the PBL environment and the stages of development of student accountability for performance of group project tasks is set. It means that the each step contributes to development of student accountability for performance of the project tasks.

Specificity of organizing PBL consists in ensuring subject study through sequential performance of the sample-project and the group projects, promoting self-formation of the collaborative groups for performing projects of different complexity levels, realizing the comprehensive process of assessment of student knowledge, and sustaining collaborative performance of the project tasks.

The accountability measure is proposed for measurement of student accountability for performance of the project tasks. Correspondence of the accountability measure of a student for performance of the project tasks with a level of his (her) accountability skills is established. It allows evaluating development of student accountability and a level of accountability skills. The accountability measure of a student combines the personal accountability measure

and the additional accountability measure of the collaborative group members. As a result of combination, the reinforced accountability measure of a student for performance of the project tasks is formed.

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