Elementary Students' Perceptions of Use of Project-based Learning in Germany

دراسة تصورات طلاب المرحلة الابتدائية حول استخدام التعليم القائم على المشروع في ألمانيا

by

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Abstract

Group project-based learning is recognized as an effectual method for involving students in a constructive learning environment that enhance their critical thinking, and gear them with the important skills they may need in their future development. This case study has been conducted to investigate the elementary students' perceptions of the project led education, and its impact on their deep learning of the scientific context, as well as its' effect on developing their high learning skills. A total of 59 grade four students from the elementary division of one of the IB international schools in Germany have participated in this study. A mixed method approach has been designed to collect data; interviews have been conducted with the students in addition to a 7-question survey that asked students to evaluate their perceptions and satisfaction of using project-based learning as a teaching strategy for science subject using a 4 points Likert scale. The results have revealed that students have positive attitudes and satisfaction toward enacting project-based learning in teaching science in their schools, in addition to its positive effect on the deep learning of science concepts, as well as acquiring the important skills that students may need in their future

Keywords: Project-based learning, critical thinking, high learning skills

الملخص

يعتبر التعلم القائم على المشاريع المشتركه طريقة فعالة لإشراك الطلاب في بيئة تعلم بنّاءة تعزز تفكيرهم النقدي ، وتزودهم بالمهارات الهامة التي قد يحتاجونها في تطورهم المستقبلي. أجريت هذه الدراسه لفحص تصورات الطلاب الابتدائية عن التعليم باستخدام المشاريع ، وتأثيره على تعلمهم العميق لمساق العلوم ، بالإضافة إلى تأثيره على تطوير مهارات التعلم لديهم. شارك في هذه الدراسة 59 طالبًا من الصف الرابع من القسم الابتدائي في إحدى المدارس في المانيا ،حيث أجريت مقابلات مع الطلاب بالإضافة إلى استبيان يتألف من 7 أسئلة طالبت الطلاب بتقييم تصوراتهم ورضاهم عن استخدام التعلم القائم على المشروع كاستراتيجية تدريس لمادة العلوم . وقد كشفت النتائج أن الطلاب لديهم مواقف إيجابية ورضا تجاه تفعيل التعلم القائم على المشروع في تدريس العلوم في مدارسهم ، بالإضافة إلى تأثيره الإيجابي على التعلم العميق لمفاهيم العلوم ،و اكتساب المهارات المهمة التي قد يحتاجها الطلاب في حياتهم المستقبلية .

الكلمات و العبارات الرئيسيه: التعلم القائم على المشروع، التفكير الناقد والمهارات المستقبلية

Dedication

Every challenging work needs self-effort as well as the support of people who are very close to our hearts**,** thus without their support it would be difficult to reach for this achievement.

I dedicate this work to my parents whose prayers days and nights made me able to reach to this Success. This work is also dedicated to my husband, Mohammed, who has been a constant source of support and encouragement during the challenges in my graduate level and life, as well as, to my lovely kids: Saif, Faris, and Kareem for their endless love and support.

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Chapter one: Introduction

The new reform in science education in the 21st century aims to involve students in the teaching process to enable them to construct their knowledge. According to Kim, & Lefler, (2016 in Wang & Sampson, 2017), this can happen while students participate in solving authentic problems related to their daily life. Thus students will be engaged in the activities that help them build their perceptions. As Bell (2010) confirmed that in PBL students can resolve the authentic conundrum that is related to their life events. Therefore for the last three decades, science education has widely supported the implementation of PBL in the teaching process (Egenrieder, 2007 in Cakici &Türkmen2013). However, while using project- based learning students will be motivated to be part of a student-centered approach through which they will have the chance to cooperate to find a solution for an ill-constructed task (Capraro, Capraro&Morgan, 2013). Thus (Barak & Raz, 2000in Cakici &Türkmen 2013) emphasize that this method is favored because it is believed that motivated students will have a positive impact on the retention of the scientific knowledge, as it will improve their deeper understanding of the scientific context. (Wang & Sampson, 2017).

In congruence with the efforts of this new reform, the aim of teaching science has moved from the area of gaining science knowledge, to the place where students can possess the skills that can guide them to construct their knowledge, as they will have the mastery of developing their understanding of the scientific context, (Bell, 2010). This can develop in a companionable learning atmosphere, where students work in groups, exchange ideas and concepts through debate and discussions to accomplish their tasks (Orlich, 2010). Also, these arguments can help in to develop the analytical learning skills among students which will develop their pedagogical perception of knowledge (Slavin, 2014), thus make learning science an enjoyable experience.

1.1 Project based learning as a teaching method

Project-based learning is an analytical teaching method that captivates students to learning knowledge by engaging them in an extensive inquiry approach that is methodized around an intricate, authentic problem and a carefully investigated dilemma, (Moursund &, Bielefeldt 1999 in Hughes, 2015). Liang, (2012) affirms that through this constructivist approach, students will be able to overstep intractable problems which are evocative, authentic and correlated to the topic they are studying. Thus the enactment of this inquiry challenge along with the critical employment of the investigation method will enable students to construct their deep understanding of the scientific context. (Harada et al. 2008).

According to Tomlinson and McTighe (2006 in Subban & Round 2015), the PBL approach was developed to meet the educational needs and concernment of young learners. Moreover, it compromises the coadunation of the different subjects, the involvement of home and society in school education, while involving the learners in a communistic, interactive, companionship work, (Yuen,2009 in Liu& Kang 2014).

ChanLin,(2008 in Tseng.,et al 2013) ; Christophe & Romain, (2009) affirm that in PBL approach, each project represents a unique experience, as the various projects in PBL differ in project time span, number of members in each team , and in the means of cooperation between team members. Also, this approach is considered a less formulated when compared to the well-structured, traditional teaching method, that in such an ambiance, it is challenging for students to clarify the phases through which the project outline proceeds. Meanwhile, the degree of collaboration is not easy to control, which will make it difficult for the instructors to evaluate each regarding capabilities and perception of the given topic, (Liang, 2012). Therefore, Chisholm & Leyendecker, (2008 in Liang, 2012) argue that the effectual enactment of this new educational reform, where the students' personal needs and distinctness are addressed, depends on having the ability to handle the diversity between students' capabilities rather than assuming equality. Thus that raised the need to investigate to which extent the PBL is accurately employed inside the classroom, and the extent of perception of this new method among elementary students.

1.2 Project-based learning as a cooperative student-centered approach.

Recent research suggests students be engaged in the learning process, thus teaching in the 21st century is the art of introducing knowledge to students through involving them in the learning process through active learning,(Liu, Lin, Jian, &Liou, 2012). Indeed, changes in the individuals by exposure to different experiences can cause learning (Slavin, Lake & Groff, 2009 in Laguador 2014). Therefore, PBL, as a cooperative learning approach, helps to captivate the student's interests through participating in a collaborative teamwork, that is based on cooperation, debate, and self-reflection on their own work, which will lead to the construction of meaningful perception of knowledge, (Williams, Morgan, & Cameron, 2011). In this modern educational approach, students work in groups, discuss ideas and share information to construct their cognition. Orlich et al. (2010), believe that working within a team help students share their experiences, thus learn from each other. Therefore they will all share the responsibility of learning outcomes, in addition to sharing the success of goal achievement.

On the other hand, the predominant factor of the successful enactment of PBL as a modern teaching approach revolves first and foremost around students' ability to construct their knowledge. Therefore in this student-centered approach, the teacher is a facilitator who guides the learning process in the direction of successful fulfillment of the task without interfering with the students' work. McCombs, (1997 in Brophy, 2013, p23) argues that in a student-centered classroom the teacher becomes the "guide on the side" instead of the "sage on the stage". González & DeJarnette (2015) confirm that teachers' instruction in this student-centered approach should set to minimum as over instruction will diminish the students' discussion and interaction inside the classroom. Consequently, through this discussion, students cooperate within the group to accomplish the assigned project, hence the inspiration and captivation of students during the science lesson will be increased, and this will have a positive impact on their social and cognitive development (Kutnick & Berdondini 2009).

Moreover, the PBL approach is based on competency, which endorses the views of emancipation among learners that give them the chance to control their learning criteria, in which they will master the creation of knowledge in addition to the self- regulation of their quality of perception. (Muller, 1998; Rowell, 1995; Taylor, 1999 in Sikoyo, 2010). Thus Atan et al., 2005; Newman et al., 2004 in Liang (2012) believe that learning within a specific framework, deepening of understanding through social cooperation, accentuation of metacognitive skills and self-regulated learning are the most valuable features of PBL as a method of learning. Also, Brush & Saye, (2014) argue that the successful enactment of this approach in education will help to enrich the curriculum. Also, it will greatly improve the problem-solving skills of young learners by assigning them the active role of mystery solvers, who has the duty of revealing the riddle of the empirical, authentic dilemmas that they may be confronted with in their real life.

1.3 Project-based learning method: skills for the future

Project-based learning has been found to enrich the learning experience with multiple benefits. Lightner et al., (2007 in ChanLin,2012), proclaim that the main aim of the new educational revolutions is to create a new learning environment that is based on self- management, resolving complications, decision making, and self-evaluation of personal progress. In this regard, Wolk (1994 in Grant&Tamim, 2013) illustrates that PBL is considered the avenue where each learner can demonstrate expertise success because of its ability to promote intrinsic inspiration and improve students' aptitude and ingenuities.

Furthermore, Noe and Neo (2009in Tamim& Grant 2013) discussed the effect of PBL enactment on enhancing students' critical thinking, as well as improving their communion, and presentation skills through encouraging them to work within a team and share their thoughts and ideas. Moreover, Hernandez-Ramos and Pas (2009in Tamim& Grant ,2013) believed that through this enterprise, students not only communicate information, but also they try to interpret and scaffold knowledge, collaborate to present their work, which gave them a positive attitude toward learning, as well as moving them from the level of amateurs to the level of expert scientists.

Consequently, project-based learning seems to be a productive approach for developing the educational process in terms of academic attainments and attitudes toward learning, (Korkmaz, 2002; Meyer, 1997 in Beyhan & Bas, 2010), despite the fact that the results vary with the difference in project perfection and the level of learners' involvement. (Thomas, Michaelson & Mergendoller, 2002 as cited in Ozdemir, 2006 in Beyhan & Bas, 2010).

1.4 Background of the research

Capturing students' attention to learning through tackling their interests, developing their excitement to dig deeper in the knowledge, in addition to practicing knowledge construction as real scientists, is the main aim of the new reform in science education. Through this new reform, we can produce a new generation of young learners, who are equipped with the right gear that guide them in their future development, as well as giving them an active role to construct their apprehension. Therefore, Studying students' perceptions and attitudes toward the application of

this new reform in teaching science along with measuring their deep understanding of the scientific context is required to evaluate the successfulness of this approach.

According to the National Research Council (2012), there is an expansive concurrence that it is significant to involve students in an authentic practice to gain scientific knowledge. Thus this study manifest that while using PBL as a science teaching practice, students will work with their hands to accomplish the task; hence this will deepen their understanding and develop their self-esteem, in addition to improving their communication skills as well as their critical thinking . Yuretich (2004 in Kim et al. 2013) agrees that applying PBL approach will help improve scientific reasoning and critical thinking among learners. Moreover, the best part of this study is to evaluate the PBL approach regarding its role in increasing students' engagement and motivation, as they will be pleased to accomplish their task and enjoy the collaborative learning experience.

Accordingly, the successful enactment of PBL in science education will dispose of students to the 21st-century skills, and make them ready for facing the problems in the real world.
Thus The National Research Council (1996 in Kim et al., 2013) reported that the prime target of teaching is to foster the critical thinking, problem-solving and communication skills among students. Also, teaching the students to distinguish problems in different circumstances, examine compilations, reaching to reasonable conclusions, in addition to evaluating relative materials to reach to better achievements (Paul 1995; Perkins 1998 in Kim et al., 2013).

So in this current study, the elementary students went through an actual project approach in their studying of the energy transformation unit. The students were given an introduction to the energy and energy transformation processes; then they were asked to perform a project that demonstrates their understanding of the given subject. Students were divided into groups and were asked to invent a design that shows types of energy transformation. After they had finished their projects, students were asked to answer the questionnaire that asked them to evaluate their experience, and part of the students had been interviewed to talk about their projects. Thus the focus of the questionnaire and the interviews was to determine the perceptions and attitudes of students toward this new educational approach. Also, it will help in evaluating the effect of this approach on the developing of the high order skills among elementary students such as self-confidence, collaboration, analytical thinking, deep understanding, as well as readiness for the workforce in the future.

1.5 Statement of the problem

Education is the most valuable element that unlocks the doors of novelty; it is the essential element that leads to the modernization of nations. Therefore, most countries in the world are calling for a great conversion in the teaching and learning process that goes in line with the fast social and technological development in the 21st century. Thus these new methods in teaching should help prepare students to become productive members of their society and possess the skills that prepare them to meet the challenges they may face in their real life.
Accordingly, Germany is considered one of the leading countries that necessitated this

educational development, as it is considered among the top ten European countries regarding students' performance. According to the organization for economic cooperation and development (OECD,2015), German students were above the average in the fields of science, reading and mathematics when compared to other 72 different countries in PISA assessment results published in 2015 (figure 1).

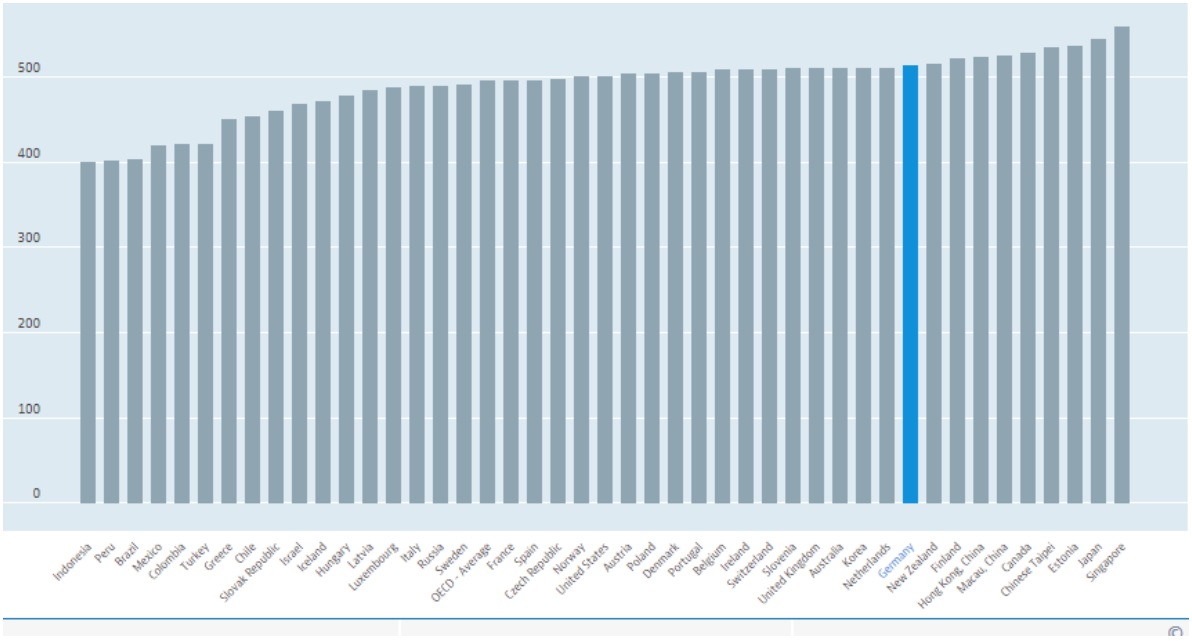


Figure -1-

Moreover, as the main objective in German schools is to ensure that every student benefits from quality education, in addition to increasing students' awareness of their career opportunities in the coming future, there was a great turnaround in the German education that suggested the involvement of students in the educational system. Thus, as acquainted by this study, the application of the PBL method in science education will help students practice the creation of their knowledge. Thus they will be more confident in expressing their perception and will move to a higher degree of professional readiness for the workforce.

Unfortunately, even though that the enactment of project-based learning as a teaching, learning method in science education is favorable in most schools in Germany, we are still facing the problem of understanding the student's perceptions and attitudes toward enacting the PBL method in their science classes. In addition, to know the ability of students to evaluate their experience effect on science knowledge perception, as well as higher learning skills acquirement. That raised the need for more research in this area so that educators can evaluate the successfulness of the application of PBL as a modern educational approach.

1.6 Purpose and Questions of the Study

The main purpose of the study is to investigate the elementary students' perceptions of the use of PBL in their science classes, along with its impact on their critical thinking as well as their deep understanding of the science concept. The study took place in one of the international schools in

Germany that follows the IB curriculum. A total of 59 grade four

Students had participated in the study, among them there were 31 girls and 28 boys. A mixed method approach has been designed to collect data. The quantitative data were collected using a 7 point survey that asked the students to evaluate their PBL experience, while the qualitative data was collected using a semi-structured interview that asked students to talk about their projects and the steps they went through to reach to the final design. As well as discussing the effect of this approach on their high order skills.

The study had addressed the following questions:

1- Did the elementary school students have a clear perception of the PBL approach as a new teaching method?
2- What is the impact of enacting project-based learning on students' deep understanding of the scientific context, and its effect on their higher learning skills?

1.7 Scope of work

Based on what was discussed before, the ambition of the new educational reform is to raise a new generation of young learners who will be effectual representatives in their society, armed with the expertise of real scientists, able to construct their own comprehension of knowledge, while working in collaborative atmosphere, where all share ideas in order to achieve the desired outcomes.

To translate this understanding into real practice, we should investigate the effect of the application of PBL in science education on students' perceptions, attainments, as well as its effect on their attitudes toward learning. Thus this will help reveal to what extent is the PBL method successfully applied in the science education, and to what level students and teachers can comprehend their understanding of PBL to real, productive work inside the classroom.

Moreover, the study of PBL application in the energy transformation unit and the process that the students went through their investigations, will give a clear view about the effect of collaborative learning on students' engagement in the classroom, and its effect on providing the students with the 21^{st}-century skills, preparing them for their future, as well as helping them to adopt the scientific investigation through a well-organized scientific approach.

1.8 Structure of the Dissertation

This study is divided into five chapters; the first chapter discussed the main features of the research, which highlighted the key elements that form the basis of this study such as the project-based learning as a teaching-learning method, the importance of involving students in

this cooperative learning approach. Also, the effect of the enactment of this new approach to developing the skills students may need in their future jobs.

The second chapter explores the literature review that discusses the conceptual framework that

represents the foundation of the study, the history of PBL as a teaching method, the importance of project-based learning in science education, the steps for the successful enactment of PBL in the science class, the effect of cooperative learning on students achievement, and skills acquired by students after applying the PBL in their science classes. The third chapter presents the methodological approach and methods that have been used to collect the data and how relevant these methods in enriching the research results. The fourth chapter will explain all results and the data analysis, whereas the last chapter, number five, presents the discussion of the main results, conclusions, limitations, and the recommendations.

Chapter 2: Literature review

2.1. Conceptual framework

The impetus of the project-based learning as a teaching strategy is to enthrall students' curiosity by introducing a messy problem that is related to their authentic life events. Thus this will help inspire students to work coactively and develop their creativity and critical thinking. According to Ennis (1985 in Barnett 2012); Critical thinking is defined as ingenious thinking that can be revealed in the persons' actions and decisions. Halpern (1999 in Kim et al. 2013) believes that handling convoluted problems entail students to adopt critical thinking activities through which they can practice resourceful, rational high order thinking.
Wurdinger& Qureshi, (2015) affirm that students' exposure to these new methods in teaching has a pronounced impact on students' creativity, inspiration and teaming spirit. Moreover, Boss (2013 in Wurdinger& Qureshi, 2015) claimed that students could acquire new life skills while they are involved in PBL activities, including plan preparation, task initiation, time controlling in addition to comprehension and intelligence.

Although the attention of modern education favors deep thinking over memorizing, in addition to engaging students in intellectual tasks that includes operation, inquiry, synthesis, and self-assessment, (Sezer, 2016). Hence the application of these approaches is still ambiguous for both students and teachers. (Yuretich 2004 in Kim et al., 2013).In addition, many students and teachers are not aware of the possible influence of such educational approaches on the improvement of students' critical thinking , and many are ill-considered to ameliorate students' developmental skills that they may need in their careers and civic life in the near future, (Teasdale, et al., 2017). Therefore, there was an urgent need to study the PBL from students' perspective and to examine the effect of PBL enactment on students' perceptions, attainment, high learning skills, as well as long retention of knowledge.

Accordingly, many types of research have studied the impact of enacting PBL in teaching science on students. Three domains have been investigated: cognitive, affective and behavioral domains (Han, 2016). In regard to the affective domain, enacting PBL in science education was found to have a positive effect on students' attentiveness to learning, thus increasing their self-assurance and self-competence (Baran & Maskan, 2010), in addition to its effect in developing the communion and cooperation skills among students (Kaldi et al., 2011) . Thus PBL exerts a positive effect on the behavioral and affective domains through improving the learner's academic attainment. (Han, Capraro, & Capraro, 2015). As when students' passion for learning is increased, they will gain a positive attitude toward learning, thus this will improve their final scores and therefore improve their achievements. Han and Carpenter (2014) endorsed five elements of PBL: self –managed education, cooperative teaching environment, interdisciplinary approach, empirical teaching, that is based on technology. Additionally, Capraro et al., (2013); Han & Carpenter, (2014), affirm that PBL has a positive effect on the behavioral, affective and cognitive domains because of its anomalous construction and elements that involve the students in the teaching process.

Moreover, when the science education literature was reviewed, it is recognized that increasing

amount of research has investigated the effect of the enactment of project-based science teaching on the students' attainment and attitudes toward science learning. When Çakici &Türkmen (2013) studied the effect of enacting PBL on fifth grade students on their achievements and attitudes toward science learning, in addition to measuring the effectiveness of the PBL approach compared to the traditional teaching methods, they found that the enactment of PBL has shown its effectiveness in fostering the students' achievements in learning science when compared to the old traditional methods. Moreover, Doppelt (2003 in Carpenter, 2014), in his aim to improve the achievement of low achievers, pointed important goals for the learners and educators, and then performed projects that foster students' skills and abilities. He proclaimed that the PBL approach influenced students' self- esteem and inspiration and proved its efficiency as a constructive learning method, as most of the low achievers were successful to pass the matriculation exams and enjoyed the learning experience.

In addition, Kanter and Konstantopoulos (2010 in Çakici &Türkmen ,2013)), aiming to explore the effect of the application of PBL on students' performance and attitudes, through fostering teachers pedagogical knowledge perception through professional development program, reported that students have improved in terms of perception of science knowledge and achievements with the implementation of the project based methods in their science curriculum, while their attitudes toward learning science didn't change.

Furthermore, Krajcik et al. (2004) conducted a research study on 24 educators and more than 2500 students by designing a project-based curriculum that appraises teaching science as a meaningful, authentic experience. The study revealed that the employment of this new teaching method was significant to bolster the experience of teaching science as meaningful real-life experience.

In another study, Papastergiou (2005), examined the influence of enacting a project based environment on students teachers, the study revealed the significance of PBL on increasing the ambition of students toward possessing new empirical, developmental skills. Thus this boosted the self-assurance of students to design the attended project.

Furthermore, Korkmaz and Kaptan (2002) explored the impact of using PBL method on the academic achievements and self-confidence of 7th-grade students; the results revealed a significant difference after using PBL regarding academic attainment, and self-confidence among students. Similarly, Altun Yalçın, Turgut and Büyükkasap (2009) studied the effect of project-based learning on first-year science undergraduates ' attitudes toward learning physics and electricity modules, in addition to its effect on developing scientific approach skills, using the quasi-experimental, to measure the pretest-posttest results. The results showed that there was a significant improvement in students' attitudes toward learning physics and electricity, as well as developing the important science process skills that students may need in the workforce in the future. In similar study, Deniş Çeliker and Balım (2012) studied the imprint of using PBL method on learning the "Solar System and Beyond: Space Puzzle" unit of the 7th grade science book, on the students achievements, using also the quasi-experiment ,results also revealed that the enactment of PBL had a positive influence on the students achievements .

Additionally, similar to this study, Karaçallı and Korur (2012 in Çakici &Türkmen, 2013)

performed a study on 4th-grade students to explore the effect of enacting PBL in their learning about electricity unit. The sample consisted of 73 students in the experimental group who were taught the electricity unit using the PBL method, while other 70 students were in the control group and were taught using the old traditional methods. The results favored the PBL method regarding increasing students' performance and retentiveness of knowledge, while no differences regarding students' attitudes toward learning have resembled in the results.

Moreover, Şahin and Benzer (2012) explored the effect of the application of PBL on the students' scientific skills using mixed method approach. The study was conducted on 14 undergraduate student teachers, in addition to 111 elementary school students. They discovered that the employment of PBL method influenced the students' critical scientific skills of each group.

Accordingly, many studies in the literature have investigated the effect of enacting project-based learning in the science education, and its effect on students' achievements, attitudes toward learning along with acquiring the scientific process skills like group cooperation and critical thinking as well as gaining longer retention of knowledge. Thus these studies agreed on the significance of PBL as a valuable pedagogical approach that guides students in the right direction toward gaining meaningful learning to construct a solid bridge between the acquired knowledge and real-life events.

Therefore this study was conducted to measure the effect of project-based enactment on 4th-grade students' attitudes toward learning the energy transformation unit as well as its effect on their achievements, critical thinking, in addition to its' influence on acquiring the high order scientific skills.

2.2. Project-based learning between past and present.

Project-based learning in science education can be considered as the most effective conversion in the methods used to teach science in schools in the recent years. Accordingly, this new method was developed to meet the desideratum and acquaintanceship of young learners to help them construct and produce their knowledge, (Katz and Chard, 2000 in Catapano& Gray, 2015). Thus, Project based learning is considered a more contextualized and sovereign interdisciplinary learning that is continuously assessed which link the students to their actual life and give them superiority to accomplish their task. In contrary to the traditional approach where the end term competency would be to pass the final exam. (Dorça, et al., 2013). Thus this method is considered more efficient in fostering students' attainment, through developing their critical thinking and reasoning, in addition to improving their ability to employ their understanding compared to the old didactic approach, (Hu, Kuh, & Li, 2008 in Lysne, Miller& Eitel, 2013). As this new teaching method requires deep investigation of subjects, ideas or problems without predetermined answers (Harada, Kirio, & Yamamoto, 2008 in Lysne, Miller& Eitel, 2013). Consequently, this will provide students with problem-solving and decision making proficiency. (Boaler, 2002 in the Chu, Tse, Chow 2011).

However many research studies have been conducted to define this new educational approach. David, (2008 in Peng, Wang & Sampson, 2017) explained that this new approach is based on exploring the natural life that guides the creation of new artifacts. In the same way, Adderley et al., (1975); Nuutila, Törmä, & Malmi, (2005 in Peng, Wang & Sampson, 2017) assumes that through this new teaching approach, students can be indulged in the creation of genuine, realistic products that develop their professionalism. According to Tseng et al., (2013), in PBL students will be involved in a variety of group educational activities to reach to the end product. Wurdinger & Qureshi (2015) confirmed that the work could sustain for a considerable length of time as the students go through multiple phases of trial and error to reach to the achievement of their task. Thus this method can help to engage students in the learning process through activating the cooperation among students. Consequently, this will promote the construction of a solid base of knowledge through social interaction (Von Kotze & Cooper, 2000 in Lee & Lim 2012). According to The Korean National Human Resources Development Council, this cooperative learning approach has captivated educators awareness of the importance of this new learning method for both enhancing the quality of teaching and developing the learning efficiency among elementary students (. Jung, 2001 in Lee & Lim 2012).

Moreover, Thomas (2000, in Grant& Tamim, 2013) describes five criteria for PBL: projects should be derived from the curriculum, concentrate on the problems that motivate students to delve into the main concepts, embrace the students in the constructivist inquisition, instigated from the students' concerns and rational. Additionally, Grant (2002 in Grant& Tamim, 2013) affirms that the accomplishment of the project is anchored to the activity, the exploration of the task, allocation of resources, cooperation between team members, scaffolding and finally self-reflecting on the final product. Furthermore, Rieber (2004 in Grant 2011) affirms that these projects represent the students' solution to the authentic guiding dilemma. Bridges & Hallinger, 1996; Torp & Sage, 1998 in Stearns et al., 2012) explains that this dilemma is intricate and tangled by nature. Thus through solving this dilemma, students can reach to the artifact that represents their deep understanding of the scientific context, and this is considered as the integral component of the PBL approach, (Adderley et al., 1975; Blumenfeld et al., 1991 in Grant, 2011).

Also, through this authentic experience, students will be captivated to the learning environment, as they will be involved in creating and recreating their image of understanding, and they will need to speculate on their own experience and achievable knowledge. (Panasan & Nuangchalerm, 2010). Thus using this inquiry approach can help students to inaugurate their previous knowledge with the new concepts they acquired, which will deepen their understanding of the natural world surrounding them, (Nuangchalerm and Thammasena, 2009). Ultimately, enacting PBL will develop the quality of teaching, like Brown, Collins, & Duguid, (1989 in Wang & Sampson, 2017) claims that the development of meaningful knowledge can be achieved when knowledge is invented and applied.

A look back to history revealed that the project based education is not very new (Merkham , et al. 2003 in Lee et al., 2014). Although the roots of PBL were thought to be aroused from the work of John dewy in the 19th century, The recent research suggests that the crux of the of the idea goes back to the late 16th century after the evolvement of the architectural and engineering instructions in Italy, (Knoll1991; Scholler, 1993; Weiss, 1982 In Capraro &Capraro& Morgan 2013). Whereas others believed that the base of the project-based learning is related to the sloyed system of carpentered work (Capraro, Capraro &Morgan, 2013). In the 1940s the project method was denied as it was insufficient to meet the requirements of the instructors, students and society. Then it was re-established in the 60s where many studies proclaimed that PBL is essential to promote the critical thinking of students, to teach them to think as experts rather than young learners (Capraro&Capraro&Morgan, 2013), As this approach will basically produce a modern authentic, educative practice that emulates the real world in which students live and learn. (Ozdemir, 2006 in Beyhan&Bas 2010).

According to Capraro&Capraro&Morgan, (2013), the prolonged and prominent history of the project based method can be arranged in five distinctive stages:
1590-1765: The initiation of project-based approach at engineering schools in Europe. 1765-1880: The evolution of project-based learning in the American curriculum.
1880-1915: Work on projects in manual training and general public schools.
1915-1965: the re-exemplification of the project method while moving back from America to Europe
1965-today: the international recognition and enactment of the PBL as a new teaching approach.

Apathetic from these chronological deliberations, Kilpatrick (1925 in Capraro, Capraro &Morgan, 2013), who is considered the procreator of the project based approach Attentive to show the didactic and intellectual fundamentals of project-based learning as a method of teaching, and provide guidance to teachers on the best way to enact the PBL inside the classroom, (Capraro& Capraro&Morgan 2013). Moreover, Kilpatrick (1925, in Capraro, Capraro &Morgan, 2013) pinpointed the importance of students' attentiveness in the blooming of the project based method. Thus he affirms that the project based method is "a hearty purposeful act''. Consequently, students' invitation is the most importunate element that influences the enacting of project-based learning inside the classroom (Capraro& Capraro&Morgan 2013). And he believed that this purposive work is the main aim of the respectable life, that each one has to be the owner of his destiny, and each human has the right to control his goals in order to meet the requirements of empirical adequacy and ethical accountability (Kilpatrick, 1918 in Capraro& Capraro&Morgan, 2013). Furthermore, Kilpatrick agrees with Dewey's view that this unique purposive educational experience qualifies students for their authentic life, as it represents the authentic life itself. Consequently, in one of his succinct articulations, Dewey affirmed that purposeful learning which happens through social interaction resembles the power that leads to a successive life, (Dewey, 1916 in Capraro& Capraro&Morgan 2013).

2.3. **PBL and constructivism**

Project-based learning is an educational method that is derived from the constructivist philosophy which involves students in constructing their perception through social interaction and allows for personal attentiveness in gaining scientific knowledge. (Duffy & Cunningham, 1996 in Grant& Tamim, 2013). According to Jumaat, et al. (2017), constructivism is an adventure through which one can discover the meaning of knowledge, and construct his pedagogy through the interaction between previous knowledge and the newly discovered information. Jonassen, (1999, in Freidin, 2014) affirms that constructivism speculates that the perception of knowledge is personally formulated and then socially reformulated by students and derived from their apprehension of the real world around them. Accordingly, this learning model indicates that young learners should create their pedagogy from their authentic experiences through cooperation and social debate which can lead to the meaningful learning (Chen 2007 in Freidin, 2014). Thus, enacting the PBL approach can help to reveal the individuality of each student and frame an independent personality that has a sense of reliability which will make them ready to face the workforce in the future.

Accordingly, Vygotsky (1978 in Beyhan & Baş 2010) believes that students can construct their understanding through interactive learning. Thus this constructivist model explains that students can gain a better understanding when they are active agents in the learning process. Consequently, students can construct retain and shape knowledge according to the unique way they observe their world (Senturk & Bas, 2010). Thus Chanlin (2012) affirms that the active participation of students to build their understanding is the main proposition beneath constructivism, consequently as a constructivist teaching method, PBL endorse young learners to enact their investigation, adjoin scientific theorem with practice, and employ collaborative skills to guide them to the right answer of the ill-structured dilemma that is derived from their real-life events (Capraro& Capraro&Morgan ,2013). Moreover, this teaching method can pinpoint the different capabilities among students in the classroom, as each one of these learners has a unique learning ability, thus a unique learning style. (Dunn, 2000 in Senturk & Bas, 2010).

However, While in this approach teachers hold an advisory role rather than the authoritative role they used to do in the traditional teaching approach, as the teacher helps gear the educational process in the right direction for high student involvement, and consequently high student attainment. Therefore Constructivist teaching doesn't absolve teachers from the responsibility; it broadens the meaning of teaching, as teaching is not considered the process of knowledge transfer; it is the act of planning the acquaintance that empowers the learning process (Lattuca 2006 in Hubbard 2012). Orlich et al., (2010) confirm that in this learning approach, both learners and teachers can benefit from each other. Thus through this collaborative atmosphere, where teachers and students collaborate to construct their knowledge, students will develop a better understanding of the given material, as well as they will be able to gain the competency of the high order skills that will make them ready fortheir future, (Smaldino, Lowther, & Russell, 2012; Trilling & Fadel, 2009 in Wang, Huang, & Hwang, 2016).

2.4. Phases of PBL enactment

There are multiple stages for the successful enactment of the Project based learning inside the classroom; thus to ensure a gentle flow and successful task achievement, the PBL application needs careful planning of these multiple stages (Bell 2010). Stevenson, (1921 in DeWaters, 2014) affirms that the intensive planning in project learning help is assuring the comprehensive teaching of the educational subject.

The PBL experience starts with introducing an" authentic ill-structured problem with a well-defined outcome'' that is derived from students' real life (Capraro, Capraro&Morgan 2013, p.26); thus the expected outcome can help students to expand the possible designs for the project, as well as deciding on the fundamental elements and the restraints that may impede the accomplishment of the final design (Cpraro, Capraro&Morgan, 2013). According to (McMurry, 1921 in DeWaters,2014), the previous exposure of young learners to ground information about the subject is essential to help them estimate the expected results.
With teacher guidance, students will compose different questions they need to examine, as well as determining on the methods they will employ in their working plan. The teacher in this stage acts as a facilitator who steers the learning process. Thus in the students centered learning approach, the teacher role is to guide the inquiry investigation toward the correct path that leads to the profuse completion of the task. Orlich et al., (2010) confirm that this method is convenient to share expertize, as both teachers and students interchange knowledge and learn from each other. Thus Through deliberation and confabulation students can apply brainstorming to find possible resolutions and different ideas. Indeed, one of the most recognized benefits of brainstorming in research is that brainstorming rules foster the formulation of a great number of quality ideas (Paulus et al., 2013).

At the final phase of the work, students try to make conclusions from all the results and abridge the findings of the investigation (Helm & Beneke, 2003 in Beneke& Ostrosky2015). Thus this will lead to the development of the final product. Meanwhile, deliberation between members

Of the groups can help test and refine the project and self –interpret the overall experience. Undergoing peer evaluation will encourage students to evaluate their peers' effectiveness in succession of the task (Molly&Wei, 2014). Carbone et al. (2015) believe that peer evaluation can instigate individual liability of his work, as well as fostering the Metacognitive cognition among group members.

2.5. Project-based learning and critical thinking.

While living in this technology-rich era, people should have the ability to face the rapidly-evolving technological challenges; consequently they should have the mastery of conjoining the new and previous knowledge as well as coping with the different problems they may encounter, (Chu, Hwang, Tsai, & Chen, 2009 in Sung, Hwang & Chang, 2015). Thus this readiness to adapt to changes begins from the young ages, as preparing the young learners to be effective members of their outside community, starts from their small school community. Therefore, learning through solving complex tasks and creating authentic projects was adopted to arm the students with skills they may need in their future development, (Wang & Sampson, 2017). Kirschner, Sweller, & Clark, (2006 in Wang & Sampson, 2017) argue that the complexity of the task will create a huge cognitive load for learners, thus encourage them to adopt the critical thinking to solve the encountered problems. Johnson, Archibald, & Tenenbaum, (2010 in Sung, Hwang & Chang, 2015) affirm that involving students in independent thinking will help praise their critical thinking competency.

Critical thinking is a type of high order thinking that people can adapt to encounter the intricate problems they are confronted with in their life (Sung, Hwang & Chang, 2015). McPeck, (1981 in Udi1& Cheng 2015) believes that critical thinking is the talent of being involved in solving tasks that entails reflective skepticism. Similarly, Ennis, (1985 in Udi1& Cheng 2015) defined critical thinking as rational thinking that depends on self-reflecting to accomplish the required task; it is the decision of what a person should believe or do. On the other hand, Paul (1993 in Howard, Tang, Austin, 2015) affirms that critical thinking helps to improve the quality of judgments; it is

the metacognition that one can think and speculate on his thoughts. Additionally, Ennis (1987 in Udi1& Cheng 2015) argues that thinking critically is the process of persistent examination of the diagnosed problem, making interpretations to reach to the right decision, and then self-evaluate on one's thoughts. Accordingly, it is important to engage students in a Project-based learning environment to develop their analytical thinking and reinforce their intelligence in facing the real world, (Kuo, Chen, & Hwang, 2014).

2.6. Project-based learning and deep learning.

Arguments and debate about the best instructional method in education have engaged many types of research in the educational field, (Hwang & Wang, 2016). While Kirschner, Sweller, & Clark, (2006 in Ozverir, Osama, & Herrington, 2017) believe that the explicit instruction is the ideal method in teaching, others argue that giving the opportunities to young learners to construct their cognition will be more effective in gaining the deep learning, (Alfieri, Brooks, Aldrich, & Tenenbaum, 2011; Lee & Anderson, 2013 in Ozverir, Osama, & Herrington, 2017). Ramsden, (2003 in Pegrum, Bartle & Longnecker, 2015) affirms that deep learning can be achieved by active understanding and self-construction of knowledge, as this will lead to higher learning outcomes among students as well as higher achievements. Houghton,(2004 in Pegrum, Bartle & Longnecker, 2015) believe that while constructing their perceptions , students can connect between pre-existing and new knowledge while applying the critical analysis of the ideas that will help deepening their understanding as well as their longer retention of knowledge.

Therefore to develop deep learning in science education, students should be involved in the learning process. Hence this can be applied by using the Project based method in teaching sciences. Thus this will lead to the deep perception of scientific concepts that will develop longer retention of knowledge and better attainment (Lee et al., 2014). Slavin, (2014) confirms that students who are engaged in active cooperative group learning will get higher attainment compared to others which depend on traditional methods.

Chapter three: Methodology

Based on the foregoing literature review, there is an imperative need to measure the perceptions and satisfaction of primary school students after using the project-based method approach in learning science in their classroom, and its effect on their motivation and deep understanding of science concepts, along with acquiring the skills they will need in their authentic life events. Thus according to this study, this can be measured by asking students to evaluate their experience of performing a project about energy transformation after studying the unit (How the world works: Energy) in the science class. A total of 59, fourth grade students from one of the international schools in Germany that follows the IB curriculum were involved in this study, A mixed method approach has been designed to collect data; quantitative analysis has been collected using a 7- point questionnaire with a four points Likert scale that was adopted from other research and modified to fit to this study. The questionnaire asked students to evaluate their Project-based learning experience, after conducting a project during their studying of energy unit. On the other hand, the qualitative data was collected through semi- structured interviews with five students to explain the projects they have performed, in addition to evaluating the PBL experience in term of its validness and its influence on their deep understanding and the development of new skills.

The study was carried out on the elementary level students, particularly grade four students upon completion of performing the projects. The duration of the study was for three weeks and the projects were performed in two sections of grade four in the school mentioned above. After completing the task, the teachers asked the students to answer the questionnaire, and the interviews were conducted with the five students.

The methodology chapter will demonstrate how were the mentioned instruments used, as well as explaining the fundamentals of the research approach. Also, the reason for using this methodology will be justified to clarify its coherence with the main goals of the study.

3.1. Research Design

This study was conducted to measure the perceptions of elementary school students after using the project-based method approach in learning science in their classroom, and its effect on their deep understanding of science concepts, along with its impact on their development of new skills while working in groups and simulating the real scientists' investigations.

Therefore, this research has adopted the mixed method approach, where both qualitative and quantitative methods are conjoined, to enrich the research results. Creswell, (2009) describes the mixed method approach as the process of the acquisition and investigation of both quantitative and qualitative data within a study. According to Johnson& Mayoh&Onwuegbuzie , (2015) the mixed method approach aims to consider multiple viewpoints while respecting the sageness of both of these standpoints. Lund (2012) believes that mixed methods research is more convenient to give accurate answers for complex dilemmas than qualitative or quantitative methods in isolation, which will help to draw a complete picture of the studied material. Rossman and Wilson (1985 in Mayoh, Onwuegbuzie, 2015) pinpointed three advantages of conjoining quantitative and qualitative methods. First, consolidations are used to enable justification and attestation of each other through triangulation. Second, blending both methods will facilitate the interpretation of data that will help in to enrich the results. Third, this blending will open new channels of thinking by addressing contradictions that may emerge from the different data sources. Lund (2012) affirms that these contradistinctions may lead to more deliberation and rectification and further research. Thus this will ensure that the data has been assembled and interpreted correctly.

Furthermore, Mayoh&Onwuegbuzie, (2014) affirms that each of the quantitative and qualitative methods has its patterns of strength and weakness that help to complement each other and therefore reinforce the research results. For example, the qualitative methods study the cases from the participants' perspective. Thus it is derived from the constructivist philosophy that the participants can create their perception of the situation (Creswell, 2009). Therefore the qualitative research helps study the natural context from the apprehension or assimilation of participants about the studied phenomena (Denzil & Lincolin 2005 in Mayoh&Onwuegbuzie , 2014), which can help to reach to a described form about the daily events related to the research topics that the participants had experienced, (Frederick Erickson, 2012). Thus this will help obtain more extensive and deeper results (Lund, 2012). As well as, indulging the research with the sense of innovation and creativity (Creswell, 2009).

On the other hand, the quantitative research is more applicable to hypothesis testing and often offers more generalizability and neutrality in the research results than the qualitative methods (Lund, 2012). Thus, in the quantitative approach, the researchers will be more ample with the flow of the research procedure as it uses the positivist philosophy for the creation of knowledge through deep investigations and data analysis (Creswell, 2009). Accordingly, one can notice that the credibility of the mixed methods approach is that by applying both the quantitative and qualitative strategies, one can employ their points of strength and avoid their points of weakness. (Tashakkori & Teddlie, 1998 in Lund, 2012).

The study involved multiple phases for data collection. First, after ending the projects, the researcher with the aid of the science teachers introduced the questionnaire for all the grade four students. The students were asked to evaluate if they agree or disagree with different aspects of their experience after using PBL in their science classes. Secondly, the researcher interviewed the five students and asked them about their projects, ideas and their satisfaction with the enactment of PBL as a teaching method in their science classes. Those students were chosen randomly from different genders and different capabilities to evaluate the perception of the PBL experience from multiple viewpoints and different students' levels.

Insight of all what has been mentioned earlier, this research is a mixed method approach study that combined the qualitative research methods represented by the semi-structured interviews that has been created for this study, with the quantitative research methods presented by the survey that has been adopted from other research and modified to fit to this study , in order to take advantages from both methods to reach to a deep analysis of the collected data ,and therefore a clear interpretation and assimilation of the results.

3.2. Site and Sampling

The study took place in one of the international schools in Oberursel, Germany that follows the International Baccalaureate (IB) curriculum and teaches in the English language. Through this curriculum, the school focuses on developing the whole child, helping students to make connections across academic disciplines and challenging them to achieve their highest potential as individuals, as well as caring, honorable, ethical and adaptable global citizens.
The study involved 59 grade four students, who have different nationalities, their age ranges between 9-10 years old, 28 Males and 31 females. All the 59 students have participated in answering the survey, while only 5 students agreed to be interviewed by the researcher.

3.3. Procedure, Questionnaire and Interview Protocol

The insight of the previous literature, project-based learning has been acquainted and increasingly adopted as a modernized teaching method that enhances the construction of

Knowledge among school students through social interaction (Von Kotze & Cooper, 2000 in Grant, 2011). As this method has improved its competency in developing educational efficiency (Jung, 2001in Lee & Lim 2012).In addition to improving students higher learning skills such as collaborative skills, analytical and conventional thinking, team working as well as accountability (Moursund, 2003 in Lee & Lim 2012). Therefore it was important to investigate the perceptions of students of PBL and its effect on their higher skills development.

The study went through multiple stages; in the first stage, the teachers introduced the energy transformation unit explicitly to the grade four students, to give them a clear idea about energy and types of energy transformation then allowed the students to investigate different forms of energy. In the second stage, the students were divided randomly into groups of three and were asked to apply what they have learned to build an invention that highlighted energy transformation. The teacher guided them through their inquiry investigation and gave them the complete freedom to make decisions about their projects to give them the opportunity to show

their perceptions of the unit in their work also of developing their creativity, critical thinking and team working skills. Accordingly, the students designed their inventions on papers then went through the creation process, and then they self-evaluated their work.
Finally, the students were asked to write procedural writing to explain how they built their project and what type of energy transformation their model represents. In the third stage, the teacher spread the questionnaire that asked the students to evaluate their perception and satisfaction of enacting project-based learning in their science classes and its effect on their learning skills and deep perception of the scientific context. Finally, in the last stage, the researcher interviewed five of the students to talk about their projects, and steps they went through to accomplish their tasks, in addition to their perception and satisfaction about this experience.

3.3.1 The students' questionnaire

The quantitative research tool in this study was the 7 points questionnaire (Table- 1) that was adapted from another study and modified to fit this study. The questionnaire asked the students to evaluate their experience after the enactment of PBL in their studying of the energy transformation unit in the science class, using four points Likert scale ranging from strongly agree, to strongly disagree. Cohen, Manion and Morrison, (2000 in Wang& Zhu 2016) affirm that the questionnaire is a broadly used and beneficial instrument for gathering survey information, providing analytical, often numeral data that can be collected straightforward to be analyzed directly. Moreover, Cohen, Manion and Morrison,(2000 in Wang& Zhu 2016) believe that through using the questionnaires that applies rating scales the researchers can catch enunciated, legitimized, observable features of the studied culture, that will make it easy for them to measure the amount of sharedness in this culture, as well as the congruity between actual and exemplary, in addition to the aptitude and keenness of that studied culture.

The data analysis plan in this study had different components, as the procedure for analyzing data involved creating a clear image by making sense of all the collected information ,in addition to looking in depth into the multiple data sources , in order to represent the data clearly and reach easily to the acquired interpretations (Creswell,2009) . Rossman and Rallis (1998 in Creswell,2009) describe data analysis as an ongoing practice compromising perpetual contemplation about the gathered data, asking rational questions and writing notations that can guide to the profound apprehension of the results.

Table 1

Questions After finishing your project, explain how did you find this group project experience?
Inspiring and motivating, it made learning science an exciting experience
It helped me fully understand the context of the subject, and I can easily recall it in the future
Encouraged me to work with others and interact with colleagues who I usually do not interact with
Made it likely for group members to observe and monitor each other's understanding of the project
Improved my critical thinking and problem-solving skills and helped me to make decisions
Gave me an idea about real scientists investigations and examples of related science careers
I feel this experience is useful to me and will help me in my future

3.3.2 The semi-structured interviews

The qualitative data were collected using five questions, open-ended, semi-structured interview that was created to fit this study (Appendix A). Where the researcher interviewed five of the students and asked them to talk about their project-based learning experience. Thus the interviews were taped and recorded. Major boon (2005 in Kasim & Al-Gahur, 2015) affirms that the interviews are ways for participants to get entangled and express their views. Cohen, Manion and Morrison (2000) explained that the interviews are not only a method of gathering information about life; it is an essential part of life where the embeddedness of humans is ineliminable. Thus Driver, (1995 in Kasim & Al-Gahur, 2015) affirms that in the semi-structured interviews the person being interviewed will have the right to decide on his responses, explanations and how much to talk. Moreover, the sequencing in which the assorted topics are dealt with and the wording of the questions are left to the interviewer's preference (Corbetta, 2003). Furthermore, Gray, (2004) believes that this type of interview gives the researcher the liability to delve into and probe the views and opinions of the interviewee. Thus probing is a process that helps the interviewer to dig into new paths which were not estimated previously. Thus the researcher can determine on the grounds to be covered formerly, and leave the detailed frame to be agreed on during the interviews (Driver, 1995 in Kasim & Al-Gahur, 2015).

The interview contained four open-ended questions; the first and second questions asked students about the steps they went through to accomplish the task, and what difficulties they faced to reach to the final design. The last two questions asked students to evaluate their experience if they had enjoyed the collaborative teamwork, and what new skills they have

acquired after going through this investigational process.

The interview was held in the science lab, where the students were asked to answer the questions. The researcher gave the participants simple information about the research and the aim of this interview. The interview was audiotaped; the use of an audio recorder was explained and agreed on by the participants before the interviews. The participants have been assured that their anonymity will be confidential. Also, the researcher took the permission of the science coordinator to see some of the projects and take photos to use them as documents in the research.

(Images 1,2,3,4,5)

3.3.3 Ethical consideration

Gajjar, (2013) beliefs that it is essential to adhere to the ethical standards in research as this can help certify the research aims such as inventiveness, truthfulness and error avoidance. Therefore in order to ensure the application of all the ethical norms in this study, the researcher conducted a meeting with the elementary school director to explain the purpose of conducting the research, in addition to submitting a professional letter of request from the BUID university (Appendix B) in order to take the permission to perform the study in the elementary section.

The researcher has assured the anonymity of the students' identities. Similarly, the school principal was assured that the school name would be kept anonymous, and all findings will be used appropriately, as will their reporting and dissemination.

Moreover, as any research should be directed by the elements of people respect, benevolence and equity, (Capron, 1989 in Creswell 2009), the participants were given the freedom to participate in this study, and they were informed that they have right to withdraw from the research if they felt they need to without penalty. Also, they were assured that their dignity and privacy would be respected.

Accordingly, regarding what was illustrated before, all the recommended ethical norms were considered while conducting this study, based on all the points that had been agreed on with the school administration.

3.3.4 Credibility and trustworthiness of the quantitative and qualitative instruments.

The use of the mixed method approach by conjoining the qualitative and quantitative methods in this study helped to ensure the validity and reliability through the triangulation of the data resources. Triangulation is the amalgamation of two or more data sources, methodologies, and hypothetical prospective (Kimchi, Polivka, & Stevenson, 1991in Hussein 2015). According to Denzin, (1970 in Flick 2017), involving the triangulation methods in data collection will help to develop the credibility, reliability and the interpretive strength of the study, thus decreasing the researchers' bias, as well as developing multiperspective views of the phenomena. Thus this will help provide rich, unbiased data that can be easily interpreted with an adequate degree of assertion (Breitmayer, Ayres, & Knafl, 1993; Jick, 1979 in Flick 2017).

Even though the researcher is not a teacher in the school where the research took place, but the researcher has conducted a meeting with the elementary school science coordinator who gave the researcher a clear idea about the students projects, in addition to providing the researcher with the important information that may be needed to assure the trustworthiness of the results. Additionally, the science teachers, who guided the students in their tasks, were responsible for the collection of the quantitative data by spreading the questionnaire. Thus the involvement of these teachers in data collection has reinforced the validity and reliability of the study as they possessed a deep understanding of the studied phenomena.

Chapter 4: Data Analysis and results

The main purpose of this study was to investigate the perceptions of the elementary school students after the enactment of the project-based learning in their science classes while studying the energy transformation unit. In addition to measuring the impact of this method on the deep learning and high order skills. This current chapter presents the outcomes of the quantitative data represented by the 7 questions survey that asked students to evaluate their experience after the accomplishment of their projects, in addition to presenting the qualitative data results represented by the one to one interviews that asked the students to talk about their projects and evaluate their experience.

4.1 Demographic Information

The target of this research is to investigate the perceptions and attitudes of the targeted sample after the employment of the PBL method in their science classes, in addition to measuring the impact of this method on the students higher order skills in one of the international schools in Germany, (N=59). The table below illustrates the results of the demographic information which include gender, the age of the students, and the grade they belong to.

Gender	Female	53%
	Male	47%
Age	9 years	45%
	10 years	55%
Grade level participating	Grade 4	100%

Table 2: Percentage of students' demographic information.

4.2 Qualitative data results

The qualitative data were collected using the semi-structured, one to one interviews with some of the participated students to obtain a profound insight into the students' apprehension of the PBL approach as a teaching, learning method. The interviews were audiotaped, and the data were analyzed using the descriptive analysis method (Creswell, 2009), that displayed the students' responses and abstracted their quotes that recapitulate their perception of the investigated aspects.

The students were asked to talk about their projects, what they built, what kind of energy transformation their projects represent, how their invention helps people, and what kind of difficulties they faced while conducting their group work.

4.2.1 The perceptions and satisfaction of enacting the PBL method among the elementary students

Asking the students about their attitudes toward the enactment of the project based method after their studying of the energy transformation unit. This question aimed to measure the students understanding of the PBL as a new teaching method, and to what extent they found this method as an effective, enjoyable experience. The students' answers revealed that they had well understood the PBL method and the steps they need to go through to accomplish their work. Also, the answers manifested that the students had enjoyed working as a group and creating their projects. Thus this made learning about energy transformation easier and entertaining. The following are quotes from the students' answers:

"We are building a fan that uses the solar energy from the sun; we worked as a team. It was nice to work together and collect information, we wrote a progression sheet and every one was telling what is going well and what is difficult in inventing the fan and we evaluated the work at the end of each day."

"It was nice to invent the potato battery, doing the project was better than taking the lesson at the beginning as that was boring. We used YouTube to find information. I like to work with my friends; we wrote the progression sheet and had too many discussions that one of my friends got mad.

"I enjoyed the group work; we were taking turns and communicating very well. The creation was progressing very well and we finished on time, and we evaluated our work because we really worked hard with good planning and we did teamwork all the time."

4.2.2 The effect of the enactment of the project-based learning on students' understanding of the science unit.

The second question asked the students if the enactment of the PBL method in studying the energy transformation unit made them understand the energy transformation concept better. This question aimed to measure if the enactment of the PBL method will have a positive effect on the understanding of the scientific context. The answers revealed that the students had understood the energy transformation process better after they finished their projects; the following are quotes from their answers:

"Our invention is very creative; it will help people because the sun is always there. We need a small motor and a solar panel, we collected information and we understood how the energy from the sun would move the fan, but our problem was with the cabling and the solar panel because it didn't power the engine."

“It was nice to work on the energy transformation invention; we investigated the chemical energy and the electrical energy, we used the internet and YouTube, but we had so many problems in connecting the alligator clips. Yes, now I understand better how the energy will change.

“We investigated the electrical energy; we used salt water and copper coins and wires to create an electrical charge that lights the light bulb, I searched on you tube and learned many things.”

“We are inventing the solar car that helps injured animals; it uses the solar energy to move. And this invention helped me understand the energy transformation unit better while creating it.

4.2.3 The effect of the enactment of the project-based learning on the student's high order skills.

This question aimed to measure the effect of enacting the PBL method of gearing the students with required skills they may need in their future. The answers revealed the students had developed different high order skills, like working collaboratively, thinking critically to solve problems, self-evaluating their work, self-dependency as well as high ingenuity and self- esteem. Also, students recognized that their work is connected to their real life as they believed that their creations would help people in different ways. The following are some quotes from their answers:

“I liked the way we worked as a team; we had so many negotiations to solve the problems we faced**”**

“I was the leader of the group and told them our plan, it was nice to find solutions and our design will help because it will make electricity if people don’t have it, they can use the electrical charge to create more light from the light bulb.”

“Our fan is a good invention; it will help people because the sun is always there, when I grow up I can work in a factory and show them my invention.”

“I like our invention, it can help if you want to take your pet out while it’s injured, and you don’t want to carry it. We had problems because the motor was not working; it was hard to build the motor that we had to change plans and make a new motor.”

Accordingly, in sight of all the quotes mentioned above, we can notice that students had positive attitudes and perceptions toward the enactment of PBL in their science classes, as well as its positive effect on their understanding of the science unit, in addition to gearing them with the important high order skills that will make them ready for the workforce in the future.

4.3 Quantitative data results

The quantitative data was collected using the 7 points questionnaire that asked the students to evaluate their perceptions and attitudes toward using the PBL method in their energy transformation unit, as well as its effect on their acquiring the high order skills while working in groups and experiencing the real scientific investigations, using a four points Likert scale that ranges from agree to strongly disagree. The data were analyzed using the SPSS program that

measured the reliability and consistency of the survey items, along with analyzing the percentage of response on each question of the survey that revealed that the students have a positive attitude toward enacting the PBL method in their science class as well as its positive effect on their high order skills.

4.3.1 Reliability Statistics

Table 3 Reliability Statistics

Cronbach's Alpha	No of Items
0.708	7

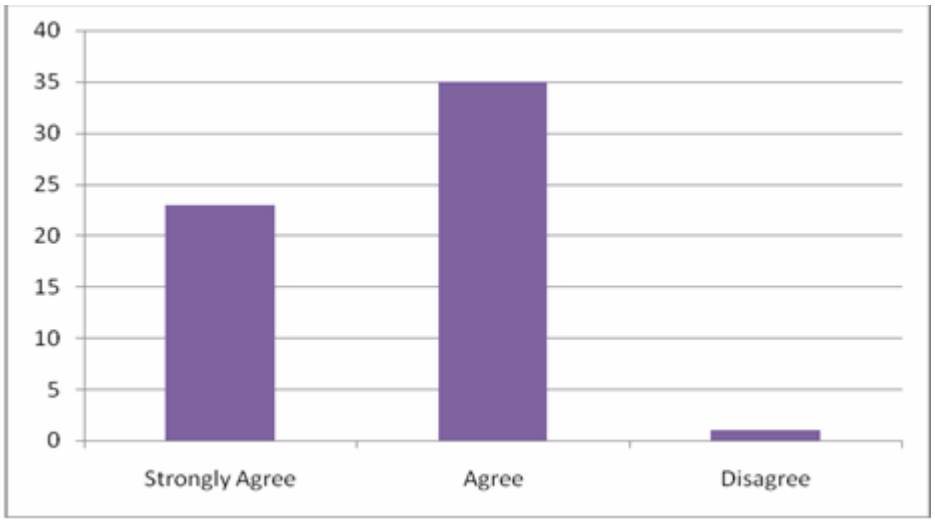
As shown in the table (3) the alpha coefficient for the seven items is 0.708, suggesting that the items have relatively high internal consistency or reliability. (Note that a reliability coefficient of 0.70 or higher is considered "acceptable").

4.3.2 Percentage Frequency Distribution

Table 4: Inspiring and motivating, it made learning science an exciting experience

	Frequency	Percent	Valid Percent	Cumulative Percent
Disagree	1	1.7	1.7	1.7
Agree	35	59.3	59.3	61.0
Strongly agree	23	39.0	39.0	100.0
Total	59	100.0	100.0	

Figure- 2-

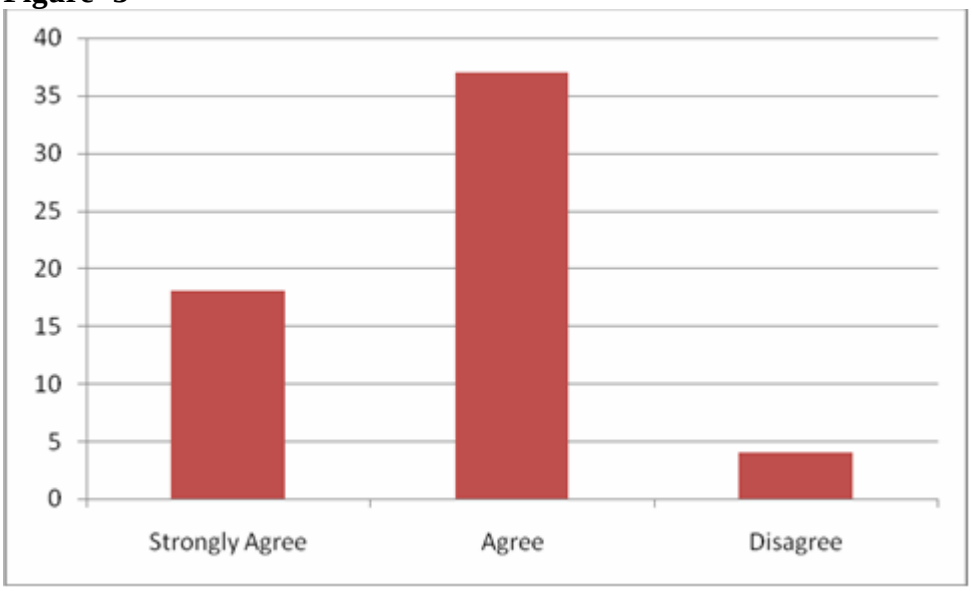


As shown in the table (4) and the figure above, about 39.0% of the respondents strongly agree that the group project-based learning is inspiring and motivating as well it made learning science an exciting experience, 59.3% also agree while 1.7% of the respondent disagreed. This implies that the group project-based learning is inspiring and motivating as well as it made learning science an exciting experience. Thus most of the students had positive attitudes toward the enactment of PBL in their science classes.

Table 5: It helped me fully understand the context of the subject, and I can easily recall it in the future

	Frequency	Percent	Valid Percent	Cumulative Percent
Disagree	4	6.8	6.8	6.8
Agree	37	62.7	62.7	69.5
Strongly Agree	18	30.5	30.5	100.0
Total	59	100.0	100.0	

Figure -3-



Based on the results from table (5) and the figure above, about 30.5% of the respondents are of the opinion that PBL has helped them fully understand the context of the subject and they can easily recall it in the future, 62.7% agree while 6.8% of the respondents are of the opinion that PBL has not helped them to fully understand the context of the subject. Thus this manifests the positive effect of the PBL method on the students understanding of the scientific context.

Table 6: Encouraged me to cooperate with others and interact with colleagues who I usually do not interact with

	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly Disagree	1	1.7	1.7	1.7
Disagree	11	18.6	18.6	20.3
Agree	27	45.8	45.8	66.1
Strongly Agree	20	33.9	33.9	100.0
Total	59	100.0	100.0	

Figure 4

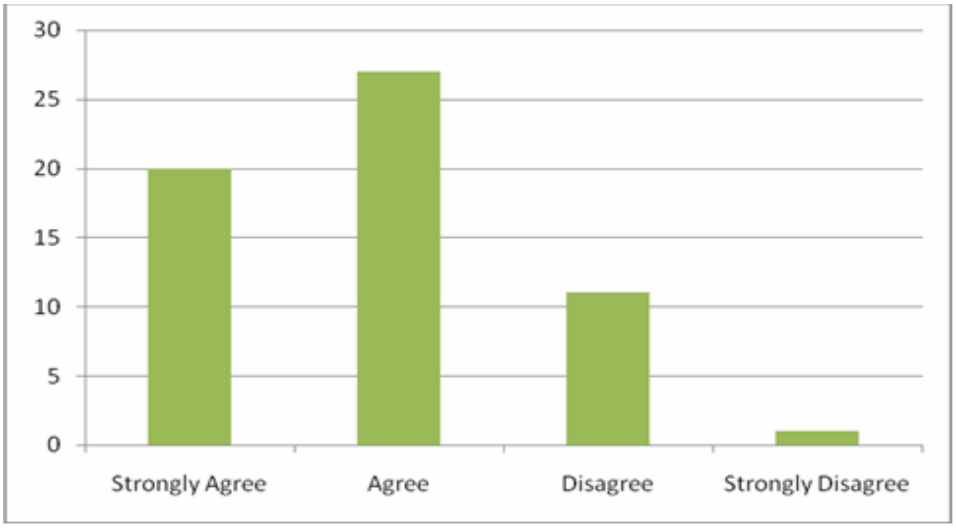


Table (6) and the figure above shows that about 33.9% of the respondents strongly agreed that the enactment of the group Project Based Learning has encouraged them to cooperate with others and interact with colleagues who they don't usually interact with, 45.8% agree, while 18.6% of the respondents disagree as well as 1.7% of the respondent who strongly disagreed with the fact. Accordingly, we can conclude that the enactment of the PBL in the science classes developed the cooperative teamwork skills among the elementary students that will encourage them to work collaboratively with their colleagues to reach to the successful accomplishment of the assigned tasks.

Table 7: Made it likely for group members to observe and monitor each other's understanding of the project

	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly Disagree	1	1.7	1.7	1.7
Disagree	4	6.8	6.8	8.5
Agree	33	55.9	55.9	64.4
Strongly Agree	21	35.9	35.9	100.0
Total	59	100.0	100.0	

Figure 5

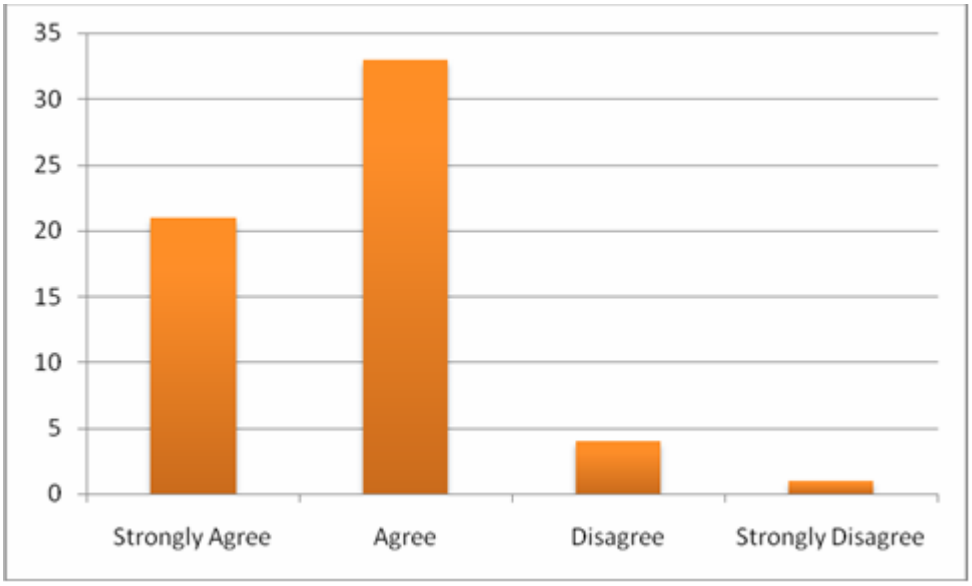


Table (7) and the figure above shows that about 55.9% of the respondents agree that Group Project Based Learning has made it likely for group members to observe and monitor each other's understanding of the project, 35.6% agree, while 1.7% strongly disagreed as well as 6.8% of the respondent who also disagreed. Thus this supports the idea that using PBL as a teaching-learning method will produce a new generation of students who are self-confident and can evaluate their work.

Table 8: Improved my critical thinking and problem-solving skills and helped me to make decisions

	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly Disagree	1	1.7	1.7	1.7
Disagree	7	11.9	11.9	13.6
Agree	31	52.5	52.5	66.1
Strongly Agree	20	33.9	33.9	100.0
Total	59	100.0	100.0	

Figure 6

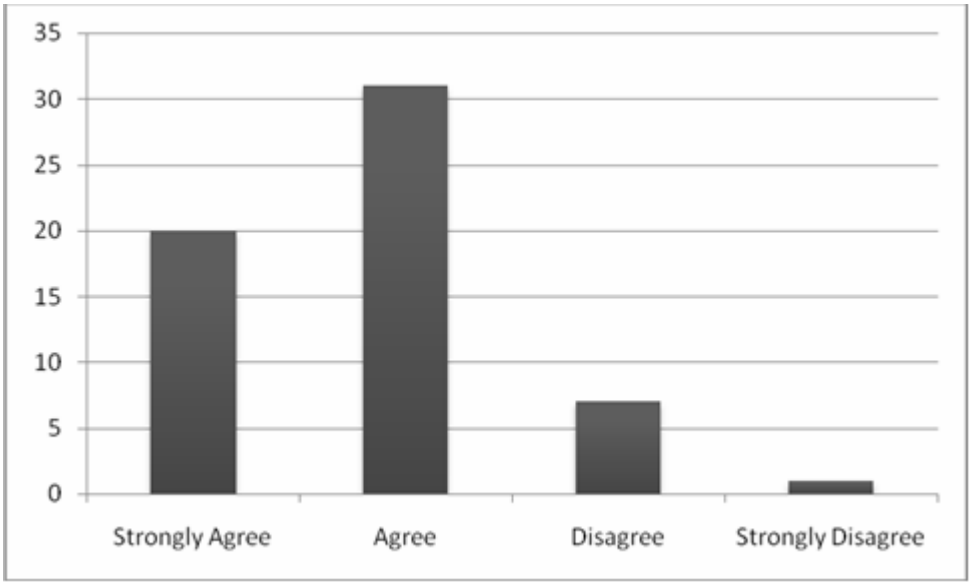
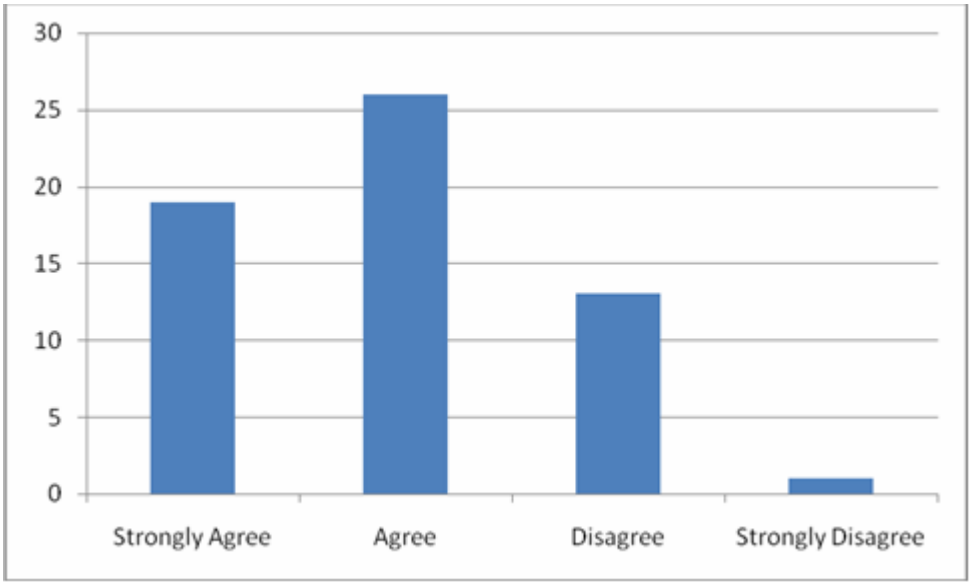


Table (8) and the figure above reveals that about 33.9% of the respondents strongly agree that PBL has improved their critical thinking and problem-solving skills and has helped them to make decisions, 52.5% agree, 11.9% disagree while 1.7% of the respondents strongly disagreed with the fact that PBL has improved their critical thinking and problem-solving skills and has also helped them to make decisions. On that account, we can conclude that the employment of PBL in teaching science has helped students to think critically to reach to the correct solution of the problems they may face while working on their design. Hence the enactment of PBL as a learning method will boost the critical thinking skills among school students, thus produce a new generation of young learners who can employ the analytical thinking to reach to the influential decisions that will guide them to success in their authentic life events.

Table 9: Gave me an idea about real scientists investigations and examples of related science careers

	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly Disagree	1	1.7	1.7	1.7
Disagree	13	22.0	22.0	23.7
Agree	26	44.1	44.1	67.8
Strongly Agree	19	32.2	32.2	100.0
Total	59	100.0	100.0	

Figure 7



As shown in table (9) above about 32.2% of the respondents strongly agree that their experience in using PBL in their science classes has given them an idea about real scientist's investigations and examples of related science careers, 44.1% agree, 22.0% disagree while

1.7% of the respondents strongly disagreed with the fact. Accordingly, we can recognize that the enactment of PBL as a new educational method will help students understand the real scientific investigational process, and conjoin between what they are learning in their school and what is going on in their real life.

Table 10: I feel this experience is useful to me and will help me in my future

	Frequency	Percent	Valid Percent	Cumulative Percent
Disagree	24	10.2	10.2	10.2
Agree	29	40.7	40.7	50.8
Strongly Agree	19	49.2	49.2	100.0
Total	59	100.0	100.0	

Figure 8

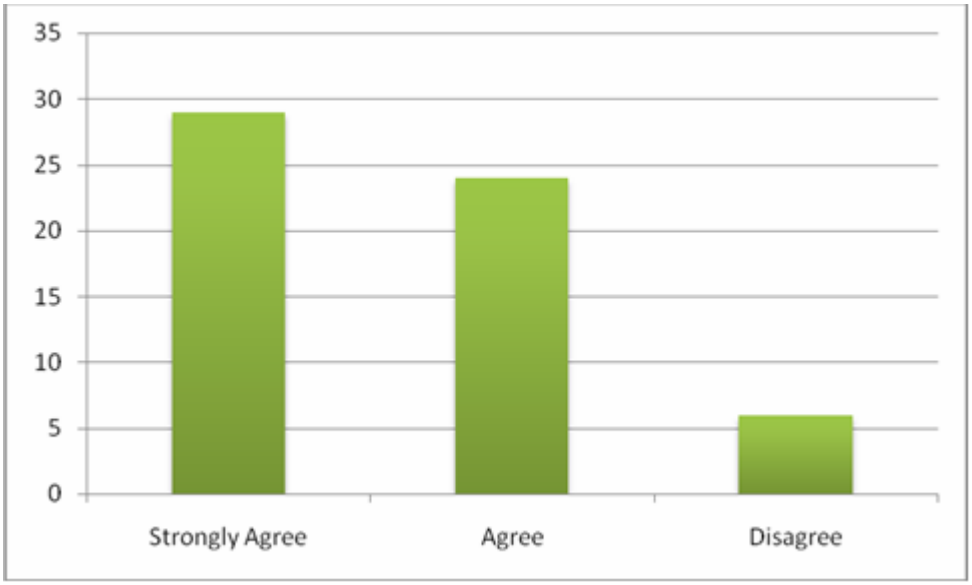


Table (10) shows that about 49.2% of the respondents strongly agree that they feel this experience about PBL is useful to them and will surely help them in the future, 40.7% agree while 10.2% of the respondent disagrees with the fact that they feel the experience gained from PBL is useful to them and likewise will help them in the future. Consequently, we can conclude that the application of PBL will gear students with the high skills they will need in their future development.

Chapter 5: Discussion and Conclusions

5.1 The positive effect of the PBL enactment on students' deep learning and high order skills.

This study has revealed the elementary students' perceptions of enacting project-based learning in teaching science context, as well as its positive effect on their acquiring the high order skills, as the employment of project-based method has developed students' engagement and cooperation during the science lessons, build their team collaborative spirit, improved their critical thinking skills, as well as increasing their ingenuity and self-confidence , thus it developed a new generation of school students who are well prepared to be indulged in the workforce in the future .

Project-based learning is a new revolution in teaching methods that gear students with new techniques that are crucial for their success in the 21st century (Bell 2010). This innovative approach to teaching depends on students to construct their knowledge. Kilpatrick (1918in Hall, Palmer, and Bennett, 2012) affirmed that students should be spiritedly entangled in constructing their knowledge; hence one way to do so is through performing projects. Accordingly multiple researches throw a spotlight on the importance of students' engagement in the learning process, while working on their inventions, students can develop multiple life skills, such as cooperation, accountability, analytical thinking as well as problem-solving skills (Hall, Palmer, and Bennett, 2012; Starobin, Chen, Kollasch, Baul, and Laanan, 2014; Wolff, 2003; Zhang, Peng, and Hung, 2009). Thus as manifested in this study, group project-based learning can develop the internal incitement among young learners, as well as improving the empirical skills that will influence them to accomplish their work successfully, (Hall, Palmer, and Bennett, 2012). Krauss and Boss (2013) also recognized the important skills the students earn while engaged in the learning process, which include adaptability, orientation, self-evaluation, task authorship, time control, and metacognition. Therefore, increasingly, teachers are reinforcing the use of this new educational method because they recognized its influence on challenging students and motivating them by twinkling into their individuality and making them aware of their awareness (Bender, 2012).

In agreement with Liu & Chien (1998 in Lai & Hwang, 2015), the research shows students prefer this type of instruction, as it helps develop the engagement of students through interaction with team members, and giving them a new learning experience(Kolodner et al., 2003in Hwang, Tu&wang ,2018). Similarly, teachers had manifested that they prefer the project based method in teaching rather than the traditional one, as they noticed that applying the project based method can promote the eagerness of students along with their joyfulness in accomplishing the task, (Beneke, 2000). Papert, (2000 in Hwang, Tu&wang, 2018) affirms that through this new educational approach students' ambitions to move to a higher level will be embellished science the process of investigation will enhance their desire and motivation to learn more. Moreover, Jonassen & Carr, (2000) believe that among all the various teaching methods, learning by designing, which is based on constructivism, is favored because it encourages students to think about the key elements of the science content to propose it fully to others in their design. Thus students can create their projects without constraints after conjoining what they have learned

with what they have to create (Hwang, Tu&wang, 2018). Consequently, students can inaugurate their ideas and employ their plan of work or resources by manipulating it themselves. Hence this can help students be fully engaged as they actively participate to move step by step to reach to the meaningful learning, along with the successful accomplishment of their design. (Minovic, Milovanovic, Evic& Minovic, 2011)

Also, entrancing students in peer –evaluation and teamwork is also considered among the learning strategies that influence students' learning ambition, sentiments and attainment. (Lai & Hwang, 2015). Spandorfer et al., (2014) believe that this strategy will help develop students' learning attainment and analytical thinking ability, and further bolster communication between students and teachers. Thus through acquiring the communication skills, students can understand each other's perspectives, and esteem the value of teamwork (Pheeraphan, 2013). Vygotsky, (1978 in Wang, Huang, & Hwang, 2016) pinpointed that through communication and collaboration with people, children can earn the important collaborative competencies. Thus through the provision of the project working plans, students can exchange knowledge while practicing social interaction to solve the complicated problems that they face to accomplish their task (Van Rooij, 2009 Wang, Huang, & Hwang, 2016).

Furthermore, this will give a potential policy to improve and enrich the educational experience of students while also nourishing their positive attitudes and self-efficiency toward learning, (Hwang, Hung, & Chen, 2013). Hence, through peer – evaluation, students of similar backgrounds will be engaged in assessing the learning outcomes of each other in addition to sharing information and suggestions. Hwang, Tu&wang (2018) suggest that through peer interactions and feedback, students not only have more creative ideas but also learn to make reflections through viewing others' work. Through taking the role of the instructor, learners can have more creative ideas and learn from reflecting on their peers' work. Thus this will develop competitiveness and excitement toward learning science. However this was revealed in the data analysis as students preferred learning science concepts using the project-based method as it had a positive effect on improving their engagement and increasing their enthusiasm toward learning science, as well as students preferred the team collaborative work and considered it more influential in teaching science when compared to the old traditional approach . Thus enacting project-based learning in teaching help develop the students' social skills, through peer interaction and scaffolding students can be engaged in negotiations and discussions that broaden their social intelligence. Lee & Lim (2012) Believe that working in groups will enhance cooperation, interaction, and students' management skills. And this will provide students with the important skills they will need in their future careers (Caprano, Capraro&Morgan, 2013).

In the same way, this research results identified that the employment of project-based learning in science education would help develop the analytical thinking and problem-solving skills among participants, as well as stimulating students by encouraging them and grabbing their attention (Bender, 2012). Chu, Hwang, Tsai, & Chen, (2009) affirm that students will gain the ability to combine new and previous knowledge as well as encounter any problem they will face during their work. Hence students will be engaged in an independent, problem-solving environment that will develop their critical thinking competency (Johnson, Archibald, & Tenenbaum, 2010). Eggen & Kauchak, (2007 in Wang, Huang, & Hwang, 2016) affirm that solving complex problems give the students the ability to understand the problem and determine between the

different possible solving strategies. Kamarudin et al., (2012) found that students prefer to work in teams to solve these complex problems, as they can exchange knowledge, brainstorm to find different solutions, and negotiate to make decisions about the best-solving strategy. Therefore, they recommended the application of the PBL approach, in which learners have a chance to collect information related to their projects and choose possible solving plans, as this way will situate students in a real problem-solving scenario.

Also, Hwang & Kuo, (2011) affirm that through the procedure of seeking information to find a solution to the intricate task, students will develop their high order thinking skills and creativity. Thus this agrees with the recent studies, as according to the International Society of Technology in Education (1997) the main advantage of performing the project based method is to develop the problem-solving skills among students, as well as fostering their interaction skills along with their ability to manage the available resources. Wurdinger & Qureshi (2015) affirm that giving the students the complete freedom to produce in-depth projects will encourage them to find solutions of the problems that turn up during their work, be creative in changing plans, and communicate with other team members in order to accomplish their task, and eventually they will become more self-oriented in their work. Thus the long-time consumed to finish the task oblige students to communicate and solve problems so that they can move in the right direction in accomplishing their task.

Moreover, Ennis, (1989) argues that developing high order thinking skills among students will help to develop their ingenuity. Consequently, students who are involved in critical thinking usually seek for truth (Ku & Ho, 2010), as a strong desire drives these critical thinkers that they undergo a deep investigation to learn knowledge even if it is not clear or obvious (Facione, 1990). (Zimmerman and Schunk, 2008) Affirm that these successful learners can self-evaluate their learning experience, as they can delve into their own beliefs (Zimmerman and Kitsantas, 2005). Thus they can evaluate their capabilities as they trust what they can do with their skills, and they can adapt to interchanging and strenuous situations, (Maddux, 2002).

Therefore, self–efficiency can help learners understand their capability levels, as they develop the strength to adapt to the different learning situations. (Bandura, 2006). Thus Learners who are confident apperceive themselves as talented in solving demanding or challenging tasks (Zimmerman and Kitsantas 2005), expound more effort and perseverance (Multon, Brown, and Lent 1991 in Määttä and Järvelä 2013), show complete adaptiveness , and can encounter any difficulty that may pop out during their work (Bandura ,2006 in Määttä and Järvelä ,2013) . Pajares' (2006) believes that, especially with young learners, the experiences of self-regulation will construct the foundation for inspiration and high attainments in the classroom. Hence this will guide students to the deep perception of knowledge and consequently will improve their achievements. According to (Zimmerman, Bandura, & MartinezPons 1992 in Määttä and Järvelä, 2013) self-efficiency for self-evaluation was shown to be related to high academic attainment among elementary school children. However, this agrees with the results of this study, along with other previous studies, where students had confirmed that their exposure to the project-based learning techniques has developed their self-confidence and ingenuity, make them believe in their capabilities, as well as improving their deep cognition of the scientific

knowledge.

Also, learning through solving authentic dilemmas will help young learners understand the real world problems. Thus Real-world projects reinforce the teaching process and develop the 21st-century skills among students, thus making them ready for the workforce in the future (Bell, 2010). Therefore, Ravitz, Hixson, English, & Mergendoller, (2012); Smaldino, Lowther, & Russell, (2012); Trilling & Fadel, (2009 in Wang, Huang, & Hwang, (2016) argue that acquiring the 5C proficiency among students, which refers to communication, creativity, collaboration, complex problem solving and critical thinking will help students be ready for their future, as these abilities will help establish the competitive capability of a country in the 21st century.

Furthermore, in the real workforce, a person will be evaluated not only for his productivity but also for his cooperative, negotiating, policy-making, regulative skills. (Bell, 2010). Thus by the enactment of the PBL in the science classes, we are arming our students with the important skills that help them to join the workforce with complete readiness and preparedness. Hence, this agrees with the results of this research, that the students agreed that their experience of the creation of the projects made them think like real scientists and gave them an idea about different related careers they may join in the future.

In conclusion, this study has revealed that the application of project-based learning in teaching science for elementary students helped to motivate students and engage them in teamwork. Through collaboration and cooperation with group members, students can construct their meanings, which will improve their critical thinking skills and help them acquire deeper understanding and perception of the scientific knowledge. Also, through group guiding, negotiations and discussion, students can practice leadership and managing skills, as well as acquiring accountability and high self-esteem. Collectively, acquiring cognitive and social skills will provide students with the important skills they will need in their future careers.

5.2 Limitations

Although this research has implemented preliminary relevant information about the advantages of enacting project-based learning in science teaching, the results didn't give a precise measurement of these advantages. The first limitation of this study is the instruments used in measuring the variables, as it was not very effective in measuring students' perception and understanding of science context as well as retention of knowledge.

The second limitation in this study that the study has been conducted in one school in Germany that follows the IB curriculum, thus the results of this study can't be generalized to the German population, as different schools in Germany differ in their teaching methods and science curriculums.

Moreover, the study was conducted on the application of project-based learning in one part of the science curriculum in this school, and only on grade four students, which can be considered another limitation in this study.

5.3 Recommendations

In order to enhance the research results in the future, more research with different instruments should be conducted to measure the variables, like pre and post-test results after applying the PBL method, thus these methods can better evaluate the students' perceptions and understanding of science context, in addition to special instruments that help to measure the critical thinking skills.

Furthermore, for more valid data, more students have to be interviewed, as well as interviewing teachers to measure their qualification in enacting the project based method in their classes. Additionally, class observations should take place to measure the engagement and cooperation between team members, and to which extent the project-based learning is applied correctly in the science classes.

Finally, more research has to be conducted on different schools in Germany that follows the German curriculum, additionally different stages of the elementary students should participate in the research, as well as conduct the research for more periods and on different parts of the science curriculum, which will help enhance the generalizability of the research results.

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Appendices

Appendix A

Questions of the interview

Q1- What have you and your group invented? How can your invention help people ?

Q2-What are the steps you went through to accomplish your task?

Q3- did you face any difficulty during your work?

Q4-Do you think that this experience is exciting and better than the normal teaching methods?

Q5- what skills you think you have developed after this experience?

Appendix B

November 11th, 2016

Dear Ms .Mccallum…,

I am writing to you to kindly request your assistance to permit, safa khuwayrah, one of my students in the master's programme of education, from the British University in Dubai, to collect data for a study in your school The significance of the study goes in line with the country's strategic plans to establish a knowledge-based economy that requires major changes in the way students learn and perceive science. This study is conducted with confidentiality and full support from the University without any expense from your part. We look forward to your cooperation. Our student will abide by the school's policies and follow yours or your teacher's' directions. For questions related to the study, please contact……safa.kh@live.com, mobile…01747277892

Sincerely yours,

Prof. Sufian A. Forawi
British University in Dubai
0501270746

Appendix C

Questions After finishing your project, explain how did you find this group project experience?
Inspiring and motivating, it made learning science an exciting experience
It helped me fully understand the context of the subject, and I can easily recall it in the future
Encouraged me to work with others and interact with colleagues who I usually do not interact with
Made it likely for group members to observe and monitor each other's understanding of the project
Improved my critical thinking and problem-solving skills and helped me to make decisions
Gave me an idea about real scientists investigations and examples of related science careers
I feel this experience is useful to me and will help me in my future