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**STUDENTS' PERCEPTIONS OF PROJECT BASED LEARNING  
IN CHEMISTRY**

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*Abstract*

This study aims to identify student perceptions regarding certain aspects such as collaboration, communication and learning in the context of project based learning. These special issues were selected because these are considered to be some of the 21<sup>st</sup> century skills. The present article aims also to search the effects of project based learning experience on student perceptions. Ninth-grade and tenth-grade students are grouped heterogeneously according to their chemistry test results. Groups carried out a research about a chemistry experiment, documenting information, preparing presentation and making video. They used mostly Google tools for the production of presentation and collaboration with group members. After presentations, data were collected through a semi-structured questionnaire survey with Likert scale and a unit test based on questions on the textbook. The findings showed that project based learning is a meaningful method and doing project helped them learning. The increase in their test results supports the finding. Most of the students stated that PBL made them more interested in chemistry. Almost all students stated that project based learning enabled them to more communicate with classmates and they liked to discuss the topics with each other. The experience with project based learning (PBL) has an effect but not significant.

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**Keywords:** Students' Perceptions, Project Based Learning, Communication, Collaboration, Chemistry.



## 1. Introduction

In recent years, technological and societal changes have affected life and brought new requirements for employers and employees such as using technology and technological tools, collaborating colleagues, communicating with colleagues, clients and public, being aware of internationalisation. Therefore expectations have changed in society and shaped up learning styles. However the expectations transformed significant challenge. Today's higher education might integrate discipline-specific knowledge and personal-transferable academic skills. Learning methods have been developed and implemented for instructional practices (Tynjälä, 1999). Today teachers and educators discuss and apply cooperative learning, problem-based learning, project-based learning, blended learning, STEM education, etc. By using these learning methods, students are tried to acquire requirements of information age (Tynjälä, 1999). describes this acquisition of knowledge as `a building process in which knowledge is actively constructed by individuals or social communities`. In the learning process, students are active mentally and interact with people to construct knowledge and skills.

### 1.1. Designing Project Based Learning Environment

Collaboration, communication and critical thinking, are called 21<sup>st</sup> century skills, could be acquired by PBL. While students do their projects, they communicate, collaborate, think critically and analytically to solve problem. During presenting their project, they explain the topics, concepts and their solutions answer their classmates` questions and must use time efficiently (Larmer, Mergendoller, & Boss, 2015).

According to Tynjälä (1999), teaching is to support students to construct actively knowledge by given tasks to improve the process and is not the transmission of knowledge.

Projects must be designed to facilitate the usage of these skills. Design elements of PBL are stated by many educators. Blumenfeld and friends (1991) stated significant elements as `They require a question or problem that serves to organize and drive activities; and these activities result in a series of artifacts, or products, that culminate in a final product that addresses the driving question. `

Larmer, Mergendoller & Boss (2015) increased the number of design elements in the BIE model of PBL and called 8 essential elements.

- Driving question means that students to explore and to complete the tasks.
- Students `necessaries, skills and knowledge, to reply the driving question, are called need to know.
- Inquiry and Innovation is extended process of asking questions, using resources, and improving product.
- Students are allowed to choose their topic and method according to their interests and work.
- Reflection depends on students` work and though in the classroom and can reveal dialogue and communication.
- Revision and feedback refer to use feedback to increase the quality of project and to consider what and how they learn.
- Presentation of the project or final product is expressed as Publicly Presented Product.

## 1.2. Students' Perceptions of Their Learning Environment

Project based learning environments could make positive effects on students' perceptions. Interpretation of the environment induces the students to get interested in the learning activities. (Anderson, 1989).

Prosser and Trigwell (1999), have drawn a model for understanding learning and teaching. According to their model, students' perceptions of context are composed of their prior experiences of learning and teaching and the learning and teaching context itself. Therefore the students do not mandatorily consider the situation in a designed way and they could act differently than expectations.

Their perceptions determine their approaches to learning which influence their learning outcomes. In this perspective, learning activities are subjective and learning process are in relation how students experience the objectives and goals of the course, the assessment procedures, etc. (Boud, 1995)

Former studies have expressed the significance of students' perceptions of their learning.

Koh et al. (2009) searched students' perceptions of group project work (PW) and views and expectations of their teachers. They applied cooperative project work for 588 8<sup>th</sup> Grade students from the five selected secondary schools within 1.5 hours weekly. They used a 7-point Likert-type scale survey for scoring and semi-structured interviews with 68 of these students, with groups of about 4–7 students, and 13 PW teacher–facilitators, interviewed individually, from the five schools.

They indicates that bridging the gaps between students' perceptions and teachers' expectations is important. Students' motivation and engagement in PW are improved by the help of overcoming the gaps.

High mean scores for students' perceptions on outcomes of learning (collaboration, communication and problem solving) indicate that project work generally developed outcomes among group members. During the interviews, some students expressed some disagreements in course of project work. The results suggest that students were generally able to find a solution for their differences. These findings would help to develop teachers' understanding and schools should consider altering the design elements of the project works deliverables to suit students' academic abilities. (Koh et al., 2009)

Some studies report students' evaluations of PBL courses, focusing on students' satisfaction with various design variables. They are based on surveys asking students how clear the goals are, how well-structured the learning materials are, etc. a few studies address explicitly the students' perception of the extent to which PBL is powerful for enhancing learning. (Trigwell, Hazel & Prosser, 1996)

In another study, survey was applied 275 6<sup>th</sup> through 12<sup>th</sup> grade students and 26 of them randomly were selected and interviewed in two schools. Researchers examined students' perceptions of important life skills. They enlisted the most important skills as self-directedness/independence, communication/social skills, time management and collaboration. Students stated that their most improved skills were communication, collaboration, and self-directedness/independence. The results underlined students' perceptions of life skills were positive and project-based learning has a positive impact on students' life skills improvement in middle school and high school (Meyer & Wurdinger, 2016).

## 2. Problem Statement

Students' prior experiences affect their perceptions and then their learning. Students who studied in PBL environment may change their perceptions. It is searched whether 1-year experience in PBL changes students' perceptions on efficiency of PBL, communication, collaboration and assessment.

## 3. Research Questions

Four related questions are investigated.

First, what are students' perceptions of efficiency of project-based learning?

Secondly, what are students' perceptions of effects of PBL to communication and collaboration?

Thirdly, how do the students' prior experiences affect their perceptions during studying in PBL?

Fourth, what are the students' overall thought for PBL?

## 4. Purpose of the Study

The purpose of the study was to find out whether students' perceptions of the learning environment in agreement with project-based learning environment. Effect of prior PBL experiences on students' perceptions was searched.

Subjects: 24 high school students studied in PBL environment in 5 weeks and presented their products in 2 weeks. 10 grade students had an experience of PBL because they studied in PBL environment in another discipline last year. 9 grade students did not have experience in PBL and most of 9 grade students were new in the school. They, are from 19 different countries, studied in English and all documents are in English.

3-member groups are formed heterogeneously in terms of means of first semester chemistry exams by teacher. Each group has one high level, one medium level and one low level students.

Students selected their topics from the list. The topics are related to a daily life use of a chemical reaction related with the unit. They searched, prepared a presentation and recorded a reaction while they were doing. They used cloud computing tool for searching, saving data, sharing with group members and preparing presentation. After that they presented related subtopic of unit and their demonstration.

Weekly reports, rubrics and written exam are used for grading students' academic achievement and teamwork.

## 5. Research Methods

A questionnaire was used to assess how students perceive their learning environment. This questionnaire was retrieved and adapted for project-based learning (Dale, Nasir, & Sullivan, 2005).

The questionnaire consisted of 14 items in four scales assessing the students' perceptions of the academic role and motivational effects of PBL, communication skills, collaboration and assessment methods in PBL. In addition, there were two item for their overall thought related to assessing PBL. The items were scored on a 5-point Likert scale. In Table 1 one sample item is presented for each scale.

Furthermore, the instrument contained one unit exam that gave a quantitative comparison between students' prior chemistry achievement and their academic achievement after project based learning. The unit exam was composed of similar questions on course book as well the previous chemistry exams.

**Table 01.** Sample questions of variables

	Sample question
Efficiency of PBL	This project method helps me to learn better.
Collaboration	Describe yourself as competitive or collaborative.
Communication	This method helps me enjoying my time discussing topics with my friends.
Assessment	Are you concerned about being fairly assessed?

Firstly, items are categorised in four design variables as efficiency of PBL, collaboration, communication, and assessment. Means and standard deviations are calculated. The results are presented in Table 2.

**Table 02.** Means and standard deviations of Variables

Scale	Mean	St Dev
Efficiency of PBL	3.844	0.875
Collaboration	3.570	1.341
Communication	3.980	0.887
Assessment	3.625	1.174

Means of efficiency of PBL (M = 3.844) is close to 4 which is agree in Likert scale. The students' perceptions are positive on efficiency of PBL and contribution of PBL to communication. They reflected their thought for the effect of PBL and stated on the item "This project method helps me to learn better." (M = 4.08)

The unit exam was applied to check students' chemistry achievements and compare with their perceptions. Independent t-test is used to analyze students' scores and results are presented Table 3.

**Table 03.** Comparison of students' prior scores and unit exam scores

	1st semester		Unit exam				
	M	SD	M	SD	df	t	p
PBL Students	68.82	21.41	81.76	19.60	23	-2.23	0.015

The chemistry achievement endorsed by the students in means of the 1st semester exams (M = 68.82) was significantly increased in unit exam (M = 81.76).

Secondly, students' perceptions about communication and collaboration in PBL were analyzed. Mean of Communication items is the highest average (M = 3.980) among the variables. It shows the positive impact of PBL on communication. An exemplary item is given in Table 1.

On the other hand, means of collaboration (M = 3.570) and assessment (M = 3.625) are lower than other two variables but more than 3.5 and are closer `agree` than `undecided` in Likert scale. Analysis of variance (ANOVA) was used to compare results of items of communication, (M = 3.980) which has the highest mean and other variables in order to find out whether the difference between means are significant or not. The results are presented in Table 4.

**Table 04.** Analysis of variance (ANOVA) between communication and other variables

Communication	Other Variable	MS	F	P
Communication	Efficiency of PBL	0.586	0.760	0.380
Communication	Collaboration	4.835	3.470	0.065
Communication	Assessment	4.301	3.550	0.061

In Table 4, three combinations of variables are compared and their p values are calculated. Although means of collaboration (M = 3.570) and assessment (M = 3.625) are lower than means of Communication (m= 3.980), the results are not significant,  $p > 0.05$ . It could be stated that students` perceptions are slightly positive collaboration and assessment.

The influence of experience (9 Grade, new in PBL versus 10 Grade, had experience in PBL) was investigated. An ANOVA analysis was conducted to search for effect of experience in PBL and the results are presented in Table 5.

**Table 05.** Comparison of variables in terms of grades

Scale	Mean	St Dev	Mean	St Dev	F	p	Mean	St Dev
Efficiency of PBL	3.938	0.755	3.750	0.979	1.08	0.30	3.844	0.875
Collaboration	3.556	1.182	3.583	1.500	0.01	0.92	3.570	1.341
Communication	3.958	0.999	4.000	0.780	0.02	0.89	3.980	0.887
Assessment	3.567	1.079	3.683	1.269	0.26	0.61	3.625	1.174

Comparison of means of variables showed that mean of efficiency of PBL of 9<sup>th</sup> grade is higher that of 10<sup>th</sup> grade and means of collaboration, communication and assessment of 10<sup>th</sup> grade are higher those of 9<sup>th</sup> grade. However differences between grades are not significant. ( $p > 0.05$ )

In addition to variables and experience comparison, students` overall thought is analysed by using 2 items, also are used to cross check their answers. The results of these items are given in Table 6.

**Table 06.** Students` overall thought for PBL

Scale	9th Grade		10th Grade		Overall			
	Mean	St Dev	Mean	St Dev	F	p	Mean	St Dev
Wasting time	1.916	0.515	2.583	1.379	2.46	0.13	2.250	1.073
Using Again	3.917	1.240	3.417	1.165	0.89	0.36	3.667	1.204

9th grade students` mean ( $M = 1.916$ ) showed that they did not think PBL as wasting time much. 10th grade students` mean ( $M = 2.583$ ) was between disagree and undecided. Some of them considered as wasting time much but some did not.

The results of the item “using again” are parallel to results of previous item. 9th grade students` mean ( $M = 3.917$ ) is higher than 10th grade students` mean ( $M = 3.417$ ). Therefore 9th grade students are willing to use PBL again. Despite of the difference between means the results are not significant. ( $p > 0.05$ )

## 6. Findings

First question of the study is the efficiency of PBL. Mean of students` answers for this variable is 3.844 and their perceptions are supported by the significant increase in unit exam.

Effects of PBL on communication and collaboration are searched. In general, improvement in communication and subject achievement are more than collaboration. Students stated that PBL motivated them to the subject, helped to learn better. It was a useful method that allowed them to communicate with classmates and discuss about their topics.

Effect of PBL experience is analysed by comparing two grades. 9<sup>th</sup> graders` mean on the efficiency of PBL is higher than that of 10<sup>th</sup> graders. 10<sup>th</sup> graders` means of other variables are higher than those of 9<sup>th</sup> graders. Firstly the results are not significant and PBL affects both grades similarly. Secondly PBL is a new learning environment for 9<sup>th</sup> grade students, could be more interested in chemistry in this method. Thirdly 10<sup>th</sup> grade students have PBL experiences and know how to study in PBL. Students` prior experiences contribute to shape their perceptions and approaches to learning.

Students` group and individual performances are assessed by using group weekly report and rubrics for group product, individual contribution and presentation. the results of the item “Are you concerned about being fairly assessed?” are compared, mean of 10<sup>th</sup> graders ( $M = 4.08$ ) is higher than mean of 9<sup>th</sup> graders ( $M = 3.33$ ). 9<sup>th</sup> graders` doubt on new assessment tools and group assessment could be explained that they are new for group assessment and these assessment methods are new for them. 10<sup>th</sup> graders agree to be assessed as a group by weekly reports and rubrics.

To find out students` overall thought, they answered whether using this method again or not. Overall mean of this item is 3.667 and the result is not significant. However there is a relatively big difference between 9<sup>th</sup> graders` mean ( $M = 3.917$ ) and 10 graders` mean ( $M = 3.417$ ). 10th graders improve their communication and collaboration skills, even more than 9th graders. They accept that PBL help them to learn and assessment methods are proper for them. Besides these facts, half of them are uncommitted to use PBL again. There could be two possible reasons for this conflict. Firstly, 10 graders are older than 9 graders and mostly high school students prefer to work independently and do not want direct supervision. (Capraro, Capraro, & Morgan, 2013, retrieved from Lambros, 2004). On the other hand, group composition could make this difference. Group size and heterogeneity affect interaction and the productivity of the group as well as student ability. Researches indicates that group must be composed of students from various ability level and the degree of heterogeneity must be narrow. (Webb, 1991, 1993; Dillenbourg et al., 1996).

## 7. Conclusion

The mean scores on almost all items are higher than 3.5 and close to 4 (on a 5-point scale). The results indicate that students enhance chemistry knowledge, communication and collaboration skills in PBL environment and they improve life skills more by gaining experiences. Therefore it can be said that PBL influences outcomes of learning positively.

On the other hand some students have doubt to use PBL again even though they improved their chemistry knowledge and life skills. Also there is a difference between means of assessment items of 9<sup>th</sup> graders and 10<sup>th</sup> graders. Students' perceptions on some variables of PBL could not suit with teachers' expectations because of the students' prior experiences.

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