The implementation of project as cultivation of metacognitive skills

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Abstract

The purpose of this paper is to highlight the effectiveness of the project as a modern technique of teaching and learning. Through a research carried out by students of School of Pedagogical and Technological Education who participated in a project implementation, a variety of benefits have emerged, focusing on the promotion of authentic learning, the cultivation of cognitive, social/communicative and especially metacognitive skills, necessary for the needs of the 21st century. The data were collected through a questionnaire for self-assessment. Our purpose was to explore the skills developed by the students, to detect the obstacles/difficulties they encountered and to explore the strategies that followed by students in order to solve problems during the implementation of the project. Based on the response in the questionnaire, the implementation of a project can lead to the acquisition of metacognitive skills, self-assessment, problem-solving skills, self-regulation, cooperation and communicative skills, digital literacy.

Keywords: Authentic learning, metacognitive skills, self-regulation, constructivism, interdisciplinary teaching.

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1. Introduction

Students of School of Pedagogical and Technological Education (ASPETE) during the year 2016–2017 implemented project in a thematic area of their expertise as a part of a constructive approach of learning where interdisciplinary teaching was applied and emphasis was made on collaborative learning and project-based learning.

According to Kilpatrick (1935), 'The Project method is a planned action that takes place with the whole heart and takes place in a social environment'. According to another definition, 'it is every organised learning activity that takes place in the educational process, it is developed in a free choice, with a predefined plan and aims at exploring, organising and managing knowledge, materials, values and actions' (as cited in Frey, 1986).

Project is seen as a key component of skills in various skill models. In the Binkley et al. (2012) model, project is a part of the 'Ways of Working', which is the second group of the 10 Skills of the 21st Century. According to this model, communication must be rapid, concise and cognizant of cultural differences (Binkley et al., 2012).

Table 1. Ways of working – collaboration, teamwork

A) Knowledge	• Interact effectively with others
	• Work effectively in diverse teams
	• Manage projects: know how to plan, set, and meet goals and to monitor and re-plan in the light of unforeseen developments
B) Skills	• Interact effectively with others
	• Work effectively in diverse teams
	• Manage projects: prioritize, plan and manage work to achieve the intended group result
	• Guide and lead others
C) Attitudes/values/ethics	• Interact effectively with others: conduct themselves in a respectable, professional manner
	• Work effectively in diverse Teams: respect for cultural differences
	• Manage projects: persevere to achieve goals
	• Be responsible to others

The term Project is also found as a skill in the Competence-Based Learning Model (Deusto, 2008). In this model, the four core features of the model as they are represented in the following pyramid are: the Values, Attitudes, Competences and Learning Model that will further progress to autonomy and the meaningfulness of learning. As stated by Morin (2000), 'a well-formed mind is a mind able to organise knowledge, thereby avoiding sterile accumulation' (as cited in Deustro, 2008). Meaningful learning occurs when students are able to relate new information to prior knowledge and experience. In this regard, they become able to build and develop knowledge by linking the logical structure of the subject to their own perspective (Deusto, 2008).
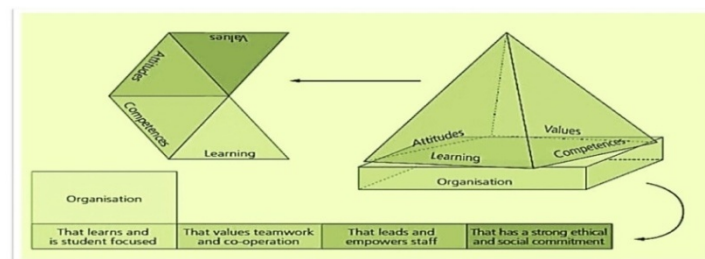
Figure 1. Project in Deusto model

Project can be a learning process that helps students to build knowledge as it is an effort carried out within a given time to achieve the specific objective of creating a product or service, by undertaking a series of tasks and making effective use of resources. So, students develop a skill in project management when they are able to devise, direct, evaluate and monitor a project effectively. The elements making up a project enable them to identify progress indicators for developing and assessing this skill (Deustro, 2008).

The project method has specific steps that must be followed by the students in order to achieve the goals they have set. These steps are the following (Petropoulou, Kasimatis & Retalis, 2015, p. 89): 1) Decision: the problem is given by the teacher, initial ideas-assumptions are made by the students, the research questions are clearly identified. 2) Programming: division of activities and tasks to each group. 3) Conduction of activities: students work individually and as members of a team in order to investigate the problem. 4) Presentation and dissemination: presenting and disseminating the results of the research to the classroom or the wider school community. 5) Evaluation: planning the mechanisms for monitoring the project and evaluating results (when and how this will be done and by whom); and introducing changes and necessary adjustments to improve the project.

In this model, project, belongs in general or transversal skills. More specifically, it belongs in Systemic Skills, which are related to the understanding of a whole set or system. They involve abilities related to an entire system. In particular, they require a combination of imagination, sensibility and ability, enabling one to see how the parts of a whole are related. Such skills include the ability to plan changes that will introduce improvements in overall systems, and the ability to design new systems. These competences are built on previously acquired instrumental and interpersonal competences (Deustro, 2008).

Participating in a project, students can develop metacognitive skills through reflection and self-assessment and the approach of knowledge as a learning experience. Many definitions have been raised for metacognition which reveal the deeper meaning of the word and correlate memory, learning and understanding. According to Koutselini-Ioannidou (1995), metacognition is defined as 'the knowledge and understanding that one has on the level and the possibilities of his thought, his personal information processing system and the construction of knowledge' (p. 48) and according to Metcalfe and Shimamura (1994) as 'the people's knowledge about what they know, remember and think' (p. 5).

'Meta-cognition' as Flavell (1979) claimed is 'the cognition of cognition'. According to other definitions metacognition is defined as 'thinking about thinking', 'knowledge about knowledge' or 'people's knowledge about what they know, remember and think' in order to understand the nature and operation of this term (as cited in Metcalfe & Shimamura, 1994). Cognitive skills are perception, memory, performance, cognition, language, critical acumen, problem solving, decision making and critical thinking. For the cultivation of metacognition, it is important to be aware of its procedures, which are two: the knowledge of cognitive function and its regulation. The ability to separate the knowledge someone can capture belongs in the first category and it consists Declarative, Procedural and Conditional knowledge (Swanson, 1990). Declarative knowledge is knowledge that has already been gained. The Procedural includes ways of learning and improving learning opportunities. Conditional knowledge is about the conditions that learning strategies can be used. The other categories include methods for regulation of cognitive functions and 'strategies to control the cognitive efforts' (Baker, 1991). These methods include the rough design before being engaged with the object, the continuous monitoring of the procedure and the evaluation of results after it (Kassotakis & Flouris, 2006).

2. Method

2.1. Purpose of the study

The purpose of the study is to highlight the effectiveness of the project as a technique of modern teaching and learning method. The aim is to investigate the development of metacognitive skills in the students of ASPETE, focusing on reflection, self-regulation and problem solving. The students dealt with a thematic area of their expertise, such as the 'Intelligent Faculty', the 'Sustainable School', 'Utopia and Reality', as a part of a constructive approach of learning where interdisciplinary teaching is applied and emphasis is given on collaborative learning and project based learning. Some indicative examples of project implementation are the following: Alternative Sources of Energy—Photovoltaics, Security systems, Microcomputers—A complete example of microcomputers in ASPETE, Smart air conditioning in ASPETE, e-shop, Green Roofs, Energy upgrading of a building, Theme park. The students followed the stages of the project as they are found in the bibliography, which are Decide, Design, Present and Assess.

In specific, the purpose of study was triple:

- to showcase the skills, focusing on the metacognitive skills developed by the students of ASPETE
- to detect the obstacles/barriers they encountered
- to explore the strategies that followed by students in order to solve problems.

The following research questions were posed to the current study:

- Did the students develop the problem solving skills and how?
- Did the students think about their way of working and how?
- Did the students develop strategies to deal with the problems they encountered during the implementation of the project and what were they?
- Were the students able to apply the new knowledge to real situations and how did they succeed it?
- Were the students able to cooperate with their fellow students?

2.2. Participants

The participants of the study were 198 students of the three Departments of Educational Mechanical Engineering, Civil Engineering, Electrical/Electronic Engineering who attended the course during 2016–2017. The participation was voluntary. However, in this study we were not able to send the questionnaires to students of ASPETE in other cities of Greece. Also, we had limited time to conduct the research.

2.3. Research strategy

The questionnaire was divided into four categories: A) Analyze B) future influence C) application of knowledge and D) skills—1) communication skills, 2) information management, 3) computer skills, 4) time management and 5) teamwork—social interaction skills and 6) problem solving skills. The first category consisted of seven questions. The second category included six questions which referred to the way this project could influence their future behaviour and their beliefs. The third category referred to the application of gained knowledge. The questions were open, so the students had the opportunity to express their perceptions without any kind of limitations. In the fourth part of the questionnaire, there were certain skills that students could develop. They students could choose the skills they could develop through their participation in project.

2.4. Data collection process

The nature of this study was qualitative. The qualitative study regarded appropriate because the researchers were interested to investigate students' skills. The study maintained a particular interest for the metacognitive skills developed through the students' participation in this project. All recoded data were analysed by thematic analysis (Creswell, 2000). This approach supplies a framework for the thematic analysis of qualitative data and provides one way of thinking about how to manage themes and data; this process is likely to reflect the analyst's awareness of recurring ideas and topics in the data (Bryman, 2016, p. 587).

The thematic analysis is important because it involves deductive and inductive coding (Boyatzis, 1998). Deductive coding focuses on categories and themes in light of the existing literature, whereas inductive coding focuses on themes and variations that emerge from the data (Altinay-Gazi & Altinay-Aksal, 2017; Zhou, 2014). The similar findings were grouped together discussed and compared with existing literature in the field. Data were collected in one phase for all the participants. Questionnaires were sent through e-mail to the all the participants, who had 15 days to complete them. Fifty-two questionnaires of them were collected.

3. Results

Obtained research findings were based particularly on the purpose of the study and they were related to the research questions. These include students' perceptions towards the development of the skills and in specific metacognitive skills through their participation in project. The findings resulted from qualitative data collected through questionnaires were grouped in three categories according to the purposes of the study. The researcher divides the findings of the research into following three categories, such as Skills, Metacognitive Skills and Obstacles/Barriers.

As far as the development of Communicative skills is concerned, the students learned to cooperate and work as a team and they developed social skills. They had respect for various opinions and they found out that communication can positively affect their future behaviour. It also appeared that they have largely recognised the value of each team member and realized that the team result was better than the individual. They could also interact effectively in the team. They had the chance to improve interpersonal communication, conflict management and the exercise of leadership in small groups. As they answered: 'Communication, mutual assistance, cooperation and interpersonal relationships, a natural climate of trust and solidarity were developed'. 'In a group, there is no weak and strong. All the children contributed equally to the result, and I would not distinguish that some people worked more or less, they did better or worse work'.

From their answers emerged that cognitive skills, such as search for information and analysis of the subject were developed as well. They answered: 'We developed the skill to recognise information and to choose what was relevant to the subject'. They also gained Knowledge in depth, which is very important in specialized courses. 'The knowledge that was gained can be applied for our future occupation in specialized courses such as lighting studies'.

Students' answers revealed that the way of working which was most used during the implementation of project was a survey over the Internet where, as they say, they had to choose the appropriate information for problem solving according to the purpose of their research. 'The collection of information was achieved with help from the internet which gave us the opportunity for further research'. 'I can organise and better analyse how to search for information over the internet'. In addition according to their answers students were able to handle personal computers easily and well, at least with regard to the applications and tasks used most widely in the majority of fields, such as file management, e-mail, browsing in Internet, spell checkers, preventive, presentation software, and the use of electronic spreadsheets. According to their answers: 'New technologies were used: the organisation and presentation were created by using various computer programs such as pdf, word and excel'.

As far as the development of metacognitive skills is concerned that the gained knowledge can be useful for their future career and job prospects, as this knowledge can be applied in similar situations of real life. Finally, their responses showed a change of students' attitudes towards key life matters such as ecology, health and people with disabilities. 'This project is a small simulation of our future job and certainly in the future we will be invited to collaborate or to undertake a project for professional reasons'. 'I have noticed that the knowledge I gained will certainly help me to recognize and understand a similar problem faster'. 'I will have more environmental sensitivity and I will seek to act with amicable actions in this respect'.

Students reflected on what they had created and on their learning. They evaluated their goals through self-assessment and self-evaluation and reflection process. They made comparisons, and they gave feedback to each other and through dialogue changed and corrected their mistakes. Through comparisons they developed critical thinking and they constructed knowledge. 'I could get information from the other team members and compare it with mine, say my point of view and correct my mistakes'. The students, also, answered that they had Internal Control and they were willing to persevere in order to achieve goals. The design, the continuous monitoring of the procedure and the evaluation of results are process of metacognition. According to their answers, they developed reflective thinking, which consists precisely in recognising the way of addressing a task or problem, and taking steps that will lead to growth in their way of thinking. 'We had internal control'. 'We insisted on our goals'. The students were checking the objectives they had set as well as the degree to which they had achieved them and their attitudes during the process and in view of actual outcomes. When a problem arose they recovered Knowledge to find a solution. 'We had to go back to our knowledge to overcome the problems that had arisen'.

Of the study obstacles, students encountered during the implementation of project, the answers revealed that Time Management Skills and Oral Presentation were flawed, something that could occasionally pose an uneasy and precarious situation. They answered that they weren't able to organise and distribute available time correctly. Also, students faced difficulty in sharing responsibilities to each member of the team. 'We had not been able to meet often due to lack of time, different timetables and our obligations'. 'The time frame we had did not allow us to better assess our work'. 'At first there was a problem in how the division of responsibilities would be shared among my team members, but it was quickly resolved because of the good team climate'. 'My biggest weakness is giving presentations'.

4. Discussion

The qualitative analysis of student response data revealed that students developed cognitive, social and metacognitive skills in the implementation of the project. The project-based learning method, in contrast to traditional teaching, in which the teacher was the centre piece of the teaching process, is based on a learner-centred approach to learning, where teacher and pupils communicate and work together equally. It is an open learning process in which the students decide to deal with a subject, plan in order to accomplish their goals. The students associate the gained knowledge with everyday life discovering links, they become an active part of the process of gaining knowledge and activate through a process of creation. It is essentially a form of experiential learning where students are initially exposed to an experience and then encouraged to reflect on it and develop new knowledge, skills, skills, attitudes and behaviours (Phillips, 2004).

The students in almost all of their responses stressed the importance of collaborative, team spirit, dialogue and respect for different views within the group, social skills that are characteristic of the project (Frey, 1986; Kilpatrick, 1935). They are also basic skills developed in the Deustro (2008) model, as well as in the (Binkley et al., 2012) model. The Deustro (2008) model is referred to communicative skills as interpersonal skills, while the (Binkley et al., 2012) model emphasises effective interaction with others and effective work in different groups. According to Cakir, Zemel and Stahl (2009), the way

the members of a team organise their activities in order to collaborate effectively in group discourse on a topic shows that it is very important their utterances, inscriptions, and behaviours to be shared.

Students were able to engage in inquiry and problem solving, decision making and scientific research (Hmelo-Silver, 2004; Panasan & Nuangchalerm, 2010; Thomas, 2000). Students who participated in project-based learning were strongly motivated by the procedure. They showcased higher teamwork commitment and communication skills than in a traditional lesson. They approached a higher level of comprehension during the implementation of their knowledge and they developed critical thinking. By participating in the project, students were given the opportunity to examine their subject matter using a variety of sources while at the same time they were able to search for and distinguish the relevant from the irrelevant information throughout the project completion process, which is also confirmed by (Reeves, Herrington & Oliver, 2002).Also, from their responses, students were able to explore and solve problems by choosing and crossing information, collaboration and dialogue. The results of the responses are consistent with other research, where through Project Based Learning (PBL), students have the opportunity to engage in problem-solving, decision-making and scientific research (Hmelo-Silver, 2004; Panasan & Nuangchalerm, 2010; Thomas, 2000).

According to the Binkey et al. (2012) model, the cognitive thinking skills are identified as interpretation, analysis, evaluation, inference, explanation, and self-regulation. In addition, problem solving has appeared in various forms in a number of large-scale international assessments such as PISA and the Adult Literacy and Lifelong Learning Skills. In terms of computer use, they developed skills related to the use of text (presentation, writing) as well as other more specialized software, for example, for the construction of a web page, image processing. This skill is one of the main skills in the Deustro (2008) model as well. It is described as PC as working tool.

Finally, they developed metacognitive skills, as reflected in their responses to the transfer of knowledge to their future lives and similar situations. Also, through reflection and dialogue, they were able to solve problems they encountered. In addition, the student, by assessing the work of the team members, realized his/her mistakes and omissions and changed the learning strategy (Andrade & Valtcheva, 2008; Dochy, 2001). Students who participate in projects need to acquire and apply information, concepts and principles and as a result they enhance deep understanding. Also, students can improve their competence in thinking because they have to formulate plans, track progress and evaluate solutions (Blumenfeld et al., 1991). The students developed the ability to dedicate time to learning, autonomy, discipline, perseverance, and information management in the learning process. Also, they learned to reflect critically on the object and purpose of learning, to communicate as part of the learning process by using appropriate means to support oral communication as well as by understanding and producing various multimedia messages (Binkley et al., 2012).

However, through the project students' creativity has not been developed, which may be a variable for analysis in a future research. Furthermore, the answers revealed that Time Management Skills and Oral Presentation, which are basic skills in the Deustro (2008) model, were flawed, something that could occasionally pose an uneasy and precarious situation. Managing time means distributing it according to priorities and it is connected with the establishment of clear priorities. It is a basic skill that affects others and that's the reason for planning what to do and when to do it having in mind that what is urgent will take priority over what is important.

5. Conclusion

The implementation of the project can be an effective learning method that can be applied at every level of education. There are abundant learning benefits and endless prospects for all participants that concern foremost the students' skills development. The innovation of this research lies in the fact that its objective is to explore the skills developed by the students through their participation in the project. Through the implementation of the project the students, following the stages of the project, learned to analyse, explore and compose a subject, set goals, organise, reflect and evaluate from the

beginning, gain knowledge and apply active ways in order to 'learn how to learn'. This survey, although comes in contrast to other related research, where the purpose is focused on the description of the process and the results of the project's implementation. So, this research can be a trigger for further factor analysis.

References

Altinay-Gazi, Z. & Altinay-Aksal, F. (2017). Technology as mediation tool for improving teaching profession in higher education practices. *Eurasia Journal of Mathematics, Science & Technology Education, 13*(3), 803–813. doi:10.12973/eurasia.2017.00644a

Andrade, H. & Valtcheva, A. (2008). Promoting learning and achievement through self-assessment. *Theory Into Practice, 48*(1), 12–19.

Baker, L. (1991). Metacognition, reading and science education. In C. Santa & D. Alvermann (Eds.), *Science learning: processes and applications* (pp. 2–13). Newark, DE: IRA.

Binkley, M., Erstad, O., Herman, J., Raizen, S., Ripley, M., Miller-Ricci, M. & Rumble, M., (2012). Defining twenty-first century skills. In B. McGaw & E. Care (Eds), *Assessment and teaching of 21st century skills* (pp. 17–66). New York, NY: Springer.

Blumenfeld, P., Soloway, E., Marx, R., Krajcik, J., Guzdial, M. & Palinscar, A. (1991). Motivating project-based learning: sustaining the doing, supporting the learning. *Educational Psychologist*, 26(3–4), pp. 369–398.

Boyatzis, R. E. (1998). *Transforming qualitative information: thematic analysis and code development*. Sage.

Bryman, A. (2016). *Social research methods*. Oxford, UK: Online Research Centre.

Cakir, M. P., Zemel, A. & Stahl, G. (2009). The joint organization of interaction within a multimodal CSCL medium. *International Journal of Computer-Supported Collaborative Learning, 4*(2), 115–149.

Creswell, J. W. (2000). *Research design*. Thousand Oaks, CA: Sage. doi:10.1016/j.math.2010.09.003

Frey, K. (1986). *The project method and preliminary education, small researchers*. Athens, Greece: Metachmio.

Griffin, P., McGaw, B. & Care, E. (2012*). Assessment and teaching of 21st century Skills.* Australia: Springer

Kilpatrick, W. H. (1935). Die projekt-methode. In P. Petersen (Ed.), *Der Projekt-Plan: Grundlegung und Praxis von John Dewey und William Heard Kilpatrick* (pp. 161–179). Weimar, Germany: Bohlau.

Hmelo-Silver, C. E. (2004). Problem-based learning: what and how do students learn? *Educational Psychology Review*, 16(3), 235–266.

Petropoulou, O., Kasimatis, K. & Retal, S. (2015). *Contemporary educational assessment with the use of educational technology*. Hellenic Academic E-Books. Retrieved from www.kallipos.gr

Kassotakis, M. & Flouris, G. (2006). *Learning and teaching*. Athens, Greece: Private Edition.

Koutselini-Ioannidou, M. (1995). Metacognition: concept and teaching. *New Education,* 74, 48–56.

Metcalfe, J. & Shimamura, A. P. (1994). *Metacognition: knowing about knowing*. Cambridge, MA: MIT Press.

Morin, E. (2000). *La mentebienordenada*. Barcelona, Spain: SeixBarral.

Olalla, A. G., Mora, G. M., Paredes, J. A. M., Otero, J. M., San Ildefonso, M. I. M., Ruiz, M. P., . . . Sanchez, A. V. (2008). *Competence-based learning. A proposal for the assessment of generic competences*. Bilbao, Spain: University of Deusto.

Panasan, M. & Nuangchalerm, P. (2010). Learning outcomes of project-based and inquiry-based learning activities. *Journal of Social Sciences, 6*(2), 252–255.

Phillips, N. (2004). *Experiential learning: definitions, concerns, prerequisites: adult education* (Vol. 3). Athens, Greece: Metachmio.

Swanson, H. L. (1990). Influence of metacognitive knowledge and aptitude on problem solving. *Journal of Educational Psychology*, 82, 306–314.

Thomas, J. W. (2000). *A review of research on project-based learning executive summary*. San Rafael, CA: The Autodesk Foundation.

Zhou, J. (2015). International students' motivation to pursue and complete a Ph.D. in the US. *Higher Education, 69*(5), 719–733.