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# E-Learning Environments and Problem-Based Learning

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***Abstract***

*This paper studies e-learning environments and problem-based learning. The authors identified to teach principles in e-learning environments for effective learning and teaching. As a research result, it is outlined that problem-based learning develops human cognition by using e-learning materials and it is necessary to change learning materials for students in order to make them think about real problem-solving decisions based acquired theory. Problem-based learning style is recommended to use in different teaching ways such as in seminars, assessment, role play, teamwork, etc. The authors also analyzed its benefits and drawbacks which are faced in teaching. Furthermore, how to use digital technologies in education was described according to different researchers.*

***Keywords:*** *e-learning, educators, students, teaching, PBL, technology*

## 1. Introduction

There is widespread concern about sustainable development across the globe. United Nations Economic Commission for Europe Strategy depicts sustainable development as being supported by an ethnic of solidarity, mutual and equal respect among people, nations, cultures, countries and generations; it is natural development in harmony which meets the needs of the modern generation without compromising the ability of future generation to meet their own needs (This definition is consistent with the United Nations Declaration on the Right to Development, established in General Assembly resolution 41/128 on 4$^{th}$ December 1986, and as well as with the Rio Conference Declaration on Environment and Development between 3-14 June 1992). Education plays a great role to support and enable people to live in sustainable society. There should be a continuous and lifelong learning and a change which will be engaged in providing knowledge and leadership in formal and non-formal learning. This process requires different competences that should be formed and developed in educators and future teachers (students) at all levels of education because educators bring up all the human beings starting from the kindergarten to becoming an expert in one specialty. According to reference [1], key competences for educators include:

- A holistic approach, which seeks integrative thinking and practice. It is related to global challenges which require global and local awareness of how change in one part impacts on the other part of the world and what other consequences this change will have in the future.
- Envisioning change, which explores alternative futures, learns from the past and inspires engagement in the present. This process leads towards to sustainable development by exploring positive futures for people and nature.
- Achieving transformation, which serves to change in the way people learn and in the system that support learning. Education is composed of human work and a key to change the practice.

Educators need such competences [2-3] as understanding the need for transformation, flexibility to change and collaborative skills for sustainable development. We should use digital technologies' benefits in education; they help educators to teach a lesson in a different way and leads to human development [4-5].

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## 2. Teaching Principles in E-Learning Environments

E-learning environments have received increasing attention since the emergence of technology-based learning in the educational process. Almost all educational programs incorporate information communication technology to some extent. Thus, e-learning environments create various opportunities for students to interact with other students, teachers and authentic online materials. Teaching principles are needed for controlling the e-learning environments and are essential to the translation of theoretical framework into practical teaching techniques [6]. Teaching is a daunting task. To develop students' cognitive competence, we came up with several principles in e-learning environments. These principles include the following statements:

- plan the educational process before the course commencement;
- encourage contact between students and e-learning materials;
- encourage students to be proactive;
- give prompt feedback and assessment in challenging e-learning tasks;
- set time on completing e-learning tasks;
- support constant communication with students to control the learning process;
- respect diverse learning styles and learning rate;
- trust in students' achievements in e-learning environments;
- organize to meet after completing e-learning assignments to discuss and to explicate the challenging and daunting tasks;
- assess the learning processes and outcomes of students.

These principle statements foster social and cognitive development of students and are also associated with the assessment responsibilities of teachers to successfully achieve desired learning outcomes. The internet and communication technologies have flattened the educational world and created enormous opportunities, interaction and flexibility for learners and teachers as well. There are different methods to meaningfully do deliver a lesson to students. To design or plan a lesson is a central task to find out the potential of e-learning environments. The educational system is a complex process which produces unexpected learning outcomes. Planning a lesson should be flexible to meet the needs of students. The learning quality depends on the principles. The first attention must be given to creating open communication among students and working independently in e-learning environments. By creating these conditions, students are expected to be sociable. Social presence links directly to the cognitive presence and learning processes. They are interdependent and influence each other [6]. In order to develop social and cognitive skills of students, problem-based learning (PBL) is one of the most effective ways. In PBL students have an opportunity to work in a team and to engage in collaborative activities by using e-learning materials.

## 3. How Cognitive Development Related to Problem-Based Learning

Bernhard Schindlholzer in Ted Talks on artificial intelligence and the future of education systems states that hiring people will decrease in the future because human working force might be replaced by artificial intelligent robotic technologies. For more information, please, visit this webpage published on 4 August 2016: https://www.youtube.com/watch?v=ZdHhs-I9FVo. In order to solve this problem, Bernhard Schindlholzer suggests using problem-based learning style, immersion and simulation in the future of education. These three aspects are interrelated with each other. Problem-based learning means that students are challenged to apply their knowledge to real-world problems, and they need to rephrase and rethink and reframe the problems to identify new solutions and maybe even realize they have been trying to solve the problem all along. That is something that is typically they do not do because most exams still try to force students to come up with only one right answer. Problem-based learning finds drastic new solutions to existing and new problems. Shifting away from this process where teachers transform the knowledge and then they examine whether students have successfully acquired knowledge, will be a thing of the past.

Next aspect which is specific to this kind of teaching is the immersion. It a real-time decision making over longer periods of time. An aspect of the simulation is great of importance for students. Students can conduct experiments on the given task, they might try again and again if it is necessary or vice versa they might fail again. If they are even at the end of the educational course, and they have been continuously failing, the course aims not only to charge on the outcomes students have achieved, but also on their style, on their ability to apply knowledge and to try to solve the problems. Thus, education needs to train students to solve hard problems while experiencing the simulation of real life. There is no need to panic about the rise of technology, the opportunities that technology brings to solve the hardest problems in the world should be actually embraced.

Problem-based learning style is a student-centered education in which students learn about a subject through the experience of solving open-ended problems given by a teacher. PBL is a teaching method in which complex real-world issues are given to learners for analyzing as a task during their study period. It promotes learning of concepts and principles as opposed to direct presentation of facts and concepts. In addition to educational program content, PBL can promote the development of critical thinking skills, problem-solving abilities, communication skills and analytical cognitive competences in adult education. It can also provide opportunities for working independently or in groups. It depends on the task of PBL. Learners find problem-based learning solution and evaluate research materials, and it might lead to life-long learning [7]. In PBL students have a good chance to use the theory in real life and they are motivated to research cases related to their acquired knowledge.

PBL style is a teaching approach to adult education that has the following features. Small groups of students discuss a problem guided by a teacher. Based on the discussion about the given case study, students activate learning goals for subsequent self-directed learning. They study individually as well while searching for a solution. Afterwards, students discuss it in a group and make the right decision by their acquired theoretical knowledge. For instance, students have a choice to decide which learning goals they would set in order to adequately deal with the problem. After a period of individual learning, students share with their data what they have collected about the topic and check if their new understanding of the problem is now more accurate than before. Once students are satisfied with their learning results, they move forward and engage with a new case study and the cycle starts all over again and again [8].

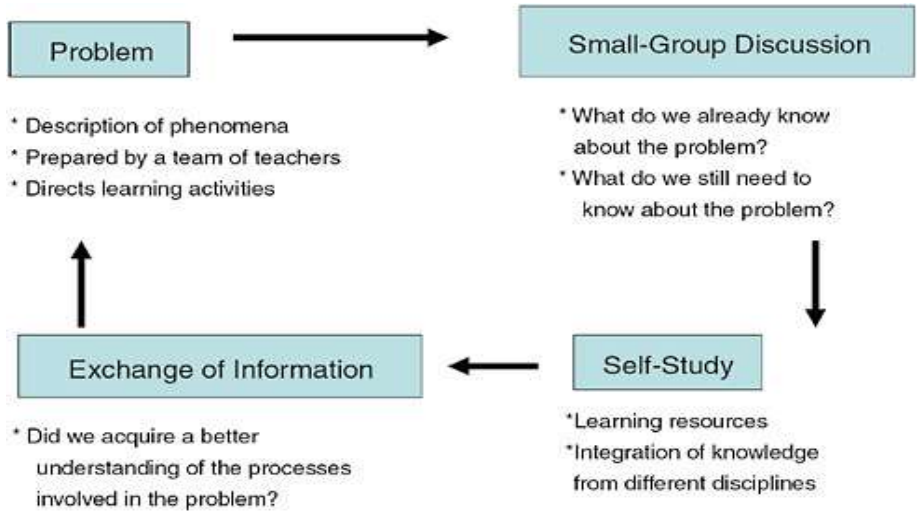


**Figure 1. Source: Gijbels (2008) https://www.nap.edu/read/13099/chapter/5#27**

This process (Figure 1) leads to students' cognitive development. David Gijbels described the cycle of problem-based learning (see the table above 'source: Gijbels'). After the teachers present a problem to the class, students will meet in small groups or work alone online, in a library to collect data in order to find information for discussing what they know about it and what they need

to learn. After an ephemeral period of independent study, students collect necessary resources to solve the case problem. They then work in a small team to re-assess their collective understanding of the issue. When they solve the problem, the teacher provides different case studies and the cycle begins anew [9]. According to [8], PBL can be interpreted as a form of cognitive-constructivist learning, based on at least three assumptions:

1. In PBL students engage in theory construction. Students in a small group discussion develop an initial theory about the phenomena described in the case. As a result, self-directed learning generates, for example, reading books or surfing internet resources for getting more information. They enrich their theoretical knowledge by analyzing the given case.
2. Studying authentic problems or real-life problems based on their experience encourages students to become interested in the topic. Subsequently, this process helps them gain a deeper understanding of the principles or processes underlying the problem.
3. Being in the position to set one's own learning goals and to achieve them to solve the problem in collaboration with peers fosters a feeling of independence. Being independent of the direct teacher intervention and students feel in charge of one's own learning, responsible for completing the given task. This process is supposed to result in increased cognitive engagement with the topic to be learned, that gradually encourages a deeper understanding of it.

There is some empirical evidence which suggests when students learn a new topic in the tutorial group, they try to construct a mental model or "theory" that explains the phenomena described in a new topic. For instance, in [10] showed students videos of their own contributions to a tutorial discussion and asked them to recall what they were thinking. This process stimulated recall procedure in combination with verbatim transcripts of the verbal interaction in the group. Learners indeed build a theory on their own, suggest hypothesis evaluation. It comes from central thinking abilities and verbal utterances of the students. Another good example comes from learning a foreign language. When a lecturer tries to explain how to form a present simple in positive sentences with regular verbs in the English language by showing them just one verb in a table. Students start to suggest own theories by analyzing the given table that a verb gets an ending 's' in the 3rd form of personal pronoun and there is no ending in other personal pronouns, or a verb does not get changed except the third form in the singular.

A language lecturer might offer a different kind of critical and analytical thinking exercises in the classroom. Consequently, language learners think a lot, it means that the first assumption takes place in this process; when students train their created theories by doing practical exercises at home as home tasks, which means that the second assumption takes place here. Thus, they start to speak in a foreign language and to understand while communicating with a native speaker. This process belongs to the third assumption. This method is aimed at adult education in foreign language teaching. Because it is not possible to teach children to theories, especially in linguistics. Children acquire foreign language knowledge in a language environment. It is a big difference between adult and child linguistic education. This third assumption is the most successful process in the cognitive development because it has a positive effect on interest and engagement. Learners have an innate psychological need for cognitive competence. By feeling satisfied with their learning outcomes and being independent of a teacher empowers students to have a motivating effect; it also encourages students to engage themselves cognitively with the task at hand. Following this line of thought, in [8] hypothesized that when students feel autonomous (from the tutor and the team members) they would display more cognitive engagement with the task.

As a result, if the task parameters change during a learning process, as it is the case in problem-based learning style. The learning style of students and their personalities are different, that is why they perceive different levels of autonomy and consequently engage differently. For example, in PBL style during the initial phase of identifying a case, students have to work in a group under the lecturer instruction. During this phase, it might be concluded that students' autonomy would be relatively low. However, afterwards, students undertake independent self-study, and their autonomy would be relatively higher than in the classroom and thus they would be more

cognitively engaged to solve the given tasks. After this, students share their findings by presenting their analysis which leads to cognitive development.

Social interaction in the PBL leads to engagement in joint activities; thus, cognitive presence evolves in students while doing their academic assignments. PBL involves an individual student or a group of students researching specific research work or completing academic assignments. This type of learning actually undertakes to use one's own theoretical knowledge in the practice and additionally to get more knowledge about the subject topic. Respectively, PBL creates individual tasks or group assignments, immediate feedback to create an educational environment in which students can achieve their academic success.

## 4. Applying PBL in Teaching

PBL can be used as a teaching aid in class to stimulate interaction between students and the exploration of a difficult concept. For example, when introducing one problem to be solved in the classroom, a simple class exercise can be used by giving groups different problem-solving tasks and asking them to see if they can detect the behavior in their example. This then leads on to an in-depth discussion of the concept at the class level.

*PBL can be used in seminars*. It can help students to think more actively about a topic by applying their given problem-solving tasks rather than the formal way of teaching which can make seminars dull and uninteresting for all who are taking part.

*PBL can be used by whole course delivery*. Students put themselves into solving learning problems on the very early outset of the course, they choose a specific topic that they want to research further and they work on that case throughout the taught part of the module. The course is delivered using a variety of learning and teaching methods with student participation.

*PBL can be used effectively in ass*essment in written examinations. A successful application in examinations is that students should be told that they would be involved in solving practical problems in the examination, which would consist of case studies and they would be asked to create their own undergone cases based on theory and suggest its solution by analyzing every character in the situation. In this way, students are encouraged to take a deep approach to the theory as they can select the theory they were particularly interested in and study it in detail rather than cramming their heads with facts, which often happens with unseen examinations.

*PBL can be used in presentations including role play*. Problem-solving tasks provide a useful way of engaging small teams of students in active information seeking and evaluation to justify an active approach and give an oral presentation on their research and even role-play scenarios.

*PBL can be used in writing essays*. Problem-solving tasks can be used very effectively for academic assignments that require students to demonstrate understanding in an applied setting. They can also be used to ask students to take a more sophisticated critical approach and use their pedagogical and psychological understanding of research.

By using PBL as a teaching tool, teachers might face some factors that indicate its benefits and drawbacks (Table 1). Notwithstanding its drawbacks, the advantages outweigh its downsides and lead to the development of students.

**Table 1. Benefits and drawbacks of PBL in teaching**

| Dimension of PBL | Benefits | Drawbacks |
|---|---|---|
| **Authenticity** | Problem-solving tasks emanate from real life to engage students to make a decision. Students may engage more with the story if they have some related personal | It might be difficult to find the correct solution to the problem because of lack of experience. |

| | | |
|---|---|---|
| | experience of the described problem. | |
| **Self-directed learning** | PBL directs students to tutor devised solutions. | It takes much time for students to learn by themselves in order to solve the problem. |
| **Academic strict process** | PBL leads students to use their knowledge and to accumulate it properly. It encourages students to develop their cognitive skills such as decision making and thinking skills. PBL requires students to engage in real authentic research work by using a variety of media and methods. Students are encouraged to present their research outcomes in front of an audience. | PBL requires students to spend significant amounts of time for investigating a research problem. Students might feel stress if the time is not enough to repeat all the related theoretical subject topics for solving a problem. |
| **Teamwork** | PBL will enable students in teamwork to meet the specific learning outcome of a particular problem-solving task. | It will be difficult to conclude one solution since there are many students in a team and respectively, too many changes in a storyline are confusing and make it difficult for students to deal with. |
| **Assessment** | PBL provides opportunities for students to assess their knowledge by themselves and to set learning goals for developing their learning strategies in order to achieve learning outcomes. | An assessment might be unfair because of the different learning styles. For instance, some students belong to a social type of learners whereas others might be a solitude learner. |
| **Consumption of Information technology** | Development of digital competence | Lack of proof that the information is completed by an assigned student. |
| **Teaching objectives** | PBL should design the course to accumulate gaps in the students' knowledge. | There is no limit to deliver PBL. |

We suggest that using PBL helps students to appreciate the contingent nature of knowledge. By this, we mean a form of advanced thinking, which reflects epistemic assumptions that our understandings of the world are not given but must be actively constructed by understanding knowledge in the context in which it was activated. In addition, PBL can be a useful tool for helping students to plan and complete their professional advancement in knowledge which leads to cognitive development.

## 5. How to Use Digital Technologies in Education

Recent research [11] has shown that online games develop collaborative learning, critical thinking, and problem-solving skills among youth. Applying online games such as in schools is significant in the digital era. For instance, students benefit from Minecraft to enhance learning activities in science, technology, architecture, physics, engineering, math and as well as linguistic skills such as writing, speaking, listening and reading. Additionally, teachers benefit from using Minecraft as a teaching tool in the classroom to increase academic engagement with students. Online games have the potential to push a player to think cognitively and to interact socially with

others. Players creatively build their new virtual world; they participate in complicated problem-solving tasks. This study recommends online games to be implemented in the classroom as a teaching and learning tool for motivation and to improve academic activities. As [12] stated that play is a significant mediator for learning and socialization. Another study [13] focused on the impact of e-learning on academic performance. This study explored traditional lectures and e-learning methods. Research result showed a negative impact of e-learning on academic achievement due to some human factors such as social demographic characteristics, individual personalities, lack of proper instruction in e-learning environments and study hours. After thoroughly analyzing the data retrieved from this research, in [13] came to conclusion that effective teaching methods in e-learning environments should be improved aiming to teaching and learning strategies in higher education.

Scott Bolland, who has been exploring the science of learning, the mismatch between how we teach and how the brain natural learns, and the important role that artificial intelligence (AI) could take in addressing the limitations in our current education system for more than 25 years, believes in Ted Talk on 'Neuroscience, AI and the Future of Education' that modern education does not need to be reformed, it needs to be transformed. Education needs less standardization and more personalization. For more information, please, visit the webpage published on 1st of June 2016: https://www.youtube.com/watch?v=_cYIvfS-knA. He states that teaching is in the ten top of the most stressful jobs and for teachers, it is a daunting task to personalize a lesson for each student. He outlines from his AI research practice that AI enabled the e-learning education and it is able to give a personalized education. It is about expanding and improving at an exponential right. AI offers 3 levels of learning:

1. Rote learning (It is about answering a simple question. For example, what is 2+3? Or which city is a capital of Kazakhstan?); here mostly students learn taught materials by heart to pass an exam but after cramming they might forget everything in a few days. Another result will be that students learn not too much. Spaced repetition is the best way to refresh what has been forgotten; for example, by giving a classroom flashcard to optimize the rote learning and here every single student will present what they know; it is a quite easy technology to repeat materials what they know and what they do not know. Teachers should possibly often use Q and A technique while planning a lesson.
2. Generative AI (Teaching should be problem-solving, active learning and creativity); lesson is not only to listen to a student and to give feedback. It should generate a student's skills; for instance, students who learn foreign languages should record new active vocabulary on the electronic device and match the pronunciation of new words with the authentic materials. It is not possible for teachers to check every single student's skills and here digital technologies benefit students and teachers to work effectively (Figure 2).

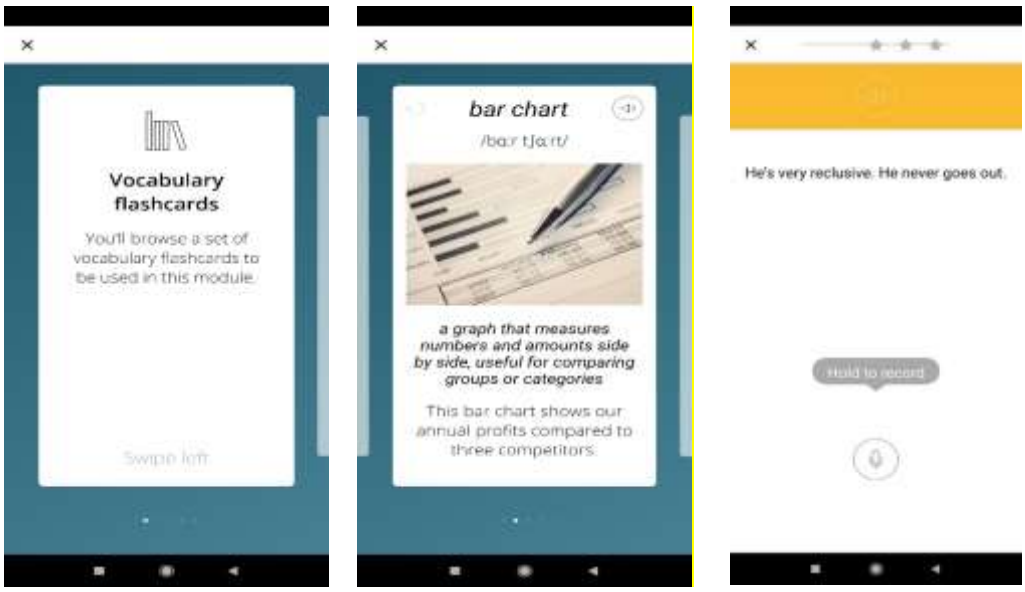


**Figure 2. Example of an online vocabulary section in the EF (Private screenshot)**

3. Integrative AI (It is coming up in the future of the education); generative AI is related to human skills and abilities for optimal learning whereas integrative AI is a tendency to change learners' potential to unlock their ability by using digital technologies. Learners need someone to delight them, someone who helps them to find a natural joy and curiosity, someone to help them to explore their one pace and topics that fascinate them. So, a teacher should be that someone! AI enables to provide personalized learning style and helps teachers to do less work, especially in examining acquired knowledge of students. That means that AI eases human beings' challenging tasks.

Digital technologies also have the potential to support collaborative learning activities [6]. Educational study has demonstrated that classroom and online activities are an effective way to engage students in the deeper learning process [16]. For example, students might be asked by a teacher to collect some information in the e-learning materials that are related to a subject topic before their lessons begin. Afterwards, they can be asked to take part in the discussion or present their data in the form of presentation. Outcomes of learning resources can be easily shared by using digital technologies for further learning. They can be also easily edited or reviewed by students and teachers (Figure 3).

**Topic** You're going to give your opinions about robots.

**Grade** 80 (out of 100)

**Comments:**

1. Missing Word: You have written the sentence 'these technologies replace'. The meaning of the sentence becomes complete after inserting the missing word. Here the missing word is 'will' which is added to the sentence. The correct sentence is 'these technologies will replace'. This is a helping verb (is, am, are, was, were, will, shall etc.) and this is necessary to show the tense (present, past or future).
2. Word Choice: Use the noun form of this word to address it as a specific concept or thing. Nouns are the only word that can fill the important roles of subject and object in any sentence. You have used the word 'advance' and writing the sentence 'The mane advance of'. The correct word to use here is

'advantage'. E.g. 'The main advantage of'. It means a condition or circumstance that puts one in a favourable or superior position.

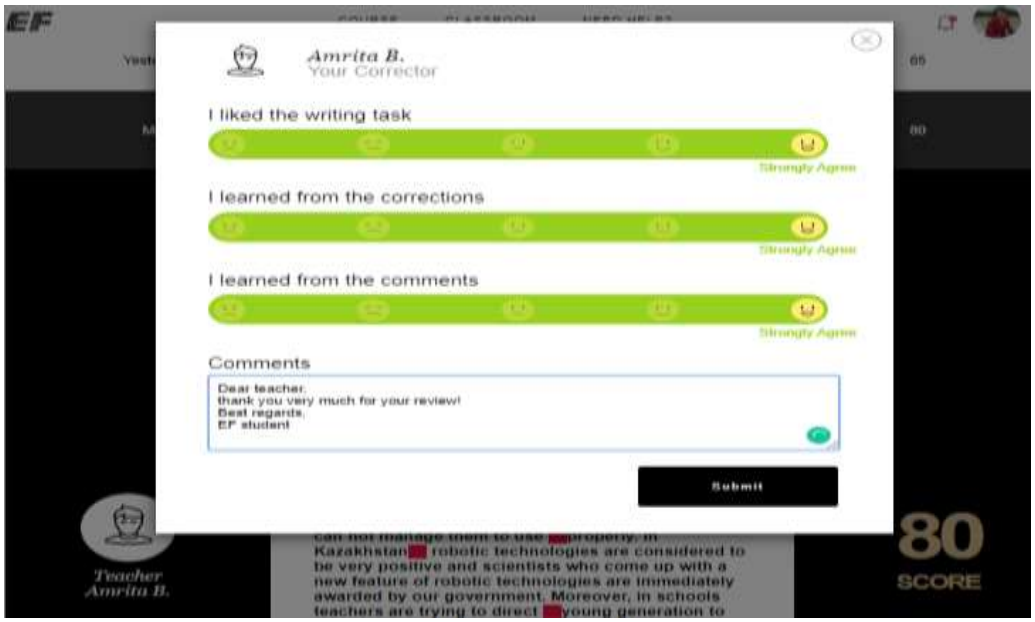


**Figure 3. Example of an online review: EF platform's feedback between a teacher and a student on writing task (Private screenshot)**

Assessment plays a key role in the learning process. By giving feedback, students and teachers learn more about the learning outcomes and this process leads to further learning and teaching correction. Assessment helps to clarify what good performance is; it fosters to self-assessment in learning and delivery of high-quality information about students' learning outcomes; it also provides opportunities to close the gap between current and desired performance [6, p. 82-83]. Digital technologies enable online assessment nowadays (Figure 4). Students and teachers can observe online their learning outcomes.

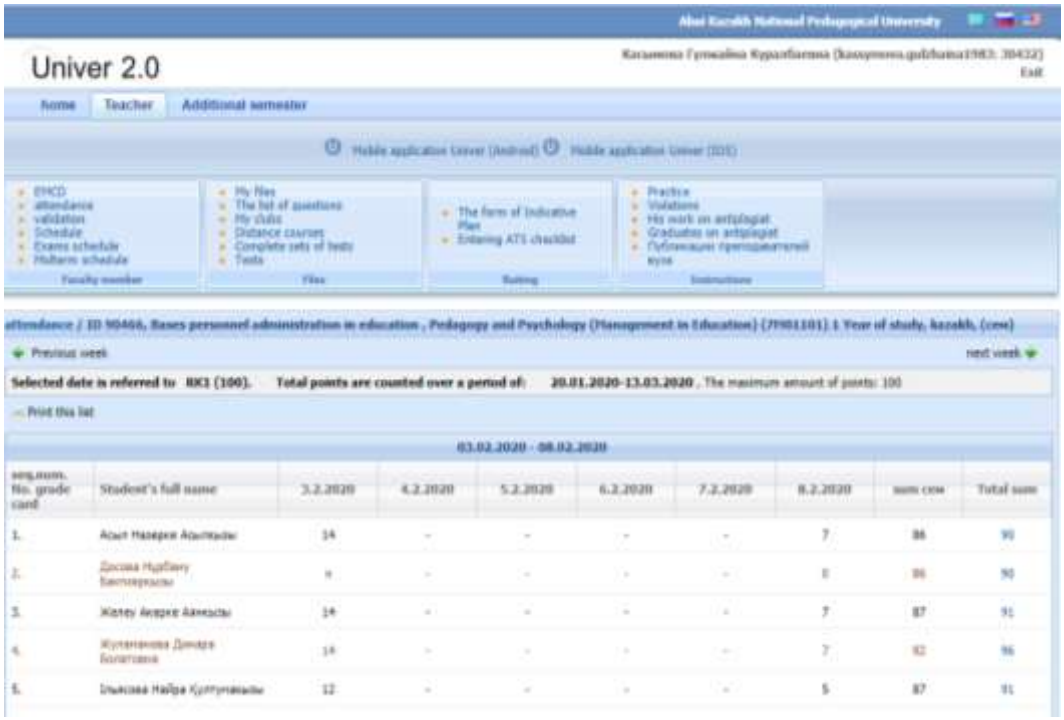


**Figure 4. Example of an online assessment system: univer-system for assessment at Abai Kazakh National Pedagogical University (Private screenshot)**

## 6. Conclusion

To sum up, learning should be challenging for students to solve real learning problems. Students should be competent in the society of today and tomorrow. We live in the digital era. Education needs for integration of digital technologies into the education system. It has more upsides than downsides. Educational researchers should give a collaborative effort on how to implement digital technologies in the teaching process. Education by nature is a daunting task and does not require only one effort of one individual. It is a purposeful and collaborative task. Technology is advancing very fast but human beings are slow to manage it properly. Additionally, in technical sciences, researchers use digital innovative technologies to make analyses in their collaborative conducted experiments [14-15]. Teachers must focus on teaching and learning materials to be collaborative, open and easily online accessible to be used by their students. Everybody must be onboard in higher education.

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