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ICEMST 2019: International Conference on Education in Mathematics, Science and Technology

Improving Student Achievement in Mathematics Courses Taught in Foundation Year at University

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Abstract: This paper presents how student achievement in foundation year mathematics courses may be improved by planning learning experiences which are responsive both to the students' learning needs and to the discipline of mathematics. A case study was conducted involving 372 students enrolled at Manchester Metropolitan University (MMU), United Kingdom, who completed an initial test for preliminary assessment of their mathematical knowledge. The results of quantitative and qualitative analysis of their answers, together with the I-Cube model, were used for planning and delivery of the mathematics learning experiences included in lectures, the aim being to enable students to build on their existing interests, proficiencies, experiences and competencies. The students then completed a second test which aimed to assess the learners' conceptual development. The results of quantitative and qualitative analysis of these answers showed an improvement in student achievement. The paper also contains suggestions for improvement of I-Cube model implementation through the design and application of online versions of the two tests. This would enable greater personalisation of learning and assessment and allow feedback to be given in real-time, thus making the mathematics lectures more enjoyable and effective in developing students' knowledge and skills. In addition, the development of online tutorials for students to study at home before attending face-to-face tutorials (blended learning approach) would enable the students to develop positive mathematical identities and become strong mathematical learners.

Keywords: Mathematics, Fractions, Teaching, Foundation and Manchester Metropolitan university

Introduction

Understanding of fractions is dependent on the middle years of students' education. During the foundation year at university, all relevant knowledge will be refreshed and tested, and a poor understanding of fractions may be revealed. This learning gap is especially problematic because fractions are a critical aspect of mathematical scholarship, essential for algebra applications and other more advanced areas of the field (NMAP, 2008).

Students' understanding of relational concepts are necessary not only for deeper mathematical understanding, but also to support daily activities. However, fractions are especially difficult for students to learn and present ongoing pedagogical challenges to mathematics teachers (Siemon et al., 2015); these difficulties are often observed across all levels of education, beginning from the early primary years (Gupta & Wilkerson, 2015). The reasons for such difficulties, particularly in primary school, are often underpinned by issues with larger cognitive processes, including proportional reasoning and spatial reasoning (Artin, 1958). In relation to having different notions of fractions, Aksu (2012) conducted a study which explored *"Differences in student*

- Selection and peer-review under responsibility of the Organizing Committee of the Conference

performance when fractions were presented in the contexts of understanding the meaning of fractions, computations with fractions, and solving word problems involving fractions…"; her study showed that limited understanding of the different meanings of fractions affects students' ability to generalise and work with fractional concepts. Similarly, Siemon et al. (2015) indicates that learning fractions is difficult because students are commonly. Firmender et al. (2014) add that the concept of fractions is perceived as one of the most difficult areas in school mathematics to learn and teach. The most frequently mentioned factor contributing to the complexity is that fractions have five interrelated constructs, namely, the part-whole, ratio, operator, quotient and measure.

A study of practices in the classrooms of the foundation year in MMU showed that students frequently initiated unexpected uses of fractions as operator and quotient and drew on a part-whole understanding when solving fractional problems. Also, the students' background knowledge varied according to their capabilities, home environment, perspective, language and different ways of solving fractions (Eichler & Erens, 2014). The problem which confronts teachers and lecturers in the foundation year of university is therefore how to enable students to overcome and solve the fraction problem, in order to look at more complex issues in mathematics or other relevant courses.

This study considers numerous strategies for improving the teaching of fractions in higher education institutions in general and universities in particular. Various frameworks and models have been investigated using this study sample.

Problems Faced by Students and Teachers When Teaching Fractions

Why do so many students still struggle with fractions? This question commonly affects lecturers, particularly those teaching first-year students in universities. The psychologist Roberts and many other researchers have outlined the reasons why rational number arithmetic is so difficult. This includes not only fractions expressed in the form a/b, but also those in decimal and percentage formats. Although fractions of the a/b form present the most difficulty for children and adults, decimal notation and percentages pose significant problems of their own. In expressions such as '130% on real performance', for example, many students do not completely understand that percentages are fractions (Siegler & Lortie-Forgues, 2017).

Many research studies have looked at the performance of rational number arithmetic among international students and teachers. These studies have identified several reasons why rational number arithmetic is so difficult, which can be divided into two classes:

A. Inherent sources of difficulty, and
B. Cultural sources of difficulty.

As rational numbers are more complex than whole numbers, they are naturally more difficult to understand and use. Inherent sources of difficulty are universal, and even students who famously outperform their peers throughout the world in mathematics still have difficulty with fractions.

Two inherent sources of difficulty

1. It is difficult to understand what rational numbers mean. Each whole number is represented by a single symbol (1, 2, 3, 37, 996 and so on). However, rational numbers can be expressed as fractions, decimals or percentages. It is not at all obvious why 1/4, 0.25 and 25% all refer to the same quantity. Even more confusing, any rational number can be represented by an infinite number of different fractional expressions. The numbers in the series 1/2, 2/4, 3/6, 4/8 and 5/10 appear to be getting larger; after all, both the numerators and the denominators are increasing, yet they all represent the same quantity.

2. Arithmetic operations with rational numbers are far more complex than they are with whole numbers. With whole numbers, the methods that students have learned for adding, subtracting, multiplying and dividing are straightforward to perform. Furthermore, the reasons why they work are easy to demonstrate with objects. However, the methods for fractional arithmetic are complex, and play different roles. For example, it is difficult to understand why the lowest common denominator is used when adding or subtracting fractions but not when multiplying them, or why the second fraction should be inverted and multiplied when dividing. With such a

shallow understanding of rational number arithmetic, it is no wonder so many students have difficulty with it (Ludden, 2017).

Although these inherent complexities plague most students, other sources of difficulty with rational number arithmetic are cultural in origin. That accounts for the better performance among some students compared with their counterparts. Specifically, these cultural difficulties include the following.

Four cultural sources of difficulty

1. Lecturer knowledge. Mathematics teachers who have received the best instruction in rational number arithmetic are, when asked what is meant by something, able to provide the most suitable explanation (Carayannis, 2015); it is hard to provide quality instruction to students when the lecturer only half understands the concepts.

2. Textbook quality. A comparison of primary school mathematics textbooks internationally shows that some devote far more space to rational number arithmetic, and provide more practice problems, than others (NCOTOM; 2007). To the extent that practice makes perfect, students from schools using these textbooks have a decided advantage over their peers.

3. Language. Fractional vocabulary may be much easier to learn in some countries' educational systems than others. For example, mathematical language in China is easier than in other countries in Asia, as the meaning of the fraction is more explicit.

4. Relevance of mathematics to students' future. One reason why so many students experience a phobia for maths is that they do not see its relevance to their future daily lives (Masters, 2017). There is ongoing debate in higher education about whether algebra or elementary statistics is the most useful mathematics course, since in some subjects, students will never need to solve a quadratic equation, but they will need to deal with statistical information such as polls, surveys, census data and economic reports. Yet these kinds of data are frequently presented as rational numbers, fractions and percentages.

Strategies for Delivering Information to Higher Education Students

In fact, there are various different strategies for tackling and solving students' problems with fractions in higher education, and many issues to consider for each one. As an international university, MMU is trying to update its teaching and learning methodology in order to raise students' levels and improve lecturer performance at the same time. The team at MMU has considered strategies such as the following.

Bloom's Taxonomy

The Taxonomy of Educational Objectives was introduced by Professor Benjamin Bloom at the University of Chicago in the 1950s. The main objective of this taxonomy was to structure a system for categorising and quantifying learning behaviour which would assist in the development and assessment of educational learning (Bloom & Krathwohl, 1956). Firstly, Bloom identified the cognitive domain with six learning levels: data recall, understanding, applying, analysing, synthesising and evaluating. The original taxonomy was used to classify and test learning objectives across the six learning levels. Then, an adjusted version of the cognitive domain was produced: levels five and six from 'synthesis' and 'evaluation' were replaced by 'evaluation' and 'creation', while the psychomotor domain addressed skills related to practical applications (Anderson & Krathwohl, 2001).

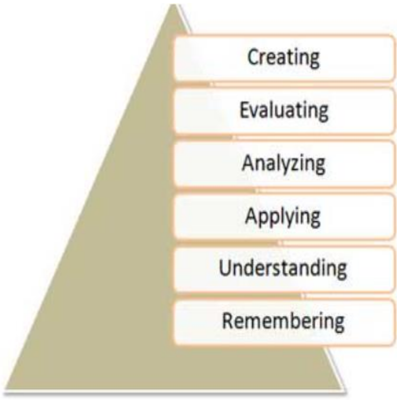


Figure 1. The six levels of Bloom's Taxonomy

Bloom's Taxonomy has developed and changed its verbs many times to provide a more specific representation of learning outcomes.

Salmon model

Salmon designed a model in 2000 that has proven its success in relation to e-learning theories, as shown in Figure 2 below. This model includes five stages, each of which requires participants to master certain technical skills and calls for different e-moderating skills.

The 'interactivity bar' running along the right of the flight of steps in the model suggests the intensity of interactivity that can be expected between participants at each stage. At the first stage, they interact only with one or two others. After stage two, the number of others with whom they interact gradually increases, although stage five often results in a return to more individual pursuits. This paper will present an active application of this model.

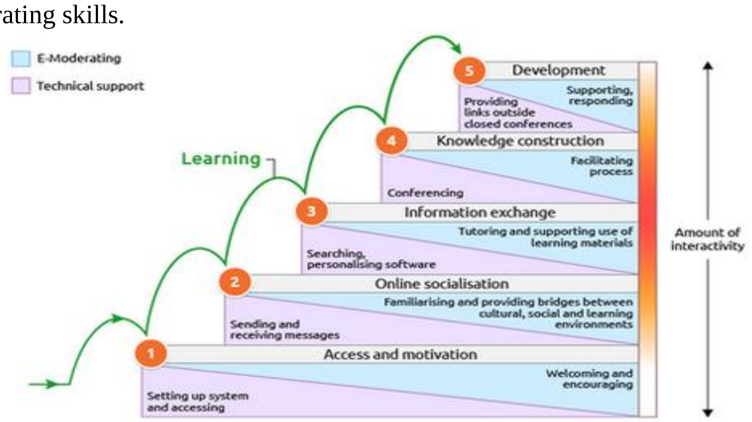


Figure 2. The Five stages of the Salmon model

I-Cube model

Kenan (2015) used interconnected lines to create a new cube-shaped model. Each edge in this cube represents an element which is essential to the success of an e-learning strategy. The cube is called the I-Cube because all elements begin with the letter 'i', as shown in Figures 3A and 3B. This is not a general solution to be implemented in every HEI, but it contains suggestions about aspects which should be considered when improving the quality of teaching and learning processes in the digital era.

The I-Cube can be considered a base or cornerstone in the creation of a strategy to improve e-learning implementation. I-cube activities will help in the development of suitable approaches to introducing blended learning, which is the basic stage in ensuring successful e-learning in the future.

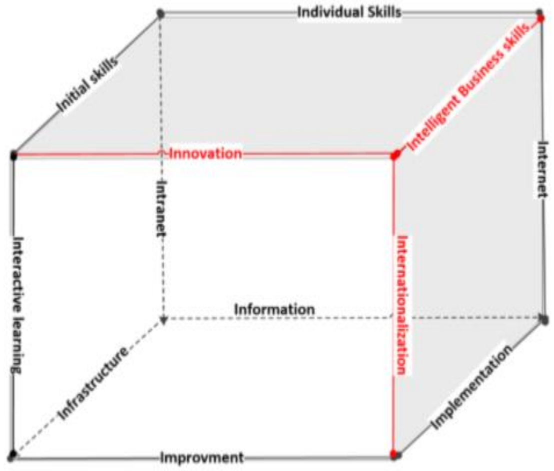


Figure 3A. The I-Cube model

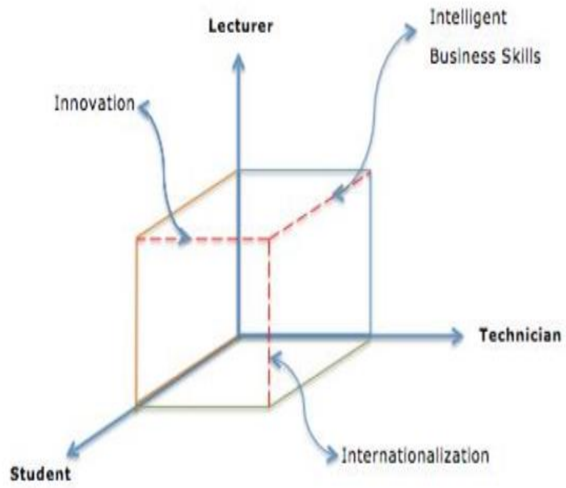


Figure 3B. The I-Cube dimensions

Methodology

The following evaluation method was adopted with a sample of foundation year students from the 2017/2018 academic year at Manchester Metropolitan University (MMU) in the United Kingdom. The sample comprised 372 students registered on the mathematics course, who would be assessed by two tests before their final examination. Test 1, at the start of the academic year, was a general assessment to diagnose the mathematical level of the students, who had come from different colleges and a variety of backgrounds. MMU receives a wide range of international students every year, and the test was designed to take into account the many different strategies they may have adopted, some of which are mentioned above. The questions were thus formulated by considering the disparity in background knowledge resulting from the students' different capabilities, home environment, perspective and language. Test 2 took place halfway through the course (in January 2018) to evaluate the level of change as a result of following the teaching and learning strategy.

The students' test papers were collected after an hour and a half (the length of the test), then marked to determine the students' different levels and identify any weaknesses that should be focused on for additional consideration in the teaching and learning plan before lessons started. The results were analysed using the Excel program from the Microsoft Office package, which enabled quick and easy feedback of averages and other related functions.

Test 1– Preliminary Assessment of Student Knowledge

Test 1 was a general assessment comprising many subjects. The teachers' intention was simply to test the students' levels and to refresh their memories of general mathematical basics, including fractions; according to Bloom's Taxonomy, remembering is considered the foundation of knowledge. There were twenty questions in the test, and those related to fractions were numbers 6, 9, 10, 16 and 20, as illustrated in Figure 4 below.

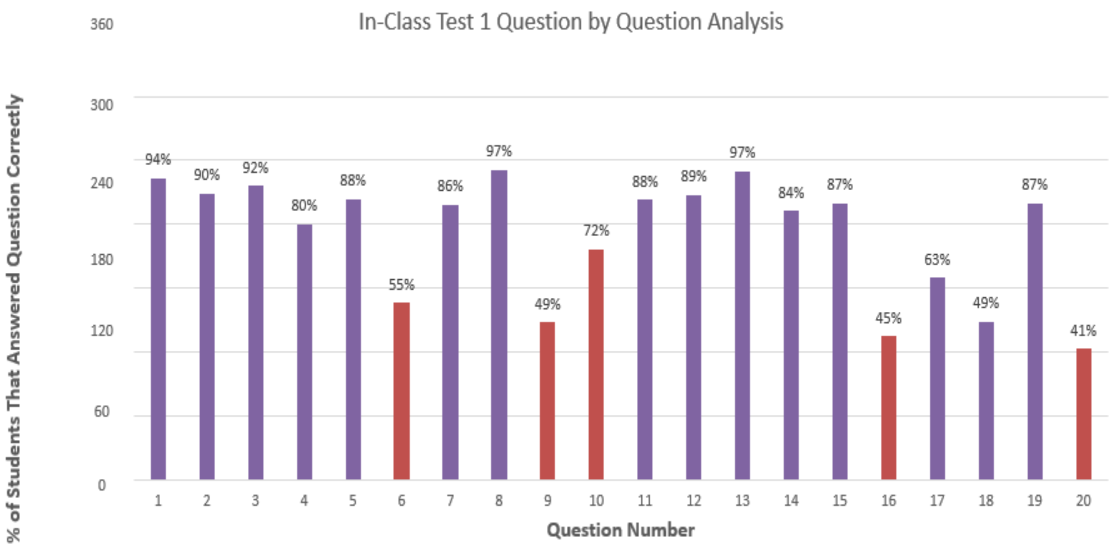


Figure 4. Results of Test 1 questions

- Q6 in Test 1

The results of question 6 are shown in Figure 5. The question was clearly and directly related to fractions and most students should have been able to answer it from their background knowledge (secondary school or college lessons). However, although the question was simple, only about 55% of the students gave the right answer (see Figure 4).

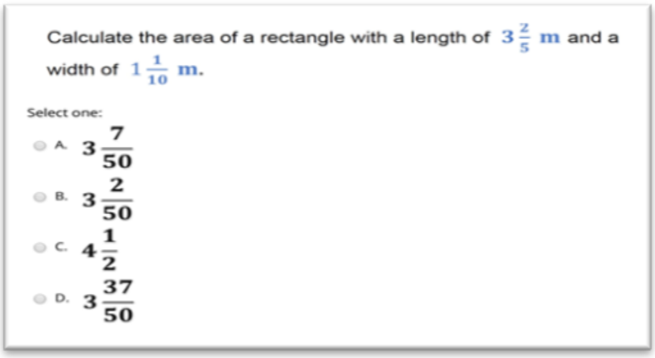


Figure 5. Question 6 of Test 1

Figure 6. Question 9 of Test 1

- Q9 in Test 1

The results of question 9 are shown in Figure 6. This question involved fractions only indirectly, but students should have been able to understand the role of fractions in enabling them to find the percentages easily. Only 49% of the students were able to answer this question correctly (see Figure 4).

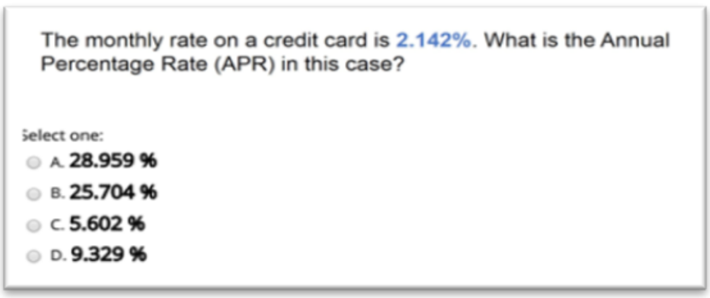


Figure 7. Question 10 of Test 1

- Q10 in Test 1

The results of question 10 are shown in Figure 7. This was similar to question 9; it was about how percentages are divided by the total or multiplied to find the total. 72% of the students got this question correct, so this can be considered the most successful of the fraction-related questions (see Figure 4).

- **Q16 in Test 1**

The results of question 16 are shown in Figure 8. This question was designed on the basis of Bloom's Taxonomy and aimed to refresh the students' memories regarding the use of fractions, but only about 45% were able to answer correctly (see Figure 4).

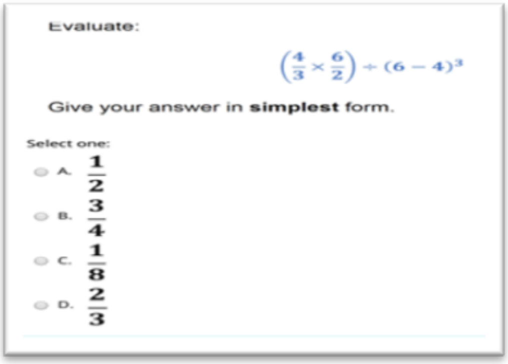


Figure 8. Question 16 of Test 1

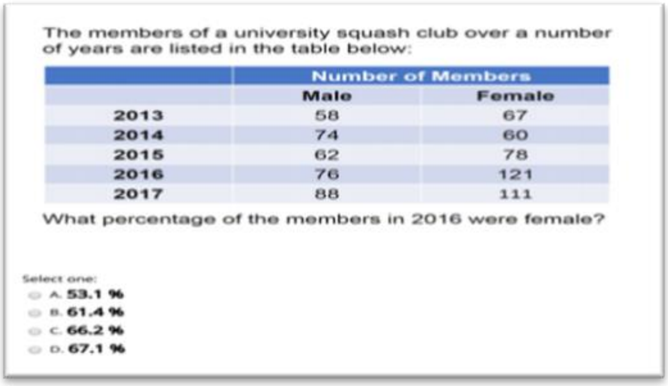


Figure 9. Question 20 of Test 1

- **Q20 in Test 1**

The results of question 20 are shown in Figure 9. The question was about percentages and how to calculate them, which can be considered as indirectly related to fractions. This should have been a straightforward question for any student in the mathematics department but unfortunately, just 41% of the students produced the correct answer (see Figure 4).

The Teaching and Learning Plan

The strategy of the MMU is to help both lecturer and students by providing prior preparation for lessons from a lesson booklet and a website with relevant links. In addition, the mathematics learning experiences included in the lectures were planned with the aim of enabling students to build on their existing interests, proficiencies, experiences and competencies (reading and listening skills, language, mathematical reasoning, ability to cope with complexity, etc.).

The steps of Bloom's Taxonomy (see Figure 1 above) were considered in choosing the test questions. For example, in Test 1, Q6 and Q16 were directly related to fractions, while Q9 and Q20 were indirectly related to them *('Remember' step).* Then, in the lectures, mathematical learning experiences were planned which would be responsive to both the students' learning needs and the discipline of mathematics *('Understand' and 'Apply' steps).* By providing appropriate challenges, effective teachers can signal their high but realistic expectations. This means building on students' existing thinking and, often, modifying tasks to provide alternative pathways to understanding *('Analyse' step).*

For low-achieving students, teachers need to find ways to reduce the complexity of tasks without falling back on repetition and without compromising the mathematical integrity of the activity. Modifications include using prompts, reducing the number of steps or variables, simplifying how results are to be represented, reducing the amount of written recording and using extra thinking tools *('Evaluate' step).* Similarly, by putting obstacles in the way of solutions, removing some information, requiring the use of representations or asking for generalisations, teachers can increase the challenge for academically advanced students *('Creative' step).*

The Salmon model (see Figure 2) was also used for the design and delivery of the mathematics sessions, and to create a relationship between the lecturers and their students. The first stage in motivating access to and use of any software system is to provide encouragement, along with helpful guidance regarding where to find technical support. The second stage is online socialisation, which involves providing openings for sending, receiving and exchanging information, and the establishment of ground rules. The third stage relates to information exchange and moving activities out of the classroom; this includes reporting and discussion of findings or results between the lecturer and students to support the use of learning materials. The fourth stage is knowledge construction to build connections between models and work-based learning experiences; open activities involving discussions and questions are used to encourage reflection. The fifth stage involves development and consideration of the learning processes. Here, students are able to become critical of the medium, and support and response is provided only when required (Salmon, 2011).

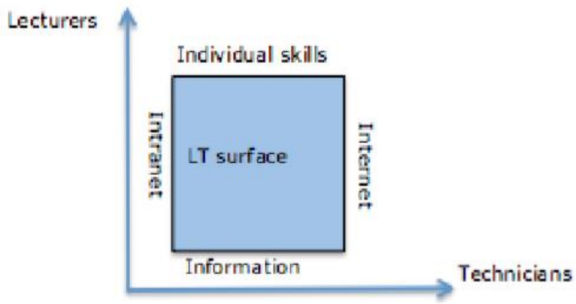
Use of the I-Cube model to design mathematics lectures

In order to include and increase the use of technology in the design of future maths lessons, it was necessary to develop and implement e-learning tutorials which could be used by students before going to face-to-face tutorial sessions in the period between the November and January tests. For any such educational strategy to succeed, three important stakeholders should be considered, namely, the lecturers, students and technicians (Kenan et al., 2017). These are the three dimensions of the I-Cube (see Figure 3B), and this model was utilised alongside the strategies referred to above, as well as others not discussed in this paper.

The structure of the I-Cube model is built on relationships between the key stakeholders as follows:

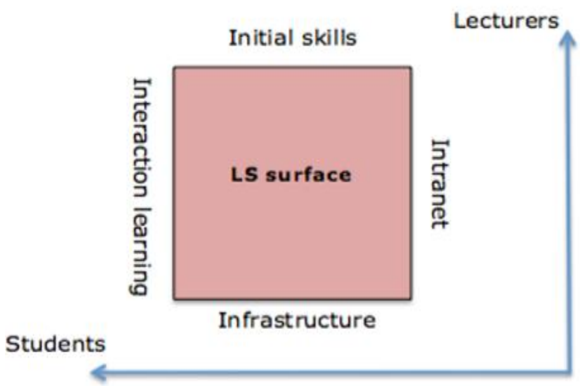
1. Analysis of the correlation between lecturers' and technicians' points of view (see Figure 10) indicates that there are four factors which are important to the successful development of e-learning in general. These four factors can be drawn as a square, with the four edges being information, the Internet, individual skills and the intranet. Each edge plays a key role in the success of e-leaning performance.

Figure 10. Relationship between lecturers and technicians



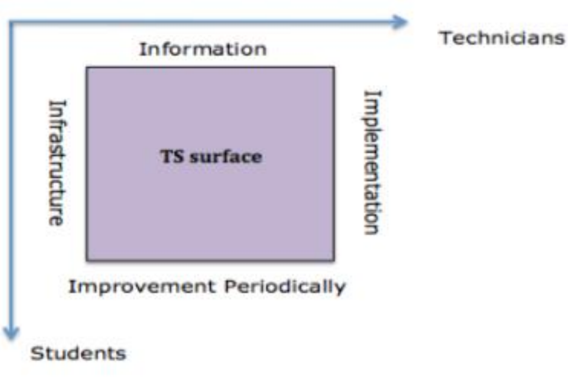
2. Pedagogical theories have presented different models and frameworks regarding the relationship between lecturers and their students. Four factors arise from this relationship which may be considered essential to success in the development of e-learning in general. These four factors can also be drawn as a square, the edges being the intranet, the infrastructure, interactive learning and initial skills (see Figure 11).

Figure 11. Relationship between lecturers and students



3. The relationship between technicians and students is complementary to the two previous relationships or surfaces. This aspect presents a further surface with four edges, representing four factors which can be drawn as a square (see Figure 12), namely, information, implementation, periodic improvement and infrastructure. There are two edges in this square which work jointly with the other surfaces (information and infrastructure) and these play an especially important role in the success of e-leaning performance.

Figure 12. Relationship between technicians and students



To summarise, the three relationships discussed above are between the main groups of stakeholders. As these are linked by joint elements (see Figures 3A and 3B), none of the surfaces can be completed without the others.

Thus, the factors to be considered after combining the three surfaces are information, intranet, the Internet, individual skills, infrastructure, interactive learning, initial skills, periodic improvement and implementation. Two further factors taken from theories of innovation, namely internationalisation and intelligent business, will have a great effect on the development of this teaching and learning process, and therefore these are applied to complete the I-Cube of skills that should be included in new strategies for higher education systems (Kenan, 2015).

Test 2 – Assessing Learners' Conceptual Development

In January 2018, the same number of students (372) who had taken the first test were assessed again using Test 2. This test was formulated differently, due to the inclusion of other mathematical subjects. There were 20 questions, testing students' knowledge and understanding of fractions, square-roots, exponents and equations for probability. Figure 13 below shows the results of Test 2:

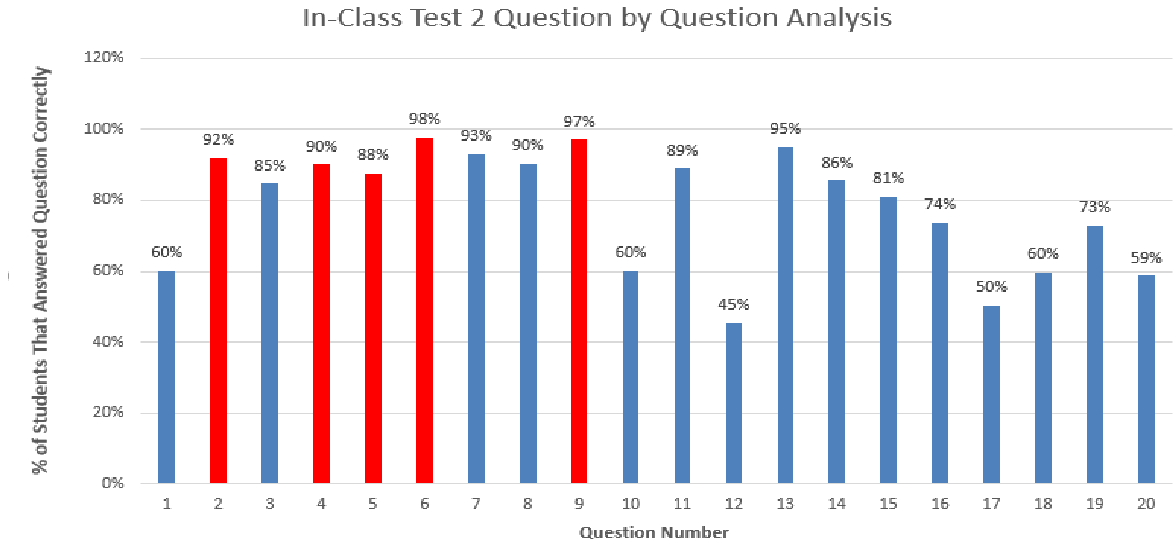


Figure 13. Results of Test 2 questions

The red columns indicate the questions involving fractions, which relate to this paper's aim of showing the students' progress in this aspect through the academic year. Questions 2, 4, 5, 6 and 9 are directly or indirectly concerned with fractions.

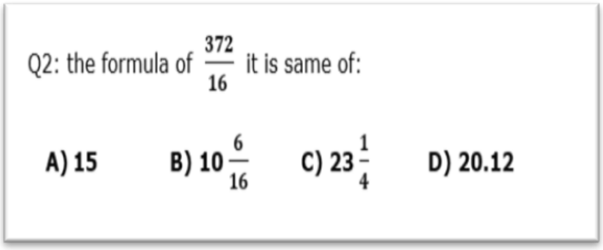


Figure 14. Question 2 of Test 2

- **Q2 in Test 2**

The results of question 2 are shown in Figure 14. This question was purely concerned with fractions, and 92% of the students' answers were correct. This means there had been considerable improvement in the students' ability to solve equations related to fractions (see Figure 13).

- **Q4 in Test 2**

The results of question 4 are shown in Figure 15. This question directly involved fractions in relation to probability. Here, 90% of the answers were correct. This improvement demonstrates the positive effects of the teaching strategy (see Figure 13).

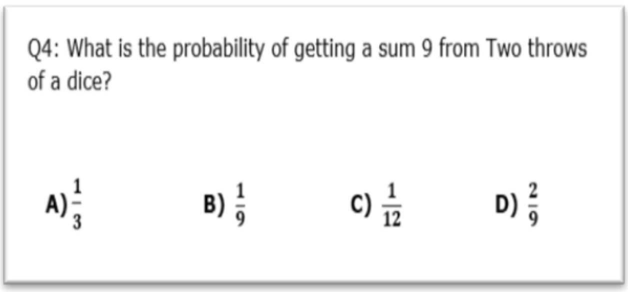


Figure 15. Question 4 of Test 2

Q6: In a box, there are 8 red, 7 blue and 6 green balls. One ball is picked up randomly. What is the probability that it is neither blue nor green?

A) $\frac{2}{3}$ B) $\frac{8}{21}$ C) $\frac{3}{7}$ D) $\frac{9}{22}$

Figure 16. Question 4 of Test 2

Q9: The following table shows the results of a test given to class of students at MMU:

Test Range	Number of Students
80 or below	0
81-90	0
91-100	0
101-110	43
111-120	56
121-130	79
131 and above	13
Total	**191**

The probability that a student has got less than 121 is:

A) 0.52 B) $\frac{92}{191}$ C) 0.41 D) $\frac{93}{100}$

Figure 17. Question 4 of Test 2

- **Q6 in Test 2**

The results of question 6 are shown in Figure 16. This question was again about probability, and here 98% of the answers were correct, showing clear evidence of development and improvement (see Figure 13).

- **Q9 in Test 2**

The answers to question 8 are shown in Figure 17. This question was indirectly related to fractions, and 97% of the answers were correct (see Figure 13).

Comparison of Statistical Analysis of Students' Answers

After application of the three strategies to the case study (Bloom's Taxonomy, Salmon model and I-cube), there were evident improvements in the students' levels of understanding, memory and deep knowledge. This is demonstrated by the answers to the probability and fractions questions, as shown in Figure 13. The results were analysed using the Excel program from the Microsoft Office package, the functions of which provide quick and easy feedback. The averages for Test 1 and Test 2 were calculated using the AVERAGE function, based on the following equations.

Average of marks for all questions in Test 1 = $\frac{\sum_{j=1}^{20} Answer1_j}{20} = 76.65\%$ ………………………………..…. (Eq. 1)

Average of marks for all questions in Test 2 = $\frac{\sum_{j=1}^{20} Answer2_j}{20} = 78.25\%$ ……………………..………….. (Eq. 2)

Then, the average marks for Q6, Q9, Q10, Q16 and Q20 from Test 1 were calculated:

Average of marks for questions about fractions in Test 1 = $\frac{A_6+A_9+A_{10}+A_{16}+A_{20}}{5} = 52.4\%$ ……………….. (Eq. 3)

Average of marks for questions about fractions in Test 2 = $\frac{A_2+A_4+A_5+A_6+A_9}{5} = 93\%$ ……………………. (Eq. 4)

These results indicate that the students' knowledge and understanding were generally improved by using Bloom's Taxonomy and the I-cube model to design and develop mathematics lessons.

In general, the difference in students' levels resulting from the online assessments available to schools is highly variable (Alcock & Simpson, 2011). Some online assessments are designed primarily to achieve more efficient test delivery, while others appear to be shaped by what is technologically possible, rather than educationally desirable (Code et al., 2014). However, instructionally useful assessments draw on an empirically-based recognition of how knowledge, skills and understanding develop in an area of learning. They are aligned with well-constructed learning progressions that describe the nature of student progress. They are designed with an appreciation of how learning builds on to earlier learning and lays the foundations for future learning; the crucial role of prerequisite skills and knowledge in learning success; the kinds of misunderstandings students commonly develop; and the common errors that students make (Viirman, 2014).

Interactive resources are also essential for practice and these have been available for several years at a range of levels. For example, the Guardian Teacher Network of 2018 describes activities on its site in which "Key stage 2 students can learn to recognise and understand unit fractions, such as 1/2, 1/3, 1/4, with online shading activities" (Guardian, 2018). Students need to be able to practise comparing and ordering simple fractions, then move onto relating fractions to division; relating fractions to their decimal representations will help learners make important links between fractions, decimals and percentages and ratio (Getenet & Callingham, 2017). These subjects may have been taught as different topics and to avoid problems later, it is important for students to be able to convert between mixed numbers and improper fractions, understand equivalent fractions or rewrite a fraction.

In the case study presented in this paper, the development of problem-solving and reflective skills alongside subject-based educational skills helped to overcome the difficulties of teaching fractions. This has been demonstrated by analysis of the students' grades for Tests 1 & 2, and is supported by the personal observations of the authors who taught this group of students (see Eqs. 3 and 4). Although the students' overall marks for Test 1 were high, their results were lower when questions about fractions were introduced. The proposed solution was to use the I-cube model and Bloom's taxonomy to develop new strategies for the design of future lectures.

Conclusions

The paper has demonstrated the improvement in student achievement on mathematics courses taught in foundation year which can be achieved by planning mathematics learning experiences that are responsive both to the students' learning needs and to the discipline of mathematics. 372 students who were enrolled at Manchester Metropolitan University (MMU), United Kingdom, completed an initial test (Test 1) for the preliminary assessment of their mathematical knowledge. The average mark for all questions was 76.65% and the average mark for the questions related to fractions was 52.4%. This was an excellent pedagogical approach to check the initial level of student understanding of fractions.

The lecturers decided to plan and deliver mathematics learning experiences based on Bloom's Taxonomy, the five-stage model of online learning by Salmon and the I-Cube model. Afterwards, the students completed a second test (Test 2) aiming to assess the learners' conceptual development. The results of quantitative and qualitative analysis of their answers showed an improvement in student achievement on this mathematics course (the average mark for all questions in Test 2 was 78.25%, while the average mark for questions related to fractions had risen to 93%). Therefore, it was obvious that the students' level of knowledge and understanding of fractions had improved considerably (the average mark for these questions having increased from 52.4% to 93%).

The authors intend to perform future work including improvement of I-Cube model implementation through the design and application of online versions of the two tests (Test 1 and Test 2). The aim of this is to enable personalised learning and assessment of students and allow feedback to be given in real-time, making the mathematics lectures more enjoyable and effective in developing students' knowledge and skills. The intention is also to develop online tutorials for students to study at home before going to face-to-face tutorials (blended learning approach), which will enable the students to develop positive mathematical identities and become powerful mathematical learners.

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Aerospace Systems Science and Engineering Program: A Novel Integrated Approach

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Abstract: A recent report on the global road map for 2015-2025 commissioned by COSPAR and ILWS emphasized the growing appreciation that the environmental conditions that we call space weather impact the technological infrastructure that powers the coupled economies around the world (Carolus, 2015). Since space borne theoretical and practical problems are complicated enough, an up to date science and engineering curricula may need to be considered to cope with such cases. The program/curricula is meant to combine basic sciences, space sciences and technology under a system engineering umbrella. In short, the objective of this program is to produce graduates who will be capable of tackling space programs with deep confidence in an integrated and interdisciplinary manner. In other words, the graduates will be able to take care of these problems from a broad-wide spectrum including for example, space sciences, such as space weather on one side, and very specific technological problems, such as space debris on the other side. So, in this paper we propose an engineering education program.

Keywords: Engineering education, Space science, System engineering, Curriculum

Introduction and Historical Background

The space sciences and technology have been developed by the very few leading countries in the world (Fortescue, 1995). The rest of the countries including the ones who are well advanced in employing the space technologies are following the pre-existing developments most of the time. Therefore, for such countries to narrow the gap at least in relevant education and training aspects, some specifically designed curricula and programs must be developed. Such a need has been our main motivation in proposing a program/curricula to serve the purpose (Y. Tulunay, 2009) (Tulunay, 2008). (Tulunay, 2001).

The 50th anniversary of Space Age in 2007 and the beginning of the International Heliophysical Year with its activities are among the other motivations leading to this work (Y. Tulunay E. T., 2009), (Agency, 2009) (International Heliophysical Year Website, 2009), (CORDIS, 2009).

Systems engineering deals with the complex technical and non-technical engineering systems in terms of input and output variables (Fortescue, 1995).The required outputs for specified inputs are considered and required functional blocks and interrelationships between them are specified by considering the "design", "implementation" and "operation" of the system. Therefore, a systems engineer sees and comprehends the whole of the system. Designs of the blocks themselves are carried out by the scientists and engineers of the associated fields (Muller, 2018) (Erik Hollnagel, 2005).

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"Design specification", "test" and "validation" requirements are considered during design, implementation and operation phases. The "test" phase answers the question: whether the product is right. In other words whether it satisfies the design requirements. The "validation" phase answers the question: Whether it is the right product. In other words whether it works satisfactorily to perform the required function.

In this overview, the first version of a novel program that we propose the title to be "*Aerospace Systems Science and Engineering*" (ASSE) is introduced. In establishing such a program for Turkish educational system, we have studied similar programs of the American and European Universities.

In this novel, comprehensive Aerospace System Science and Engineering Program, we have combined two approaches: *(i)* the space systems engineering programs of well-known American Universities (e.g. MIT) and *(ii)* as our original contribution, the dimension of the science and engineering of the Near Earth Space (MIT, 2018). (Missouri University, 2018)

Aerospace System Science and Engineering (ASSE) Program

What is Aerospace Systems Science and Engineering (ASSE) Domain?

In analogy to system engineering, ASSE is the process of designing, developing and verifying a space system as an integrated system able to fulfill the objectives of a mission within acceptable technical and programmatic frames within a reference frame of Near Earth Space (NES).

The step-by-step design process is guided by considering what a space system seeks to achieve. Among the many issues of interest the followings are some typical and common examples: What orbit will the mission need as a consequence? What kind of instruments and how large a payload? What will be the payload's optimum operating temperature, and how much power will it require? How stable and steerable does the spacecraft platform have to be? What kind of communications infrastructure and associated ground segment will the mission need? Which launcher will be best suited to deliver it into space? What are the impacts of NES on these subsystems?

There can be many potential solutions to each question so ASSE is as much an art as a science, with trade-offs made between the different options in terms of performance, risk, cost, reliability and turnaround time, among other factors. The design team includes experts on the various technical and scientific disciplines involved to advise on their integration into the overall design.

At the end of these feasibility and preliminary design studies – known as "Phase A" studies – a baseline space system plan is in existence, defining necessary elements and including initial programmatic estimates. Follow-up "Phase B" studies turn the preliminary design into a full system design which can then be developed further.

Among the most important factors in deciding whether to proceed to further stage is a mission's likely cost. The process of putting accurate price tag onto space projects is an associated discipline within, in general Systems Engineering and in particular, ASSE domain called "Cost Engineering".

To demonstrate how prospective graduates of this program can utilize the knowledge, skills and know-how gained to promote the science and society nationally and internationally, there will be two case studies given.

Aerospace Systems Science and Engineering Education

Education in ASSE is often seen as an extension to the regular engineering courses, reflecting the industry attitude that engineering students need a foundational background in one of the traditional engineering disciplines (e.g. mechanical engineering, industrial engineering, computer engineering, and electrical engineering) plus practical, real-world experience in order to be effective as systems engineers. In fact, undergraduate university programs in systems engineering are rare.

Aerospace Systems Science and Engineering is a broad term used to encompass all the disciplines needed in the design and fabrication of projects which must operate in the Near Earth Space (NES) environment, an education program on ASSE must be equipped with a NES education dimension.

In the present day society, there is a vital need for setting up education and outreach activities in the Space Weather field for creating a healthy environment for the proper development of Space Weather markets along with the fundamental and applied research activities. The Space Weather, concretely, must provide value added services for the end user that has to be the driving motivation. Last, but not the least, a portal financial support for the Space Weather service providers is the formation of the competent human resources. Sufficient financial support for the Space Weather service providers is required for the information of competent teaching (scientific and technical personnel) and, hence, for research and education in the subject.

The basic users of a Space Weather Education Program may be summarized as in the following areas: communications, satellite operations, power grids, manned spaceflight, navigation, etc. Scientific and technological developments are achieved as the results of research, observations, models and education. Forecasting and warning services use the technology developed and disseminates the results to the basic users mentioned above. Comments of users are returned back to the education program via feedback mechanisms. Thus, the quality and efficiency of the education system are sustained at satisfactory levels.

The vision of ASSE Program is to comprehend and design aerospace systems which can make optimal use of the Near Earth Space environment both from the ethical, economical and political and environmental viewpoints.

The mission of ASSE Program is to provide an interdisciplinary education and training to comprehend the aerospace systems and to provide capability for graduates to be able to design, construct and operate them for present and future needs.

General Layout of ASSE Curriculum

It is proposed that the candidates for Bachelor of Science degree in ASSE (Aerospace System Science and Engineering) must complete a program consists of

(1) Must courses: mathematics; physics; chemistry; English; computer programming; space physics seminar; thermodynamics and statistical mechanics; molecular gas dynamics; operational methods in engineering; optional non-technical elective courses such as language; history (a total of 55 credit hour; up to the level of 7th semester)
(2) Related technical core courses: engineering graphics; basic concepts in material science (a total of 6 credit hour; up to the level of 5th semester)
(3) Aerospace system science courses: introduction to space sciences; performance of aircraft and spacecraft; deterministic models in operational research; Probability and Random Variables; Dynamics; Signals and Systems; Physical Mechanics I; Aircraft and Spacecraft Structures; Aerodynamics; Aircraft and Spacecraft Propulsion (AEROSP); Electromagnetic Theory; Flight Dynamics and Control; Digital Systems Design; System Dynamics (a total of 47 credit hour; starting at the level of 2nd semester)
(4) Aerospace systems engineering courses: Introduction to Systems Engineering; Aero Eng. Seminar; Aerospace Eng. Lab I; Methods and Instrumentation; Simulation Modeling; Aerospace Eng. Lab II; Engineering Systems Analysis (a total of 20 credit hour; starting at the level of 1st semester)
(5) Elective courses: technical electives are added up to at least 18 credits of the ASSE coded courses; at least 6 credits of non-ASSE coded courses; at least one 3 credits of free elective course (a total of 21 credit hour; starting at the level of 6th semester)
(6) Summarizing the ASSE undergraduate program is constructed on 149 credit hours, 8 semesters

This sample schedule may be an example of one leading to graduation in eight terms. Technical electives are to be designated first by an academic committee in general and then the technical electives can be selected if approved by an academic adviser. Technical electives must be chosen between mathematics of science division courses; ASSE courses; and graduate seminar courses.

To facilitate a road-map for those graduates of the ASSE who would like to pursue a graduate education in Near Earth Space Science and Technology the following scheme is proposed. The program could be used as reference and illustration purposes.

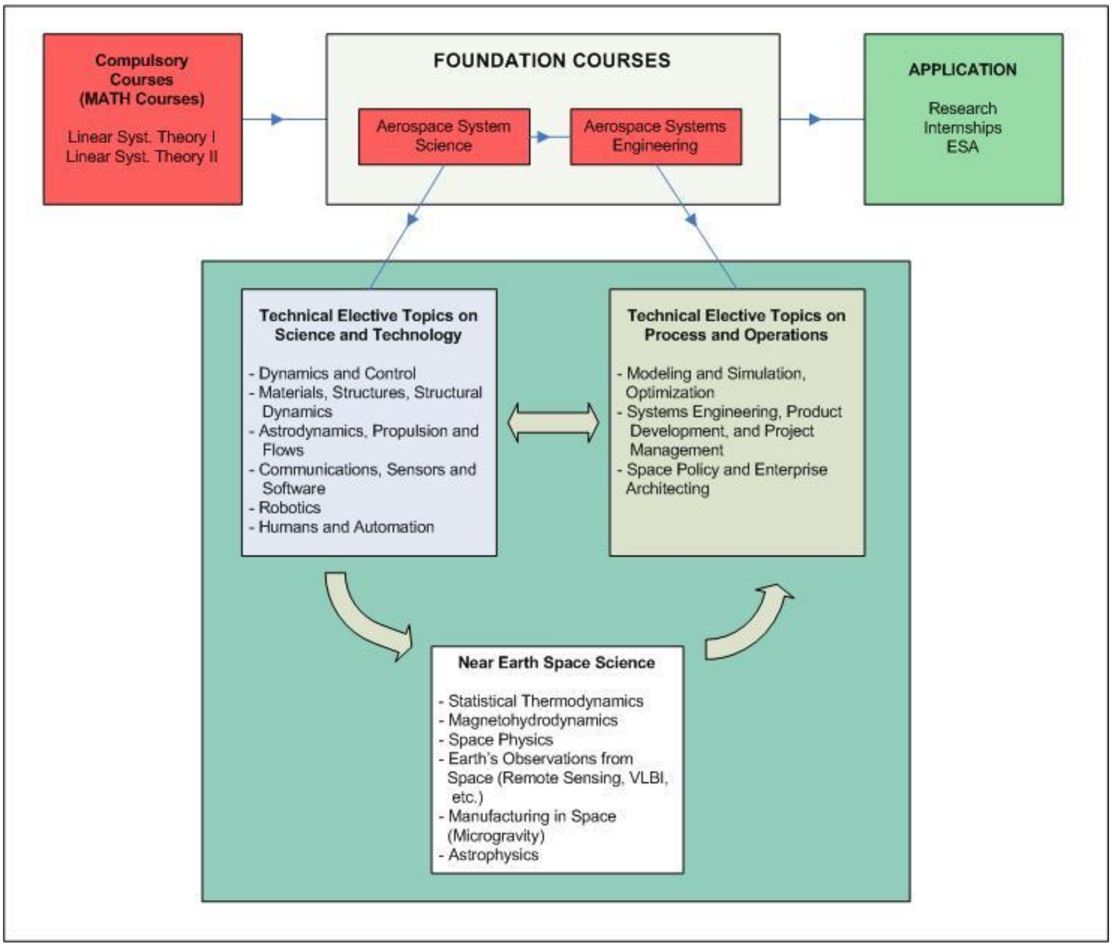

Figure 1. Block diagram of aerospace systems science and engineering program

Figure 1. Illustrates the block diagram of the Aerospace Systems Science and Engineering Program (ASSE). As illustrated in this figure, the ASSE Program consists of four main domains. The *foundation courses* domain, in turn, consists of two sub-domains of the Aerospace Systems Science and Aerospace Systems Engineering.

Conclusion

As stated in the introduction part, the required theoretical background, relevant skills and know-how for preparing and executing the space projects are provided herewith for the educational systems.

The innovations and technological developments on the Near Earth Space science and engineering have not been reflected as major applications in practice as an integrated approach in many countries who have been buying and employing space technologies for a long time. For example, the Near Earth Space concept has been created in some of the curricula of some of the Turkish Universities. In addition, the university activities in this field are neither documented nor systematic. Under the current circumstances in the international and national levels we have taken initiative to propose a contemporary educational program. The proposed program bears the title of "***Aerospace Systems Science and Engineering***" (**ASSE**). In establishing such a program, we have studied similar programs of the leading international universities.

In this novel, comprehensive Aerospace System Science and Engineering Program, we have combined two approaches: *(i)* the space systems engineering programs of well-known American Universities (e.g. MIT) and *(ii)* as our original contribution, the dimension of the science and engineering of the Near Earth Space.

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MISO – Motion in the Science Ocean Project Based Learning Using Mobile Devices – Synthesis of Biodiesel by Homogeneous or Heterogeneous Catalysis

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Abstract: Six European schools from very different parts of Europe (Agrupamento de Escolas da Maia - Portugal, Anne-Frank-Schule Bargteheide – Germany, Özel Bilkent Lisesi – Turkey, Sandsli VGS – Norway, Institut Pau Vila – Spain and Liceul Teoretic Iancu C. Vissarion - Romenia, have developed an Erasmus+ project for Exchange of Good Practices, MISO, in order to increase student interest in science, foster the use of ICT with different applications for experiments, share experiences between teachers and students and collaboratively examined new approaches to teaching and learning of science (E-learning Tools). In recent years the automobile industry has been looking for alternatives to reduce the consumption of fossil fuels. One of the solutions can be vehicles containing a normal internal combustion engine that uses the biodiesel as combustion This research study used Project Based Learning as pedagogical methodology, through the use of mobile devices and was done by students of Chemistry of 12th grade. Students aimed to synthesize Biodiesel by transesterification of refined soybean oil with methanol by basic catalysis using laboratory materials. They studied the effect of the amount of catalyst on the synthesis of biodiesel, they evaluated the acidity index of

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biodiesel and they also studied the miscibility of the produts obtained with ethanol and hexane. FT-IR was used to monitor the reaction. Mobile devices were used during the project to take photos and to record videos of the experimental procedure. Different type of APPS (Magisto, Animoto, Popplet and Scapple) were used to report the results. This work showed that transesterification is a simple, easy and economically accessible method of synthesizing biodiesel. This project enabled students to deepen and apply their previous and new learning, develop their critical thinking, their creativity and communication, increase their autonomy, organizational management of work, interpersonal relations and motivation for the learning.

Keywords: Project based learning, Mobile devices, Biodiesel

Introduction

Bearing in mind the priorities established by the European Horizon Strategy 2020 and more specifically the idea of Europe in a changing world, six European schools from very different parts of Europe (Agrupamento de Escolas da Maia - Portugal, Anne-Frank-Schule Bargteheide – Germany, Özel Bilkent Lisesi – Turkey, Sandsli VGS – Norway, Institut Pau Vila – Spain and Liceul Teoretic Iancu C. Vissarion - Romenia, have developed an Erasmus + project for Exchange of Good Practices, MISO – Motion in the Science Ocean.Such a project intended to increase student interest in science, foster the use of ICT with different applications for experiments, share experiences between teachers and students who collaboratively examined new approaches to teaching and learning of science (E-learning Tools).

The potential of multimedia applications, adapted to the contexts of teaching and learning, can be seen as important teaching tools in the different dynamics of the classroom (Lencastre, Bento & Magalhães, 2016). In addition, there is a great popularity and familiarity with mobile devices present features which will enhance potential users (Kukulska-Hulme, 2012). The rise of these resources is a fact that can be explored in the educational process, using the pedagogical model called Mobile Learning (Lencastre et al, 2016; Kukulska-Hulme, 2012). Mobile devices are necessary tools that can be used to facilitate learning. We need them to supplement schools resources, to extend learning process outside the class walls, to prepare students for working life after their graduation (Moraru P. et al, 2018).

Project Based Learning allows students to work independently to build their own knowledge in a dynamic and active learning process. Under the scope of the Erasmus+ project, MISO, 12th grade Chemistry students, working in partnership with the Department of Chemistry and Biochemistry of the University of Porto, used the Project Based Learning methodology to synthesize biodiesel by homogeneous and heterogeneous catalysis.

Biodiesel as a sustainable alternative to use on automobile industry

Since traditional fossil fuel resources are limited and greenhouse gas emissions are becoming a great concern, the research is now being directed towards the use of alternative renewable fuels that are capable of fulfilling an increasing energy demand (Ma & Hanna, 1999). Biodisel is a sustainable alternative to use on automobile industry for many reasons: it is made from renewable resources (namely from vegetable oils or animal fat); it is also environmentally friendly (lower dependence on foreign crude oil; limitation on greenhouse gas emissions because of the closed CO_2 cycle; lower combustion emission profile, especially SOx (Dorado et al., 2003); potential improvement of rural economies; low toxicity; biodegradability) and it is technically eficient (it can be used without engine modifications; it has a good engine performance; improved combustion because of its oxygen content; ability to be blended in any proportion with regular petroleum-based diesel fuel) (Jun Yang et al. 2013).

Characteristics of Biodiesel

The biosidesel has many important characteristics: high oiliness; yellow colour; high boiling point; slightly flammable; it is neither toxic nor corrosive when purified, but it should not be ingested, nor inhaled. It can be used in diesel engines and in oil heaters; it´s composed by molecules with long carbon chains and hydrogen atoms and, at the end of the chain, it contains an ester functional group (-COOR). Finally, it is obtained from triglycerides, which exist in vegetable oils or animal fat.

Biodiesel Synthesis

The most common and most used reaction for biodiesel production is transesterification, in which the triglyceride molecules react with a small chain alcohol (methanol or ethanol), which is in excess in the reaction, forming biodiesel (methyl or ethyl esters) and a by-product (glycerol). Basicly it is a method of converting primary fats (triglycerides) to esters of alcohols (methyl or ethyl esters). These reactions are often catalyzed by the addition of a catalyst. The catalyst is a substance that aims to accelerate the speed of a chemical reaction, without interfering with the final reaction result (so that the mass of the catalyst is not consumed during the process, with the possibility of recovering it at the end of the reaction). If the catalyst is in the same physical state as the reactants, the catalysis is called homogeneous. If the catalyst is in a different physical state from that of the reactants, it is called heterogeneous catalysis. Heterogeneous catalysis was invented to replace the homogeneous catalysis in order to overcame some disadvantages associated to the biodiesel production through this method. Each of the previous catalysis may use both acid and base catalyst. The base catalysts most used in homogeneous catalysis are sodium hydroxide (NaOH) and potassium hydroxide (KOH), whilst the most used acid catalyst is sulfuric acid (H_2SO_4). The base catalyst most used in homogeneous catalysis are barium oxide (BaO) and calcium oxide (CaO), whilst the most used acid catalyst are Amberlyst 15 and NAFION (figure 1).

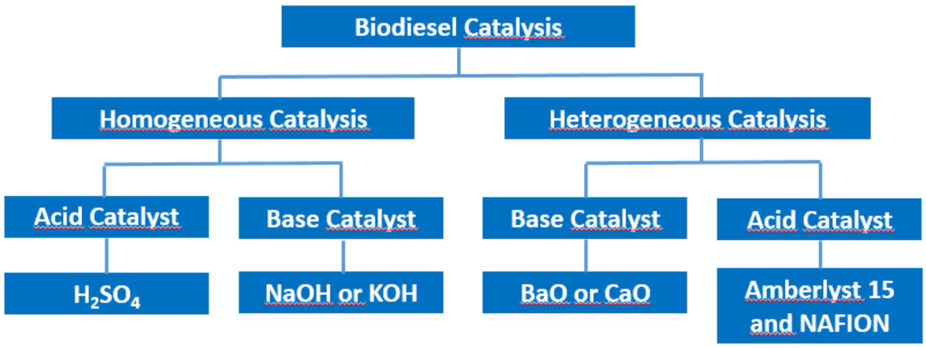

Figure 1. Catalysts used for biodiesel production

Methodology

During this project teachers used Project Based Learning as pedagogical methodology. Students had to design and develop an investigative path to answer the problem question: How to produce a Biodiesel from used soy oil? The realization of this project went through the following phases:
- Used soybean cooking oils, at home and / or at the school canteen collection in appropriate containers,
- Method research to obtain biodiesel;
- Identification of the different stages of the process, with a sequential diagram of the operations to be performed, using the mind map Popplet and Scapple;
- Identification of the chemical transformations involved and writing out the respective chemical equations;
- Laboratory work planning, including material, equipment, reagents and safety issues;
- Accomplishment of the laboratory work, to obtain the final product.
- Reuse of oils

Homogeneous Catalysis

In the homogeneous catalysis, biodiesel was synthesized from the transesterification of filtered soy oil with methanol catalyzed by potassium hydroxide. Different amounts of catalyst (KOH) were used: 0,5% (m/m) KOH, 1% (m/m) KOH and 5% (m/m) KOH. The experiment was performed at room temperature. The transesterification reaction lasted 1 hour (Rinaldi R. et al., 2007).

Methanol and KOH was added to an Erlenmeyer flask. Its top was covered with aluminum foil, and the stirring was started. After the complete dissolution of KOH, it was added the soy oil. The Erlenmeyer flask was, covered again and shake for 30 minutes. After that, the content of the Erlenmeyer flask was transferred to a decanter ampoule and the phase separation was followed for 1 hour (figure 2) (Rinaldi R. et al., 2007).

Figure 2. Homogeneous Catalysis procedure

Heterogeneous Catalysis

In the heterogeneous catalysis, Biodiesel was synthesized at 117 ºC, from the transesterification of filtered soy oil with methanol catalyzed by Amberlyst tm 45, a macroporous sulfonic acid polymer designed for use in high-temperature heterogeneous catalysis. A research group of FCUP/REQUINTE works in the development of new catalysts for the production of biofuels and bio-oils and provided one of its catalysts for these experience. A magnetic stirrer was put into a round bottomed flask. Then, the catalyst was added to it and after mixing the soy oil with the methanol, it was transferred to the flask. The mixture was placed in a preheated silicone bath at 117 degrees, the water was opened from the condensation system and the reaction occurred for about 2 hours. During those 2 hours, samples were taken to control the change of reagents into Biodiesel. At the end, the Biodiesel was decanted to make sure that no residue is left and the catalyst was recovered and cleaned with ethanol (figure 3).

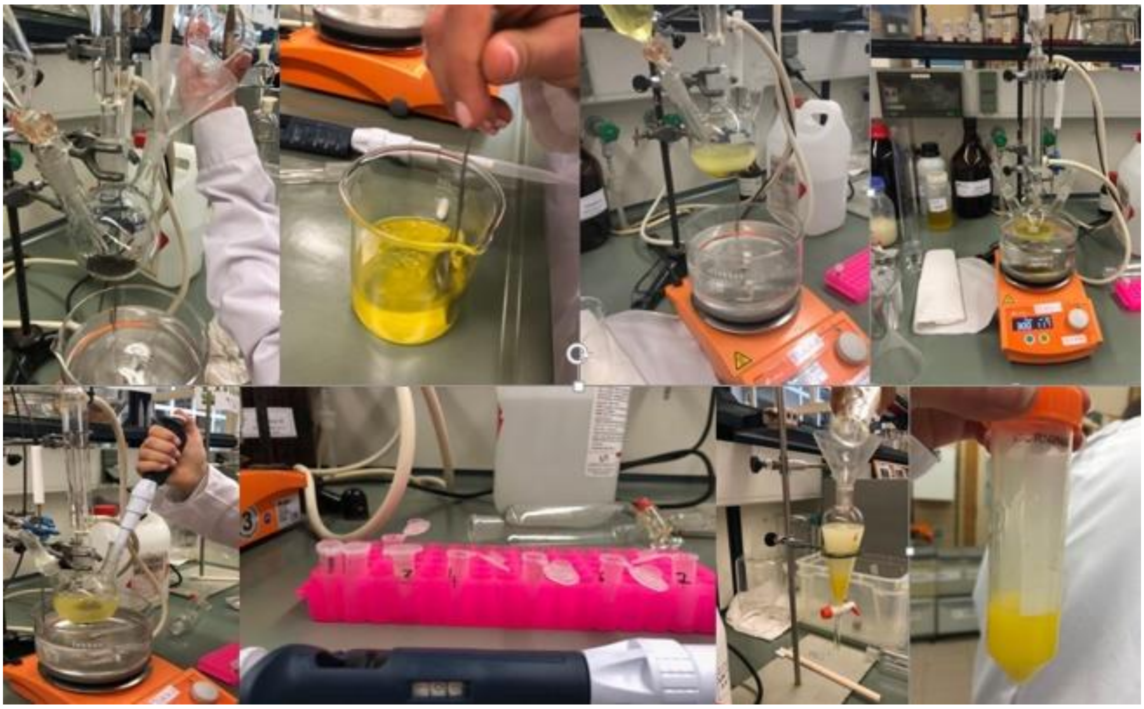

Figure 3. Heterogeneous Catalysis procedure

Determination of Acidity index for both catalysis

The acidity of the biodiesel obtained in both catalysis was also analyzed by acid-base titration (figure 4). It was added isopropanol to the biodiesel and then the mixture was titrated with KOH using phenolphthalein as indicator (Pinheiro I. et al., 2009).

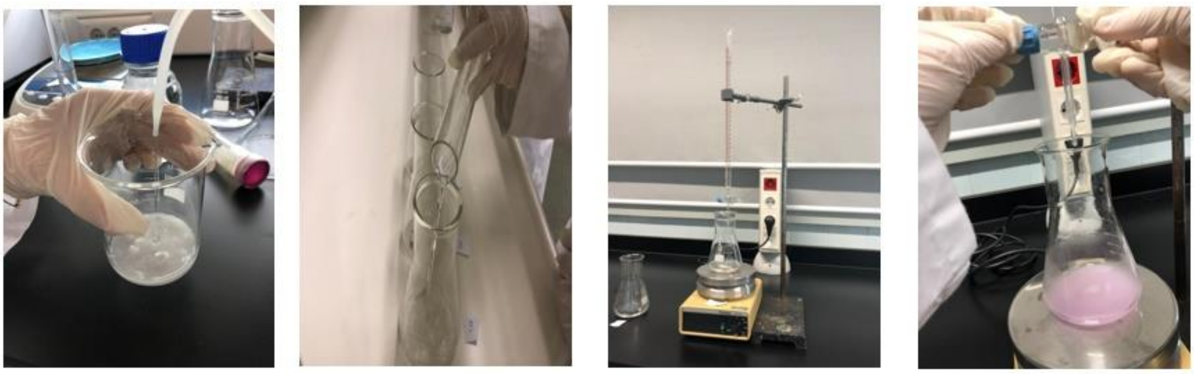

Figure 4. Determination of the acidity index of biodiesel

Miscibility Test

For the miscibility test (figure 5), 2 mL of the lower phase and 2 mL of the upper phase were transferred to two beakers each, so that the miscibility of these phases could be analyzed with ethanol and hexane. The top phase corresponded to the Biodiesel

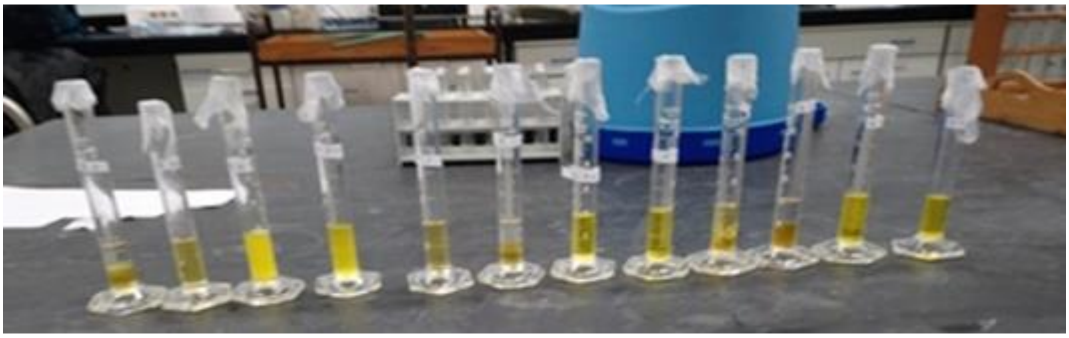

Figure 5. Miscibility test

Results and Discussion

The APP`s Magisto (figure 6) and Scapple (figure 7) were used to do the lab report as well as the video of the procedure of the homogeneous catalysis. The APP`s Popplet (figure 8) and Animoto (figure 6) were used to do the lab report as well as the video of procedure of the heterogeneous catalysis.

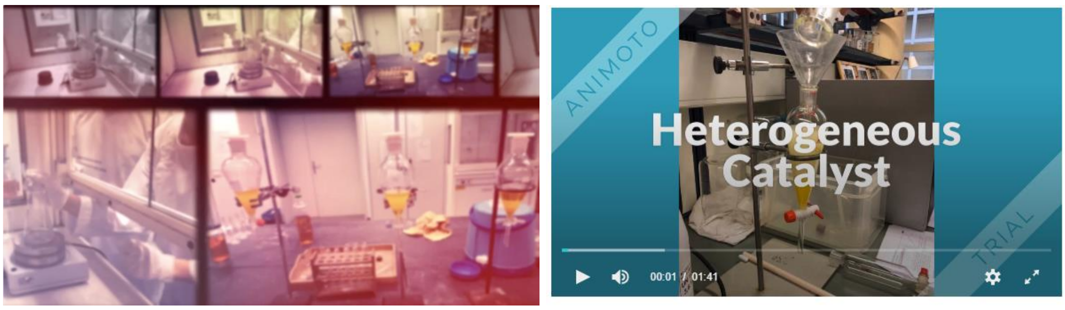

Figure 6. Apps (Magisto and Animoto) used to make the video

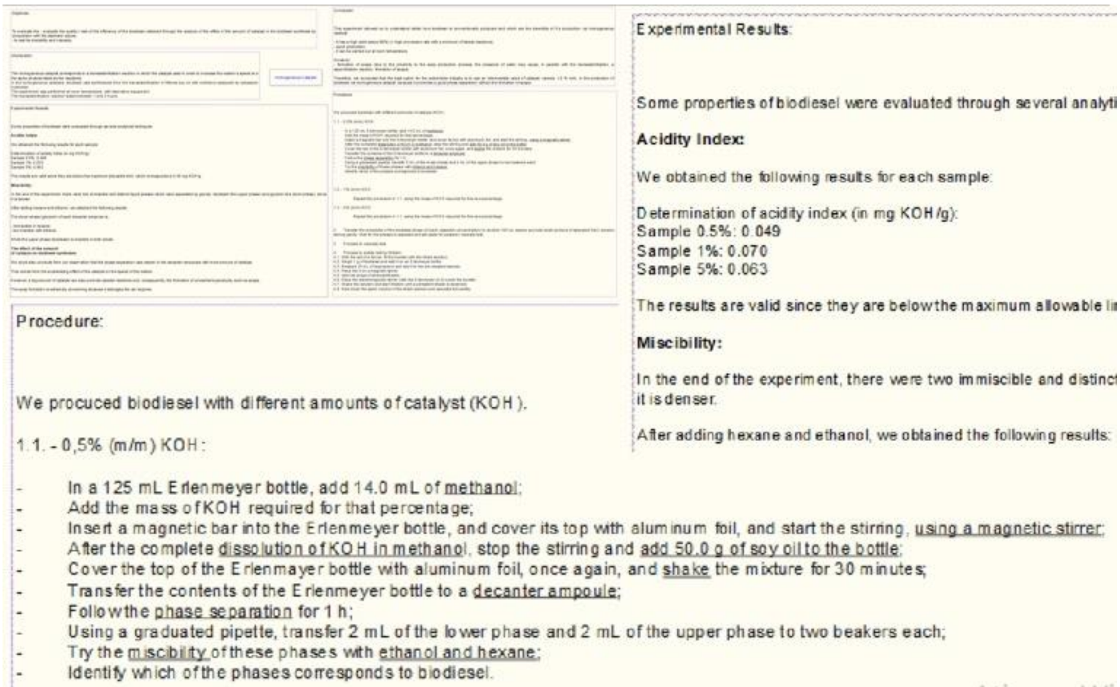

Figure 8. Lab report – Mind Map Scapple

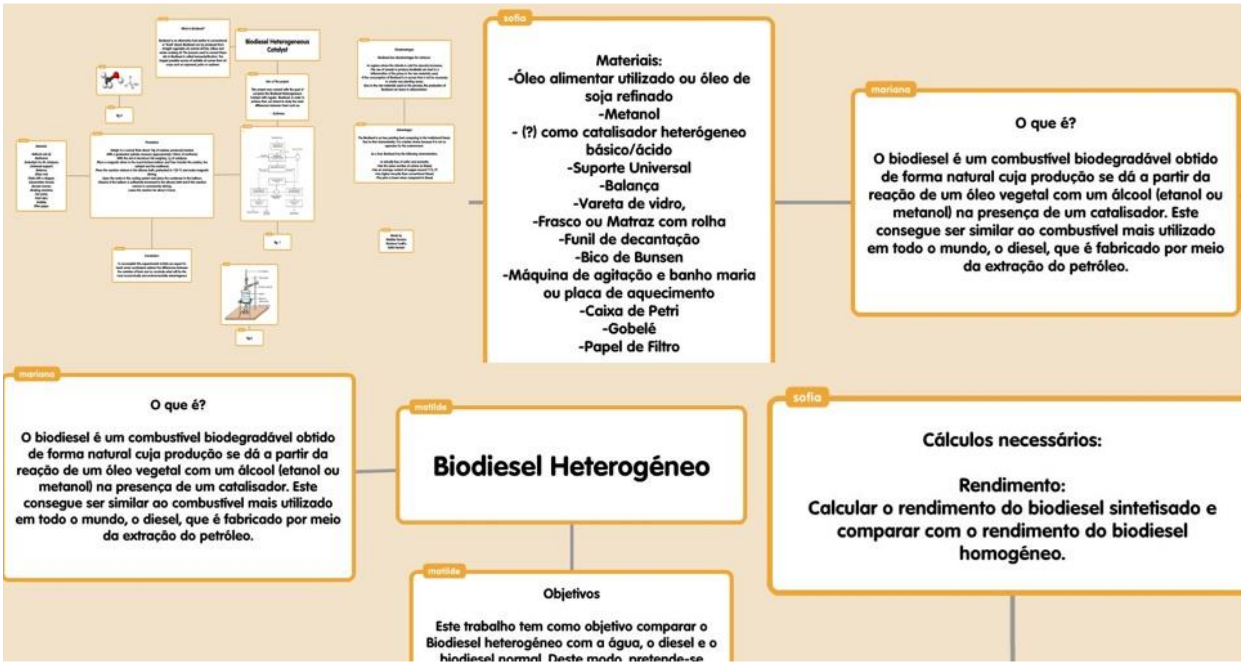

Figure 8. Lab report – Mind Map Popplet

Study of the miscibility

At the end of the experiment, there were two immiscible and distinct liquid phases which were separated by gravity: biodiesel (the upper phase) and glycerol (the down phase), since it is denser. After adding hexane and ethanol, the following results were obtained: the down phase (glycerol) of each decanter ampoule is immiscible in hexane but miscible with ethanol (figure 9), while the upper phase (biodiesel) is miscible in both solutes (figure 9).

0,5% (m/m) KOH	0,5% (m/m) KOH	1% (m/m) KOH	1% (m/m) KOH	5% (m/m) KOH	5% (m/m) KOH
Upper phase	**Upper phase**	**Upper phase**	**Upper phase**	**Upper phase**	**Upper phase**
Ethanol	Hexane	Ethanol	Hexane	Ethanol	Hexane
Miscible (light yellow)	Miscible (light yellow)	Miscible (light yellow)	Miscible (light yellow)	Miscible (light yellow)	Miscible (light yellow)
Lower phase	Lower phase	Lower phase	Lower phase	Lower phase	Lower phase
Ethanol	Hexane	Ethanol	Hexane	Ethanol	Hexane
Miscible Bottom - dark Top part - yellowish	Immiscible Bottom - dark Top - colorless	Miscible Bottom - dark Top part - yellowish	Immiscible Bottom - dark Top - colorless	Miscible Bottom - dark Top part - yellowish	Immiscible Bottom - dark Top - colorless

Figure 9. Study of the miscibility of the upper and lower phase with ethanol and hexane

Effect of the Catalyst amount on the production of biodiesel:

By the observation it is concluded that the phase separation was clearer in the decanter ampoules with more amount of catalyst. This is due to the accelerating effect of the catalyst on the speed of the reaction. However, a big amount of catalyst might also promote parallel reactions and, consequently, the formation of unwanted, such as soaps.

Infrared Spectrum of the Biodiesel

FT-IR is being employed for monitoring the reaction of biodiesel production. Bands above 3007 cm^{-1} indicate the presence of methanol. Bands at 1467 and 1436 cm^{-1} show the presence of methyl esters. (Baroi C. et al., 2009) In homogeneous catalysis, it is possible to visualize the specific areas of oil absorption by soy oil, methanol and biodiesel formed (figure 10). The higher is the catalyst amount, the higher is the efficiency to convert oil in biodiesel.

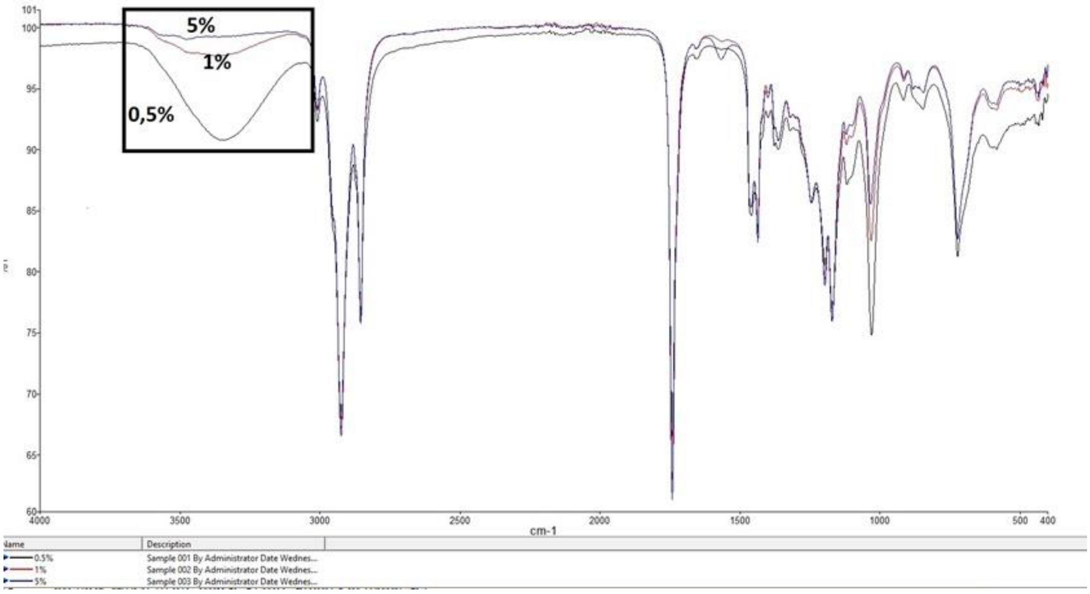

Figure 10. FT-IR of biodiesel – Homogeneous Catalysis

Conclusion

With this project, we may conclude that the transesterification corresponds to a simple, easy and economically accessible method of synthesizing Biodiesel. Homogeneous catalysis can be carried out at room temperature but there is the production of sops by catalyst consumption. On the other hand, the heterogeneous catalyst has no soap formation and the catalyst can be recovered because it is in a different physical state of the reaction elements, so it is easily separated from the final product.

By carrying out this project, students developed personal competencies/skills, the ability of dealing with the unknown as well as facing a challenge, always with the perspective of solving a problem. They developed social skills through teamwork and contact with the entrepreneurial world. Contacting with a research environment, they were led to the development of their ability to structure and analyse complex problems that require multidisciplinary skills as well as executing all tasks relating to each stage of the project in a lab environment. The teacher had a more tutorial role, intervening whenever requested.

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Effect of Technology-Integrated Inquiry Based Learning Approach on Middle-School Students' Conceptual Understanding of Lunar Eclipse

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Abstract: The aim of this study is to investigate the effects of technology-integrated inquiry based learning method and learning method that is based on the curriculum of science on the conceptual understanding shifts among students. In the research mixed explanatory model was harnessed. Sampling of the research consisted of 6th graders in a state middle-school. 33 students in one section constituted the test group whilst 29 students in a different section formed the control group. Members of test and control group were randomly assigned. Test-group students were taught in line with the learning method based on technology-integrated inquiry whereas control-group students received inquiry-based method as per the effective curriculum. In line with the aim of this research, "Conceptual Understanding Test" was administered to students as pretest and posttest before and after the learning process. In addition, a semi-structured interview was implemented among 9 students from each of the 2 groups. In the selection of students for this interview, their science grade from the previous year was examined. In the conceptual understanding test that was prepared as our data collection tool, 5 open-ended questions to measure 3 of the program acquisitions were included. The said questions entailed acquisitions on "the student can predict how lunar eclipse is formed", "the student is informed about what phase the moon is in during lunar eclipse" and "the student is informed about the fact that lunar eclipse is not a regular phenomenon for each month". 5-category grading key was utilized for the analysis. These categories comprised of "exactly true", "partially true", "scientifically invalid answer", "non-codable" and "no answer" options. In the analysis of data, total score was computed by giving 4 points to "exactly true" category, 3 points to "partially true" category, 2 points to "scientifically invalid answer" category, 1 point to "non-codable" category and 0 point to "no answer" category. In the analysis of data, t-test for unrelated measurements was harnessed. Based on the answers obtained from data analysis it was evident that not a significant difference existed between technology-integrated inquiry based learning of lunar eclipse concept and inquiry-based learning that followed the curriculum format.

Keywords: Technology integrated inquiry-based learning, Lunar eclipse, 6^{th} grade Students

Introduction

With the implementation of 2018-dated Science curriculum, research & inquiry based learning has been implemented much more effectively in Turkish classrooms (MEB *Ministry of National Education*, 2018). Conducted studies also indicate that, stipulated by a common objective, the mission was to revise the curriculum (Akuma & Callaghan, 2018). In these researches common goal has been to train students as science-literate individuals with some awareness on their surrounding and aptly using scientific-process skills. In learning of scientific knowledge there is a myriad of studies on inquiry-based method in which students gain experiences via active participation (National Research Council (NRC), 1996; Duit, 2009). Bostan Sarıoğlan and Abacı (2017) in their research implemented inquiry-based method while learning lamp radiance concept to 5^{th} graders. In the posttest results of students it was seen that, compared to pretest results, there was a rise in the ratio of scientific answers provided. Duru, Demir, Ören and Benzer (2011) in their study investigated the effect of inquiry-based laboratory applications on students' attitudes and scientific-process skills. Their findings

- Selection and peer-review under responsibility of the Organizing Committee of the Conference

concluded that inquiry-based laboratory applications had no significant effect on students' attitudes although it led to a positive effect on their scientific-process skills. In another study however; a three-dimensional graphic was used for inquiry-based learning. At the end of this study it was attested that compared to students in control group, students in test group were more successful in inquiring, hypotheses-generation and critical thinking on available data (Chen, Wang, Grotzer and Dede, 2018). Kaya and Yılmaz (2016) in their research examined academic achievements of open inquiry-based method on “Force and Moment”. They detected that students in test group achieved significantly higher academic scores than those in control group. In former studies there was a variation with respect to research groups. In another study an inquiry-based learning was provided to undergraduate students. In this practice, students utilized 3-B modeling tools in order to forge virtual-reality model of Solar System. This research pointed that inquiry-based method could be an effective learning method to help students understand astronomical phenomena (Barab, Hay, Squire, Barnett, Schmidt, Karrigan, Yamagata-Lynch, 2000).

There is an abundance of studies in which both education and technology are closely intertwined. Küçüközer (2008) in his study examined via 3D model the conceptual change in phases of the moon and seasons. This study revealed that his method triggered a significant conceptual change among prospective science teachers. Küçüközer (2013) in one of his studies claimed that prospective science teachers could facilitate conceptual change via administering computer-model supported education and this conceptual understanding could also be saved for a long time. In other relevant studies the technique was blended with technology-based methods. In their research Çakır and Oktay (2013) blended technology with brain-based learning. Although technology supported brain-based learning was implemented in test group, effective curriculum was activated in control group. Next its effect on the permanent learning level and metacognitive awareness level was investigated via checking students' academic success level. It was attested that technology supported brain-based learning had a positive effect on students' academic success and permanent learning level but had no effect on their metacognitive awareness level. Similarly in another study virtual-reality computer models were activated in order to support students' understanding of astronomy concepts. As a result of the applied modeling it was concluded that students enhanced understanding of astronomy-related contexts via computer-modeling(Barnett, 2005). In other studies it became clear that computer supported learning positively influenced students' attitudes (Yenice, 2003). On the other hand it is not, in all circumstances, viable to obtain identical results from all studies. In their study Güven and Sülün (2012) concluded that computer supported or traditional learning created not any significant change in students' attitudes. It is worth noticing that, in addition to technology, the models are also used in the learning of subjects. Türk and Kalkan (2017) in their study focused on learning of astronomy via models. Commonality between their study and this research is mentioning of Lunar Eclipse Concept. In the study of Türk and Kalkan(2017) it was identified that students' responses favored learning of Lunar eclipse concept via models.

Moon concept has been a focal point in numerous studies. Bostan (2008) in his analysis aimed to compare the “position of the Earth, Sun and Moon during Lunar eclipse” via conducting interviews across a wide range of age groups. At the end of this research he concluded that with an increase in students' age there was a corresponding decrease in their misconceptions and non-codable responses. In his study Ogan Bekiroğlu (2007) investigated the effect of model based education on prospective teachers' concepts about Moon, Phases of the Moon and Moon-related phenomena. With this study prospective teachers' incorrect or incomplete mental models were regulated with the support of model-based education. In their study Kavanagh, Agan and Sneider (2005) claimed that inquiry-based researches could be effective in correcting students' misconceptions on the phases of moon. Unlike these previous studies, in our research, a mixed model has been proposed in which technology, inquiry and Lunar eclipse concept are presented collectively. In line with this aim 6th grade students were taught of moon concept. Test-group students were administered the designed technology integrated inquiry-based model whereas students in control group were taught in accordance with inquiry-based learning method as per the curriculum. It then became feasible to compare conceptual understanding levels of students’ on lunar eclipse concept with respect to the different learning methods applied.

Method

In this study one of the mixed method patterns, explanatory successive pattern in short, was utilized. Explanatory successive pattern allows to conduct a wider scope of research(Creswell, 2017). While the quantitative part of the research entailed “Conceptual Understanding Test” its qualitative part was composed of semi-structured interviews held among select students.

Sampling of the research

In the selection of research sampling one of the random sampling methods, also known as simple random sampling method, was harnessed. In simple random sampling method the sampling that refers to the whole population is arbitrarily selected (Büyüköztürk, Kılıç Çakmak, Akgün, Karadeniz & Demirel, 2014). As the sampling, two 6th grade classes studying in a state school in Manisa city were randomly selected. Classes were divided into test group and control group students. In test group a total of 33 students took part whereas in control group there were 30 students in sum. 15 students in test group were female and 18 were male while in control group 13 students were female and 17 were male.

Data collection Tool

Data collection tool "Conceptual Understanding Test" (CUT) employed in this study was concocted by the researchers. Questions in CUT were directed to highlight the acquisitions in the Science Curriculum for 6th grade "the student can predict how lunar eclipse is formed", "the student is informed about what phase the moon is in during lunar eclipse" and "the student is informed about the fact that lunar eclipse is not a regular phenomenon for each month". After the preparation of questions, experts' opinions were asked. In accordance with experts' views, questions were reorganized and administered among 30 7th grade students who were previously educated on these concepts. 5 open-ended questions in CUT were directed to students in test and control group as pretest and posttest. Interviews were conducted with 8 volunteer students from test and control groups. Semi-structured interviews were tape recorded during the sessions.

Data Analysis

To analyze CUT a five-category grading key was harnessed. These categories consisted of options "exactly true answer", "partially true answer", "scientifically invalid answer", "non-codable" and "no answer" . Exactly true answer category contained an exactly true response and correct explanation. Partially true answer category contained the true answer but lacked the explanation for the response. Scientifically invalid answer entailed false answers and false explanations. Non-codable answers contained irrelevant answers and no answer category entailed students who did not respond. Scoring was performed by giving 4 points for "exactly true" category, 3 points for "partially true" category, 2 points for "scientifically invalid answer" category, 1 point for "non-codable" category and 0 point for "no answer" category. To analyze the total scores collected, SPSS package program was benefited. T-test for unrelated measurements was implemented to analyze the relation between obtained pretest and posttest scores and test and control group. In order to compare posttest scores of test and control groups with the pretest scores of test and control groups, t-test for independent groups was conducted. In the comparison of test group's pretest and posttest scores with control group's pretest and posttest scores, t-test for related measurements was administered. T-test for related measurements is used for repetitive measurements on the same subject (Büyüköztürk, 2017). Semi-structured interviews that had been tape recorded during the sessions with test and control group were then scripted.

Teaching Process

In test group teaching process was executed via technology integrated inquiry-based learning method while in control group inquiry-based method in science curriculum was followed accordingly. In both methods common objective was to gain the acquisition of; "the student can predict how lunar eclipse is formed". In the planning stage of learning the test group 5E learning model was utilized. In the warm-up stage role-play was the preferred technique. During discovery stage students in groups of four were asked to perform the activities via Prediction-Observation-Explanation method. Students having written their predictions on relevant acquisition then watched the simulation. After viewing the simulation, observations were noted down by the students. In the following group discussions, students exchanged their explanations. During Explanation stage students clarified their views and teacher acted as a guide in directing their views. In the deep-learning stage students were provided with a worksheet in which the reasons of yearly observed Lunar Eclipse and "Super Blood Blue Moon" eclipse were noted. During the analysis stage, students were provided with a worksheet in which gap filling exercises were listed.

Results and Discussion

In this section findings obtained from the analysis of administered CUT on test and control group have been exchanged.

Comparing the Pretest Scores of Test and Control Group

Comparison of t-test results of the scores obtained from the pretests of test and control group is as exhibited in Table 1.

Table 1. T-test results of the scores obtained from the pretests of test and control group

GROUP	N	$\overline{X}$	S	Sd	t	p
Test group	33	10.48	2.516	60	.160	.295
Control Group	29	10.58	2.062			

Table 1 reveals that pretest scores are not significantly different (t(60)=.160, p>.05) in test and control group. This finding can be interpreted as the absence of a significant difference among test and control groups with respect to the results of pretest scores**.**
Below is a model interview conducted among students before learning process.

Interviewer: *Is it possible to observe Solar Eclipse or Lunar Eclipse each month?*
CGS1: *No.*
Interviewer: *Why do you think we cannot observe this phenomenon every month?*
CGS1: *Because Earth's cycle-time around itself and Moon's cycle-time around itself are not the same. So it is impossible to reach Solar Eclipse or Lunar eclipse position in only month.*

Interviewer: *Is it possible to observe Solar Eclipse or Lunar Eclipse each month?*
TGS4: *Nope, not possible. Not only one time or two times in every month. In some months it may be 2 and in some months only one.*
Observer: Why do we observe this phenomenon if it can be observed every month?
TGS4: *During a month Sun can move ahead of Moon a few times.*
Observer: *Can it be observed in each movement?*
TGS4: *Yes.*

Above is an excerpt of interview conducted with one student from control and test group before learning process. Pre-interview notes reveal that as for the question "*Is it possible to observe Solar Eclipse or Lunar Eclipse each month?"* students in control group and test group failed to give an exactly true answer unlike the concept test administered in the beginning.

Comparing the Posttest Scores of Test and Control Group

Comparison of t-test results of the scores obtained from the posttests of test and control group is as exhibited in Table 2.

Table 2. T-test results of the scores obtained from the posttests of test and control group

GROUP	N	$\overline{X}$	S	Sd	t	P
Test group	33	14.42	2.264	60	.388	.379
Control Group	29	14.17	2.842			

Table 2 reveals that posttest scores are not significantly different (t=.388, p>.05) in test and control group. This finding can be interpreted as the absence of a significant difference among test and control groups with respect to the results of posttest scores**.**
In light of this insight post interviews with the same students were reiterated individually as test and control group. In these interviews different answers from 2 students for the same questions are as seen below.

Interviewer: *Is it possible to observe Solar Eclipse or Lunar Eclipse each month?*
CGS1: *No.*
Interviewer: *Why do you think we cannot observe this phenomenon every month?*
CGS1: *Nope because Earth, Sun and Moon are not in the same line.*

Interviewer: *Is it possible to observe Solar Eclipse or Lunar Eclipse each month?*
TGS4: *No because errrmm, they cannot always get on the same line all the time.*

As for the question "*Is it possible to observe Solar Eclipse or Lunar Eclipse each month?*" results of post-learning interview indicate that, similar to the conceptual understanding test, students in test and control group answered in exactly true answer category.

Comparing the Pretest and Posttest Scores of Control Group

Comparison of t-test results of the scores obtained from the pretests and posttests of control group is as exhibited in Table 3.

Table 3. T-test results of the scores obtained from the pretests and posttests of control group

GROUP	N	$\overline{X}$	S	Sd	t	P
Pretest	29	10.48	2.51	28	6.42	.00
Posttest	29	14.17	2.84			

In Table 3 a significant difference was observed in pretest and posttest scores of control group students ($t(28)=6.42$, $p<.05$). This finding can be interpreted such; inquiry-based learning as per the science curriculum created a significant change in the conceptual understanding of students in control group.

Comparing the Pretest and Posttest Scores of test Group

Comparison of t-test results of the scores obtained from the pretests and posttests of test group is as exhibited in Table 4.

Table 4. T-test results of the scores obtained from the pretests and posttests of test group

GROUP	N	$\overline{X}$	S	Sd	t	P
Pretest	33	10.48	2.06	32	10.13	.00
Posttest	33	14.42	2.26			

In Table 4 a significant difference was observed in pretest and posttest scores of test-group students ($t(28)=6.42$, $p<.05$). This finding can be interpreted such; inquiry-based learning as per the science curriculum created a significant change in the conceptual understanding of students in control group.

Conclusion

The findings of this study led to the results below;
Pretest scores of the test and control group manifested that there was not a significant difference with respect to

mean scores of conceptual understanding test. Hereby the lesson to take is; prior to learning experience, students in test and control group were in the same cognitive level about the lunar eclipse concept. The fact that posttest mean scores of control and test group are mostly identical led us to conclude that there was not a significant difference between technology integrated inquiry-based learning and inquiry-based learning as per the effective curriculum. As for the scores that control-group students received from pretest and posttest, it was identified that a significant difference existed between pre and posttest mean scores. Based on this finding it can be argued that inquiry-based learning that followed science curriculum positively affected students' conceptual understanding. This is a finding in the same vein with a good number of literature studies. As has been attested inquiry-based learning has a positive effect on students' conceptual understanding and academic performance (Kayacan & Selvi, 2017).

As pretest and posttest scores of students in test group are examined, a significant difference becomes evident between pre and posttest mean scores. Based on this finding it can be argued that technology integrated inquiry-based learning positively affected students' conceptual understanding. Simulation learning was implemented in test group. In their paper Sarı and Bakır Güven (2013) employed an interactive board support that complied with inquiry-based learning. Besides, their research was also supported via simulation. As a result they concluded that students' academic achievement increased more dramatically (Sarı & Bakır Güven, 2013). According to the results obtained from the findings of this study, technology integrated inquiry-based learning and inquiry-based learning as per the science curriculum created a significant difference in the conceptual understanding of students. Prior to learning process, students in test and control group lacked scientific knowledge on Lunar eclipse concept but the learning session for both groups enabled a jump in the scientific answers of students. Despite that this increase failed to create a significant difference between both groups. Likewise implemented pre and post interviews also indicate that there is not a significant difference between technology integrated inquiry-based learning and inquiry-based learning as per the curriculum. Unlike this study, an abundance of analyses proved that computer supported learning is quite an effective method in bolstering students' success (Akçay, Aydoğdu, Yıldırım, Şensoy, 2005; İçel, 2011). Difference across the obtained results may be related to a variety of factors. Difference of research group, difference in practitioners, employed materials and various other factors can change the outcome of any study.

Suggestions

At the end of this study our suggestions to researchers who also aim to conduct studies related to Lunar eclipse concepts are as below;

- It is suggested that other studies, in which a new learning method, could be used instead of 5E learning model provided for the use of test group in our study. To give an example, learning domain or 7E model can be used.
- In the same way, instead of inquiry-method applied as per the curriculum in control group, it is suggested to use another learning method.
- The sampling of this research consists of 6th grade students studying in two different sections in a state middle-school. Sampling size could be much wider in the subsequent researches.
- While in this study technology was integrated to inquiry-based learning, in a different study technology could be integrated with different learning methods. Çakır and Oktay (2013) in their research integrated technology with brain-based learning. Similarly different educational methods and technology could be blended in the learning process.

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Mathematics Anxiety among Secondary Level Students in Nepal

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Abstract: This paper explores the association between the perceived classroom environment and mathematics learning and test anxiety among secondary level students in Nepal. Categorizing the students in three dominant variables- gender, ethnicity and previous schooling, and selecting sample students with respect to higher mathematics anxiety from five heterogeneous classes, the research explores disparities in student's mathematics cognition and reveals the nexus between classroom environment and mathematics learning and test anxiety. This research incorporates social learning theory and social development theory as interpretive tools for analyzing themes through qualitative data. Focusing on interviews with highly anxious students learning mathematics, the study sheds light on how mathematics anxiety among the targeted students is interlinked with multiple factors. The research basically exposes the students' lack of mathematical passion, their association with other students and participation in classroom learning, asymmetrical content and their lack of preparedness for tests, as the caustic factors behind such anxieties. The study further reveals that students' lack of foundational knowledge and the complexity of the mathematical content have jointly contributed to mathematics anxiety. Admitting learning as a reciprocal experience, the study points out that the students' gender, ethnicity and disparities in previous schooling in the context of Nepal has very insignificant impact on students' mathematics anxiety. It finally recommends that those students who get trapped into the vicious cycle of mathematics anxiety require a positive and supportive classroom environment along with inspiring comments/compliments and symmetrical course contents.

Keywords: Anxiety, Asymmetry, Cognition, Habitus, Pedagogy

Introduction

A remark made by a grade-seven student named Sita regarding mathematics learning about 20 years back still reverberates in the mind of the researcher. By then, the researcher was a Lower Secondary Mathematics teacher in his home town Pokhara, Nepal. One day, after receiving a below-average final exam result only in mathematics, she approached her teacher and frustratingly uttered, "I can't solve any problems of mathematics; it is not for me, it is others' work". As a teacher, the researcher offered words of comfort and advised her to practice well for improved performance; however, the statement left the researcher feeling restless and thinking about why and how students, even those with high intellectual capability, descend into mathematics learning and test anxiety.

Sita's difficulty in understanding mathematics was not an isolated case, there are many others who face this situation but hesitate to speak out. While the student showed a willingness to share her feelings on learning mathematics, the researcher could not anticipate that so many other students feel the same but do not show it due to the socio-cultural context of learning in Nepal. During his 20 years of teaching, the researcher has reckoned the situation has remained unchanged, as students continue to struggle and show such problems in his classes, which has motivated him to explore this problem further in the context of classroom learning in Nepal and to come up with certain findings. This research, "Mathematics Anxiety among Secondary Level students", studies an ongoing problem in the heterogeneous classroom context of the teaching/learning process in Nepal, and explores the issue with empirical data analysis from the classroom environment perspective.

Literature Review

Mathematics anxiety has been perceived in various ways in the literature. While early researches suggested mathematics anxiety to be a possible symptom of anxiety in general [1], contemporary researches suggest it is a much more complex phenomenon. Hunt describes mathematics anxiety as "the panic, helplessness, paralysis, and mental disorganization that arises among some people when they are required to solve a mathematical problem" [2]. While Hunt's definition emphasizes the emotional aspects of mathematics anxiety, other researchers focus on the effect of mathematics anxiety on mathematical performance [3]. Richardson and Suinn [4], for example, defined mathematics anxiety as involving "feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations". This definition is consistent with the description given by [5] of the process of math anxiety, which suggests that mathematics-anxious people may experience physical and mental symptoms of anxiety which results in poor performance in mathematics, avoidance of mathematics, and irresistible feelings of failure.

Both Richardson and Suinn's and Arem's definitions of mathematics anxiety are consistent with a classic psychological theory of arousal. This theory states that people perform best when they are at an intermediate level of arousal. If an individual is over aroused, as with people who are experiencing high levels of anxiety, then he or she will have difficulty focusing and sustaining attention which will result in decreased levels of performance [6].

Some definitions describe other possible symptoms and effects of mathematics anxiety. For instance, [7] defines mathematics anxiety as involving "debilitating test stress, low self-confidence, fear of failure, and negative attitudes towards mathematics learning" (as cited in [8]). Furthermore, research suggests that mathematics anxiety may be particularly apparent when an individual is under evaluation (Brush, 1981, as cited in [9]). Uusimaki and Nason reported that over one-third of pre-service elementary teachers that participated in a study cited mathematics practicum situations as causing significant anxiety due to "insecure feelings of making mistakes or not being able to solve it correctly" [1].

Mathematics learning anxiety and mathematics test anxiety are largely linked with the classroom environment. In this regard, Murray [10] referred to the perceptions of the environment by participants as beta press, the view of the inside observer, as opposed to alpha press, the view of the outside observer. Wood notes the lack of agreement among researchers about the definition and measurement of mathematics anxiety. He proposes that mathematics anxiety may not be a distinct construct because it has been found to be highly related to test anxiety [3]. Other researchers, however, suggest that test anxiety and mathematics anxiety are not synonymous despite the similarities in many ways [11]. According to Hembree, test anxiety and mathematics anxiety are separate constructs. He notes that "only 37 percent of one construct's variance is predictable from the variance of the other" [12]. He states that mathematics anxiety is comprised of a "general fear of contact with mathematics", including, but not limited to classes, homework, and tests [12].

Regardless of the precise definition, it is generally agreed that mathematics anxiety can potentially interfere with learning and performance in mathematics [13]. Mathematics anxiety can occur in all levels of education from primary school to higher education, and once established, can persist in life, interfering with every day activities involving numeracy and further learning of mathematics. Mathematics anxiety usually comes from negative experiences in working with teachers, tutors, classmates, parents or siblings [14].

Many students who pass through mathematics anxiety have little confidence in their ability to do mathematics and tend to take the minimum number of required mathematics courses, greatly limiting their career choice options. This is unfortunate, especially as society becomes more reliant on mathematical literacy [15]. As stated by [16], mathematics anxiety could be caused by a number of factors: unpleasant past experiences with mathematics in the classroom, a parent conveying the message to their children that mathematics is boring and useless, or from the attitudes of the teachers themselves. The aforementioned review reveals that mathematics anxiety is both the cause and the effect in itself and is connected to many other factors. In the Nepalese context, however, the classroom environment seems to be one of the dominant factors behind it.

Theoretical Foundation

Mathematics anxiety is often termed to be a learned behavior. Social learning theorists opine that learning occurs within a social context. It considers that people learn from one another. Reference [17] states that mathematics anxiety can be influenced by any of the following factors: the school system, gender, socioeconomic status, and parental history and prejudices. This implies that mathematics anxiety could be a learned behavior.

Bourdieu's (as cited in [18]) notion of social practice focuses on habituated activities of ordinary living that people acquire through socialization. Habitus is not fixed or permanent and can be changed in unexpected situations or over a long period of time [19]. Reference [20] views habitus as neither a result of free will, nor determined by structures, but created by a kind of interplay between the two over time.

With this backdrop, this research incorporated Lev Vygotsky's 'Social Development Theory' and Albert Bandura's 'Social Learning Theory' to see how students perceive mathematics anxiety; how it affects their learning; and, how they fall in a vicious cycle of anxiety unless proper stimulation or comments/compliments are not provided to them. By using Vygotsky's theory, this research has explored how learning would be a reciprocal experience for the students and instructors. By using Bandura's theory on social learning, this research has studied students' learning in terms of continuous reciprocal interaction between cognitive, behavioral, and environmental influences.

Methodology

This study adopted qualitative research methods to examine the complex world of perception of students in mathematics learning and manifestation of mathematics anxiety they felt through various factors like the asymmetrical nature of the syllabus in different grades, insufficient classroom motivation and improper instructional practices.

Qualitative data texts were taken for looking at variables in the natural setting in which they are found. Detailed data were generated through open-ended questions that provided direct quotations. As stated by [21], the interviewers were an integral part of the investigation. Reference [22] called this method the "narrative approach" for generating qualitative data. This research adopted purposive sampling method regarding it as the most common sampling strategies in qualitative research. Through purposeful sampling, information-rich cases were sought to make in-depth analysis [23].

Twenty students with extremely high levels of mathematics anxiety were selected to be involved for the research purpose. Each of the interviews was recorded with the participant's permission and then transcribed verbatim. Following the qualitative research approach, similar themes were investigated from transcripts and individual perspectives were considered. The unit of analysis from the qualitative data involves verbatim quotations from the students. A total 70 quotes were used as raw data for the analysis. The higher level themes, composed of combinations of the lower level themes, were generated from the quotes derived through the interviews. Quotes with common themes were clustered together and labeled. Level I themes were derived by common theme of direct quotes, level II by level I, and level III by level II themes.

Findings

The figure mentioned below reflects content analysis using inductive approach. As shown in the figure, the emergent themes from the interviews were connected to qualitative factors including students' mathematics learning and evaluation anxiety.

A new avenue that opened up from the interview with the students was the theme of the structure of mathematical content and students' familiarity with it. While talking to the students, they confessed that the complexity of the mathematics content and their lack of fundamental mathematics knowledge caused anxiety in learning mathematics. As a result, they failed to perform well in the exam, thereby causing test anxiety. Once a student conceived test anxiety, it further invited complication in learning mathematics and trapped them into a vicious cycle. The two themes mentioned above, drawn through representative quotes, are concerned with students' perception of mathematics learning. The remarks made by students regarding mathematics learning show that mathematics learning anxiety is proportional to content complexity. Few of the responses of students regarding this factor are mentioned below as testimonies:

> *I really get annoyed when I to try to solve mathematical problems in class as well as in an exam. I can barely concentrate in the classroom learning, and I don't perform well in exams, and so I keep asking*

myself why I have to learn these formulas by heart since I'm unlikely to conceptualize the matter and forget these things quickly anyway. I can't understand how these mathematical problems are connected to life. (Neha, a XI grader).

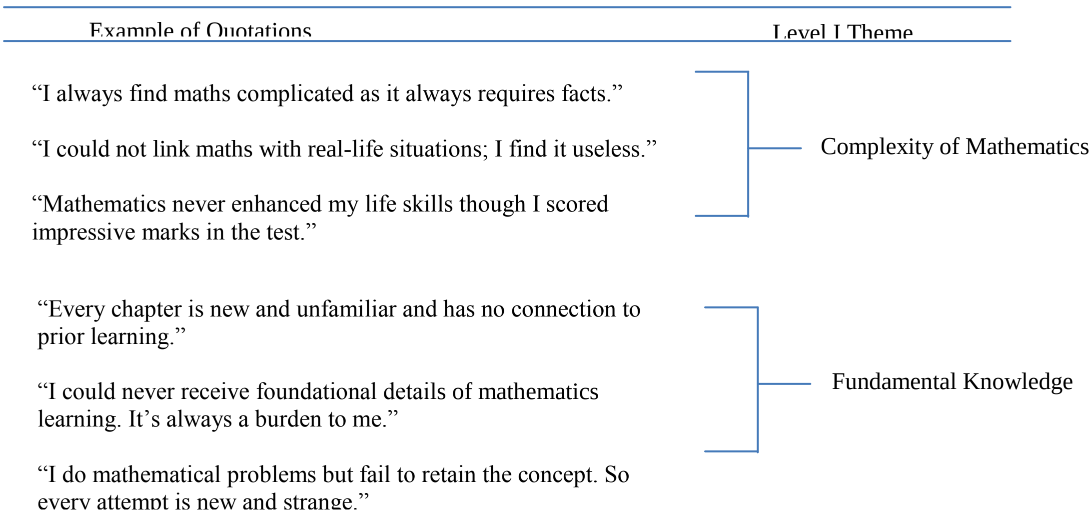

Figure 1. Quotations cluster and first level themes

Other students also reacted to mathematical problems as Neha did. These feelings revealed that some students have greater mathematical anxiety and show less interest in mathematical activities, which in turn caused test anxiety. As Joshan, another XI grader, said:

I get lost as soon as the teacher begins a new chapter at the start of a new week. As long as he is in the class I seem to understand the things. As he leaves, I simply wonder what I was learning in the class. Everything vanishes and I get stuck up at every step of problem solving. It really bothers me. Consequently, I can't perform well in the exam.

These representative student narratives revealed that learning mathematics anxiety coincided with test anxiety and vice versa. The cluster of quotes of the students mentioned above resulted in the first level of themes. On the basis of those themes, different levels of themes, as mentioned in the figure below, are generated.

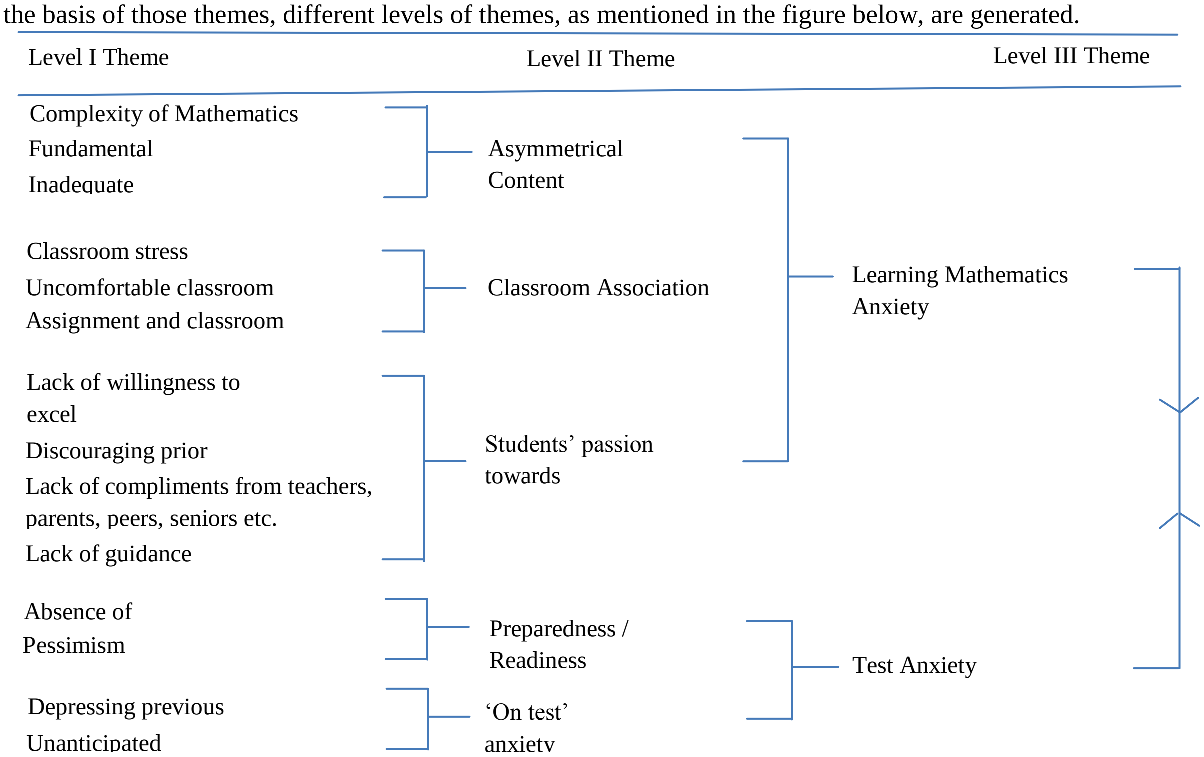

Figure 2. Nexus of three level themes

The table shows that learning mathematics anxiety and test and evaluation anxiety are connected to their passion for mathematics, their readiness and preparedness for the tests, asymmetrical content and classroom association. Some students get lost due to classroom stress, vastness of content and inadequacy of illustrations. Some, on the other hand, get frustrated by the classroom environment; they do not get much help from their peers, find assignments and classroom practices hectic and lack willingness to excel in mathematics. Other students, similarly, lack prerequisite content knowledge, become discouraged by previous results and frustrated by the announcement of exams, and remain pessimistic about mathematics learning. The narratives also revealed that students' gender, previous schooling and ethnic background do not necessarily coincide with learning mathematics anxiety and test anxiety. The responses of representative students mentioned below further substantiate the theme:

> *Sometimes, I think, I was not born to study mathematics. It's no longer entertaining to me. It bores me all the time. I generally lack mathematical concepts and get troubled when I have to perform a task.* (Sachin XI: A Male Student)
>
> *Thinking about exam results upsets me terribly. I keep scoring low marks in mathematics though I perform well in other subjects. This is indeed discouraging me to study further. Can't I get rid of it?* (Anupa XI: A Female Student)

The responses of students towards mathematics perception reveal much about their mathematics learning. In the interviews, they expressed not only their worries, but also made some insightful remarks to address teaching learning complications. Mentioned below are responses that reveal these facts:

> *If the teacher gives me more opportunity to ask questions I would overcome my difficulties, and I can also learn as per the pace of the class.* (Sammy Tamang, XI: Ethnic Group)
>
> *Is there any relationship between two units or among units of the content which can help me in understanding mathematics better?* (Apekshya Sharma, XI: Non-ethnic Group)
>
> *What is the use of my mathematics learning and the real life situation? I get nothing.* (Raisa Khatun, XI: Rural Schooling)
>
> *I think I can study well in all subjects if I get the proper guidance from my teachers and support of my friends. Guidelines before exams really motivate me do better in every exam.* (Shreya Shrestha, XI: Urban Schooling)

These representative responses are not just the bundle of problems. They replicate the reality of mathematics learning classroom in Nepal and also bear the answers within themselves. These responses indicate that the students who are trapped in the vicious cycle of mathematics learning and test anxiety need to be helped to overcome the problem.

Discussion

The qualitative data analysis mentioned above revealed that mathematics anxiety is both acquired and learned behavior. Some students lack a mathematics foundation and cannot learn the subject well, where as others find problem with mathematics learning due to various factors like classroom environment, lack of willingness to excel in mathematics, lack of preparedness etc. As a result, the students perceive mathematics learning and test anxiety.

As viewed by Albert Bandura, habitus is not fixed or permanent and can be changed in unexpected situations or over a long period of time (as cited in [24]). On the other hand, in his social learning theory, Bandura views that the learning ability of students who perceive mathematics anxiety is affected and that they fall into a vicious cycle of anxiety, and therefore, require proper guidance, necessary stimulation or comments/compliments.

As perceived by Vygotsky, social interaction precedes development; consciousness and cognition is the end product of socialization and social behaviour (as cited in [25]). His theory shows connections between people and sociocultural context in which they act and interact in shared experiences. This theoretical modality helped in identifying the fact that the students' perceptions of mathematics is influenced and sometimes shaped by peer activities or pressure. On the basis of this theoretical foundation and empirical observation of the study, it has been revealed that students' mathematics anxiety is the product of interaction between cognitive, behavioral, and environmental influences, not by their gender, ethnic background or previous schooling.

Conclusion

The study explored whether mathematics anxiety is acquired, created or something else. Based on the lived experiences of students' mathematics anxiety framed within social learning theories and social development theory, the research exposed that the problem of mathematics anxiety among students was basically caused by the students' lack of a solid foundation and the complexity of the mathematical content. Also, the research indicated that students' ethnic background, gender and varied previous schooling are not caustic factors in learning mathematics anxiety and test anxiety. It further revealed that learning mathematics anxiety and test anxiety are deeply embedded with students' passion towards mathematics, classroom association, asymmetrical content and their preparedness for the tests. As a result, the students experienced learning anxiety as well as test anxiety. The study further revealed that practical classroom strategies, explanations of mathematical principles, motivational practices, hands-on activities, use of different models, and positive and supportive learning environments would change students' attitudes toward mathematics; otherwise, the vicious cycle of learning mathematics anxiety and test anxiety is sure to continue.

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Examination of the Sixth-Grade Students' Performances in Graphical Languages

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Abstract: Graphical languages are helpful for students as they facilitate the understanding of the given data. Understanding these graphical languages is also important as students encounter tasks containing graphics when compared to the tasks in the past (Diezmann & Lowrie, 2008). The current study aims to investigate whether sixth-grade students' graphical language performances vary significantly considering gender. It was also investigated whether there is a significant correlation between the sixth-grade students' performances among the six components of the graphical language. The participants were 97 sixth-grade students in an elementary school in Ankara, Turkey. To examine students' performances in graphical languages, a graphical languages test was adapted from Mackinlay's (1999) model of graphical languages. The results of the study showed that total scores of the sixth-grade students' graphical performances did not vary significantly considering gender. However, when the students' scores were examined for each component of the graphical language test individually, it was found that the students' scores in the Axis and Miscellaneous components varied significantly. This difference in the Axis component was found to be in favor of the girls, while it was in favor of the boys in the Miscellaneous component. Furthermore, there were significant correlations among the sixth-grade students' performances in graphical languages.

Keywords: Graphical Languages, Sixth-grade students' performances

Introduction

The increase in the number of graphics in our everyday life makes people exposed to information that requires them to decode these graphics. Graphics including graphs, maps, diagrams, tables, number lines, and flow charts are defined as visual representations and they are used for "storing, understanding and communicating essential information" (Bertin, 1983, p. 2). Although looking at and decoding these graphics are important, understanding what is given in the graphics and making decisions according to these understanding are also important (Tversky & Schiano, 1989). In fact, some researchers explain that graphics are seen as the easiest way to visually give information; however, they may be difficult because of their structure (Parmar & Signer, 2005). Because of its importance, the topic of graphics has gained researchers' attention and is accepted an important topic of elementary school mathematics curriculum (Ministry of National Education [MoNE], 2018). Many content strands, particularly, the data processing content strand can be said to be aiming to equip students with knowledge and skills related to graphics (MoNE, 2018; National Council of Teachers of Mathematics [NCTM], 2000). The topic of graphics is also important as it connects mathematics and science. McKenzie and Padilla (1986) explain the connection in the following way:

"In science, more than in any other subject, students should be involved in predicting relationships between variables and attempting to quantify these relationships. Line graph construction and interpretation are very important to science instruction because they are an integral part of experimentation, the heart of science" (p. 572).

- Selection and peer-review under responsibility of the Organizing Committee of the Conference

Since the graphical languages facilitate the understanding of the given data, they are helpful for students. Understanding these graphical languages is also important as students encounter tasks containing graphics when compared to the tasks in the past (Diezmann & Lowrie, 2008; Gagatsis & Elia, 2004).

Many researchers have examined the meaning of graphics and what is necessary for being accepted as graphics (Bertin, 1980; Fry, 1984; Guthrie, Weber, & Kimmerly, 1993). While Bertin (1983) explains that graphics are used to store, understand, and communicate the given data by means of visual representations, Fry (1984) states that graphics are used to transmit the given data by means of "line or area on a two dimensional surface" (p. 5). Although there are different types of graphics and different definitions of them, graphics in this article refer to the visuals or representations which contain the necessary information to solve the questions.

Mackinlay (1999) states that all kinds of graphics can be categorized into six different graphical languages and his categorization of graphical languages is used as the theoretical framework for this article. These graphical languages are Axis, Opposed-Position, Retinal List, Map, Connection, and Miscellaneous. The first of these graphical languages, Axis, is used to encode information by the position of a mark on a vertical or a horizontal axis. The second one, Opposed-Position, is used to encode information by marks on both vertical and horizontal axes. That is, while a student decodes the information just by focusing on either vertical or horizontal axis in Axis language, s/he decodes the information by looking both vertical and horizontal axes in Opposed-Position language such as line graphs and bar graphs. Retinal List, the third of the graphical languages, does not require students to focus on the mark(s) on axes. Since Retinal List language is related to rotation or reflection, it requires visualization. The fourth one, Map language, is used to encode information with respect to the coordinates and road maps and topographic maps are examples of it. Another graphical language, Connection, is used to encode information by means of the connections or links such as tree diagrams and family trees. The last one, Miscellaneous, requires to be able to interpret the different types of graphics such as pie charts and Venn diagrams.

Though some emphasis is put on knowledge and skills related to the graphical languages in curricula, it was found that decoding and understanding these graphics and graphical languages were difficult for students (McKenzie & Padilla, 1986). Students' difficulties can result from their readiness level, mathematical level, and the features of the graphical languages (Shah & Hoeffner, 2002). Being not successful in mathematics may result in interpretation difficulties of graphical languages (Gal, 1993). Furthermore, Roth and Bowen, (1994) emphasize that traditional mathematics classrooms in which students are not encouraged to discuss and explain their thinking can be another reason for their difficulties. Students with learning difficulties do not consider the graphics' features such as labels or axis and hence they cannot understand the purpose of these graphics (Parmer & Signer, 2005). For example, Parmer and Signer (2005) mention that even fourth and fifth-grade students have difficulties in focusing on the labels or in understanding the scale of the graphics. Furthermore, they think that if the scale of the graphics changes, then the results have to change which is not correct. Moreover, students' grade levels are not an important factor in their success in graphical languages (Berg & Philips, 1994). Although much is known about students' difficulties in different countries, according to our recent research on literature, there was no research investigating students' performances in graphical languages in Turkey. Thus, the aim of this study is to answer the following research questions.

1. Do the sixth-grade students' graphical language performances vary significantly depending on gender?
2. Are there any significant correlations between the sixth-grade students' performances in the six components of the graphical language?

Method

In order to investigate students' performances in graphical languages in Turkey and to examine whether or not a significant correlation among the components of the graphical languages exists, a quantitative research method was employed. Specifically, the current study employed a cross-sectional, descriptive survey design. The cross-sectional, descriptive survey studies are primarily used "to describe what is going on or what exists" (Trochim, 2001, p. 5). Similarly, survey studies are employed to show the present conditions considering different variables (Fraenkel, Wallen, & Hyun, 1993).

This study was conducted at three sixth-grade classes of an elementary school in Ankara, Turkey. Participants of the study, 97 sixth-grade students, were selected by convenience sampling method. Before delivering the instrument, the students were informed about the purpose of the study and confidentiality of their answers. To gather the data, a graphical languages test was adapted from Mackinlay's (1999) model of graphical languages.

Throughout the adaptation process, the sixth-grade objectives of mathematics curriculum of Turkey were considered. Before the pilot study, experts in mathematics education were asked to comment on the items to ensure content and face validity of the test. In the final version of the test, there were 18 questions related with all six different kinds of graphical languages involving 3 Axis, 3 Opposed-Position, 3 Retinal List, 3 Map, 3 Connection, and 3 Miscellaneous. The first of the questions for each graphical languages were easy, the second ones were medium, and the last ones were difficult. The authors of this paper, themselves, collected the data in case the participants of the study would ask questions related to the test items. The data was collected in normal class time and it took approximately 40 minutes for the students to answer the items. The items examining the sixth-grade students' performances in graphical languages were scored as correct or incorrect. As there were three items in each category, 3 is the maximum score for each category and 18 in total. The Statistical Packages for Social Sciences (SPSS) 23.0 were used to record and analyze the data collected via the test.

Results and Discussion

One of the purposes of the current study is to examine whether the sixth-grade students' graphical language performances vary significantly considering the students' genders. For this purpose, the Mann-Whitney U test was conducted as the data collected from the students were normally distributed.

Table 1. The students' graphical language performances based on gender

Gender	n	Mean Rank	Rank Sum	U	p
Girl	47	48.17	2264.00	1136.00	.776
Boy	50	49.78	2489.00		

As shown in Table 1, no statistically significant difference exists between boys and girls considering their graphical language performances in total, $U=1136.00$, $p>.05$. However, when their graphical language performances were examined for each component of the graphical language test, it was found there were significant differences between the students' performances in the Axis and Miscellaneous components based on their gender. In the tables below, Table 2 and Table 3, detailed Mann Whitney U test results for the students' performances in the Axis and Miscellaneous components, respectively, are shown.

Table 2. The students' performances in the Axis component based on gender

Gender	n	Mean Rank	Rank Sum	U	p
Girl	47	54.66	2569.00	909.00	.041
Boy	50	43.68	2184.00		

As it is seen in Table 2, there is a significant difference between the mean scores of the boys (Mean: 0.96) and girls (Mean: 1.3617) in the Axis component of the graphical language test, $U=909.00$, $p<.05$. When the mean ranks are considered, it is seen that the girls' mean score for the Axis component is higher than that of the boys.

Table 3. The students' performances in the Miscellaneous component based on gender

Gender	n	Mean Rank	Rank Sum	U	p
Girl	47	41,64	1957,00	829.00	.007
Boy	50	55,92	2796,00		

Contrary to the Axis component, the girls' mean score (Mean: 0.4681) in the Miscellaneous component is lower than that of the boys (Mean: 0.98) and this difference is statistically significant. That is, there is a significant difference between the boys' and girls' performances in the Miscellaneous components, $U=829.00$, $p<.05$.

Therefore, it can be concluded that there was a significant difference for the boys' and girls' performances in the Axis and Miscellaneous components of the graphical language test. But no significant difference was found considering the gender in the other components of the graphical language test (Opposed-Position, Retinal List, Map, and Connection).

The second purpose of the current study is to investigate whether or not there is a significant correlation between the sixth-grade students' performances among the six components of the graphical language. For this purpose, Spearman's Rank Correlation, one of the non-parametric tests was used, as the data were not normally distributed. The results are presented in Table 4.

Table 4. Correlations among the six components of the graphical language

Graphical Language Components	Axis	Opposed Position	Retinal List	Map	Connection
Axis					
Opposed Position	-.102				
Retinal List	.176	.005			
Map	.222*	.110	.116		
Connection	.028	.175	.144	.207*	
Miscellaneous	.131	.147	.139	.300**	.240*

* $p < .05$ level ** $p < .01$ level

As can be seen in Table 4, there is a low, positive, and significant correlation between the students' performances in the Map and Axis components of the graphical language test, $r=.222$, $p<.05$. Since the correlation is positive, it can be inferred that the students whose performances are high in the Map component would also perform better in the Axis component.

Similarly, there is a low, positive, and significant correlation between the students' graphical language performances in the Map and Connection components of the graphical language test, $r=.207$, $p<.05$. Thus, it can be inferred that with the students' increasing graphical language performances in the Map component, their graphical language performances in the Connection component would also increase.

There is a medium, positive, and significant correlation between the students' graphical language performances in the Map and Miscellaneous components of the graphical language test, $r=0.300$, $p<.01$. The students whose performances are high in the Map component would also perform better in the Miscellaneous component as the correlation between these two components is positive.

Moreover, there is a low, positive, and significant correlation between the students' graphical language performances in the Miscellaneous and Connection components of the graphical language test, $r=0.240$, $p<.05$. Thus, it can be inferred that with the students' increasing graphical language performances in the Miscellaneous component, their graphical language performances in the Connection component would also increase.

Conclusion

It was found that there is no significant difference between the boys' and girls' mean scores taken from the graphical language performance test. However, when the scores taken from each component were examined considering gender, it was found that significant difference occurred between the mean scores of the boys and girls for the Axis and Miscellaneous components. Contrary to the literature, this difference is in favor of the girls for the Axis component. Specifically, this difference was found to be in favor of boys in a study conducted by Lowrie and Diezmann (2005). Lowrie and Diezmann (2005) also found that there is no gender-based significant difference in the Miscellaneous component. However, in this study, there was a significant difference in the favor of boys in the Miscellaneous component.

Considering the second purpose of the study, it was found that there were positive and significant correlations between the students' performances in the Map and Axis, and Connection and Miscellaneous components. That is, the students whose performances are high in the Map component would also perform better in the Axis, Connection and Miscellaneous components. This finding is also valid for the Miscellaneous and Connection components. Some studies in the literature reported significant correlations among all the components of the graphical language (Lowrie & Diezmann, 2005, 2007). Thus, in general, it can be concluded that the development of knowledge and skills of one component would positively affect the other components. Thus, it can be suggested that teachers can plan activities that help students improve their knowledge and skills.

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Teachers' Knowledge and their Perceived Competency in Integrated STEM Concepts: Implications on National and Global Trends

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Abstract: This study was carried out to investigate science teachers' perceived competency and their knowledge in the implementation of Integrated STEM in Gusau Local Government of Zamfara State, Nigeria. Descriptive and causal non-experimental design was adopted for the study. Three research questions were raised and answered using descriptive statistic, while Analysis of Variance (ANOVA) and t-test were used in testing the formulated hypotheses at $P<0.05$ probability level. The data was collected using two research instruments; Perceived Competency Questionnaire (PCQ) and Performance Test on Integrated STEM (PTIS) which were validated by experts and have reliability coefficient of 0.78 and 0.81 respectively. Both were administered to 37 science teachers who were purposively sampled from two Science and one Technical school in Gusau. The findings revealed that, the perception held by science teachers about their competence in implementing Integrated STEM curriculum at secondary school level was relatively high. However, difference was found between their perceived competency and their performance in Integrated STEM unit, and this varies according to their subject specializations. It was recommended that, government should look into the possibility of introducing Integrated STEM curriculum in Nigerian schools and also train science teachers in that regard so as to align them with global trends in STEM education.

Keywords: Science teachers, Perception, Competency, Integrated STEM

Introduction

The global trends in science teaching in recent time have been geared towards advancing the integration of science discipline as a result of national and international economic, social, and political demands. This has led to what is now branded as Science, Technology, Engineering and Mathematics (STEM) education. The essence of STEM education is to prepare the 21st century workforce with STEM education and its related activities so that students can take what they learn in the classroom/laboratory and apply it to their future jobs in the real world (Ejiwale, 2013). Also, Okpala (2012) asserted that, STEM education is needed to produce global citizens. The contribution of STEM to social, industrial and economic life of the world in general and Nigeria in particular have been felt on all phases of human life (Ikeobi, 2010 cited in Ugo and Akpoghol, 2016). Hence, any nation which fails to adequately consider STEM education has planned to be left behind in all spheres of development (Ugo and Akpoghol, 2016). STEM integration has been an area of interest since it was first addressed in education in the United States in the early 1990s (Quang et. al., 2015). Nations are now investing huge amount of capital in designing an enhanced curriculum that recognizes interdisciplinary approach to science teaching and giving more emphasis on teachers' competency in the delivery of such curriculum in the production of workforce in STEM careers.

- Selection and peer-review under responsibility of the Organizing Committee of the Conference

One of the problems identified as a barrier to STEM education was the perception that, STEM education consists only of the two bookends – science and mathematics (Lantz, 2009). By definition, STEM education is a "meta-discipline" and this means the "creation of a discipline based on the integration of other disciplinary knowledge into a new 'whole' rather than in bits and pieces (Okpala, 2012 and Ejiwale, 2013). Morrison (2008) and Tsupros, Kohler and Hallinen, (2009) contends that, STEM education is an interdisciplinary approach to learning by integrating the four disciplines (Science, Technology, Engineering and Mathematics) into one cohesive teaching and learning paradigm. The aim of this integration is to remove the traditional obstruction between the four disciplines (Morrison, 2008). The National Research Council (NRC, 2001) defined each components of STEM as thus;

- **Science** is the study of the natural world, including the laws of nature associated with physics, chemistry, and biology and the treatment or application of facts, principles, concepts, or conventions associated with these disciplines.
- **Technology** comprises the entire system of people and organizations, knowledge, processes, and devices that go into creating and operating technological artifacts, as well as the artifacts themselves.
- **Engineering** is a body of knowledge about the design and creation of products and a process for solving problems. Engineering utilizes concepts in science and mathematics and technological tools.
- **Mathematics** is the study of patterns and relationships among quantities, numbers, and shapes. Mathematics includes theoretical mathematics and applied mathematics (NRC, 2001).

Existing literature reports shows no clear consensus among researchers and curriculum developers as to the approach of teaching STEM concepts in secondary schools. However, there are three most reported approaches/models that are being practice. They are ***Silo****;* instruction within each individual STEM subject, ***Embedded***; technology education content is emphasized, and ***Integrated***; the walls between each of the STEM content areas and teaching them as one subject are remove (Roberts and Cantu, 2012). Proponents of STEM education suggested that integration is the best approach for STEM instruction (Roberts and Cantu, 2012; Lantz, 2009; NRC, 2012).

Several reports and research findings have revealed that, when STEM concepts are integrated rather than in unconnected entities, the curriculum offers the best opportunities for students to be creative in solving real world complex problems (Roberts and Cantu, 2012; Lantz, 2009; NRC, 2012). This has been the current global trend in STEM instruction. Although, the Federal Government of Nigeria (FGN) in the National Policy on Education (2004) came up with some policies that were meant to develop and promote the teaching and learning of STEM at various levels (Opkala, 2012), the policies however lacks explicit integration of STEM subjects as an interdisciplinary curriculum framework. In the policy, the STEM remained recognized as an isolated discipline-specific *(Silo-approach).*

Consequently, the teachings of STEM in Nigerian secondary schools is continuously under represented by being taught separately, dominated by Science (S) (biology, chemistry and physics) and Mathematics (M) with some element of Technology (T) that is largely restricted to computer (some sort of embedded approach) while Engineering (E) is completely neglected. With the emergence of a new world order called globalization (Opkala, 2012) and its demands, Nigerian STEM teachers need to keep abreast of the global trends on how STEM discipline-specific being integrated in order to prepare students for a career in line with the 21^{st} century demands. The 21^{st} century challenges such as overpopulation, emerging health issues, declining energy and water sources, floods, earthquakes, climate change, collapse buildings, fire outbreaks, food supply crisis etc. are complex and therefore require interdisciplinary approach.

To effectively implement Integrated STEM education in secondary schools, teachers' content knowledge is very important for its success, likewise their perception about their pedagogical competency in delivering such curriculum. Because, integrating concepts across the four STEM disciplines is challenging when teachers lacks confidence and have little or no understanding of the related ideas in each disciplines due to lack of structure within the lesson. It's from this perspective that this study was conceived; to investigate the level of teachers' preparedness in implementing integrated STEM curriculum, by examining their perceived competency in relation to their knowledge in integrated STEM unit in Gusau, Zamfara State.

Purpose of the Study

To find out the level of teachers' preparedness in implementing integrated STEM curriculum, by examining their perceived competency in relation to their knowledge of STEM.

Study Area

Gusau is a Local Government and the capital of Zamfara State, Nigeria. Of all the public secondary schools owned by Zamfara state, 74 (38.74%) are located in Gusau Zone. There are 28 public secondary schools in Gusau zone; three out of these schools (two sciences and one technical) are under the management of Science and Technical Education Board. Gusau has the highest secondary school enrolment in the state. Also, there exist quite a number of privately owned secondary schools

Objectives of the Study

The study was guided by the following objectives

i. To determine science teachers' perception about their competence in implementing integrated approach to STEM curriculum.
ii. To determine science teachers' performance in STEM curriculum when integrated as a discipline.
iii. To compare science teachers' perceived competency and their performance in integrated STEM curriculum.

Research Questions

The study provided answers to the following questions

i. How do science teachers perceived their own competence in implementing an Integrated STEM curriculum at secondary school level in the study area?
ii. What is the performance of science teachers in teaching Integrated STEM curriculum on the basis of their area of specialization in the study area?
iii. Are there any differences between science teachers' perceived competency and their performance in STEM when integrated as a unit in the study area?

Research Hypotheses

Two null hypotheses were formulated and tested at 0.05 level of significance

i. There is no significant difference in science teachers' performance on the basis of their knowledge of integrated STEM concepts.
ii. There is no significant difference in the mean scores of science teachers' perceived competency and their performance in integrated STEM curriculum.

Scope of the Study

Only science teachers teaching in Science and Technical schools in Gusau Local Government Area were considered for the study. In content terms, the study only determined the perceived competency and performance of science teachers in Integrated STEM unit "Waste Management and Recycling" designed by the researchers.

Significance of the Study

This study has the following significance:

i. It will establish science teachers' level of preparedness in teaching STEM in an integrated approach at secondary school level.
ii. It will enlighten the curriculum planners to look into the possibility of designing syllabus/programmes that will embrace STEM integration at secondary school level.
iii. The findings of this study will provide information to Government/policy makers on the training needed for effective implementation of Integrated STEM curriculum in order to align with global trends.

Method

This study adopted a descriptive and causal non-experimental design (Sagadin, 1993). The design is suitable for describing and interpreting the prevailing opinions, knowledge, practices or trends that are developing. The population of the study encompassed all science teachers of the two Science and Technical schools in Gusau, Zamfara State. Using purposive sampling technique, 37 teachers were sampled and used for the study. Two research instruments were developed and validated. The instruments are Perceived Competency Questionnaire (PCQ) and Performance Test on Integrated STEM (PTIS), aimed at generating data on teachers' perceived competency and knowledge of Integrated STEM unit respectively. A trial test was conducted to determine the reliability of the instruments using test-retest method. The coefficient of 0.78 and 0.81 were obtained for PCQ and PTIS respectively these indicated the reliability of the instruments.

To construct items for PTIS, an Integrated STEM unit on "Waste Management and Recycling" was purposely developed for the study. Thereafter, 30 test items were constructed from it, comprising fifteen (15) items in science (i.e. 5 items in biology, chemistry and physics each) while Technology, Engineering and Mathematics have 5 items each. The unit posed a 21st century problem and solution concerning waste in our immediate environment using STEM interdisciplinary approach. PCQ on the other hand, contained 10 items on teachers' self perceived competency in implementing Integrated STEM curriculum. Both PTIS and PCQ were administered to the same participants at separate days, and were returned completed. Descriptive statistic was used to answer the research questions raised while the research hypotheses were tested using Analysis of variance (ANOVA) and t-test. The mean response was used to analyse the data generated from the questionnaire. In order to determine the degree of agreement/disagreement in each of the scaling statements in the items, nominal values of 3 to 1 were assigned to the different scaling statements where 3 was for yes, 2 for undecided, and 1 for No. Consequently, any response with a mean of 2.0 or more was regarded as "Yes" and any response that was below 2.0 was regarded as "No".

Results and Discussion

The data collected from the study were analysed and presented in the tables below according to the research questions and hypotheses.

Research Question One: How do science teachers perceived their own competence in implementing Integrated STEM curriculum at secondary school level in the study area?

Table 1. Perception of science teachers on their competency in implementing an Integrated STEM curriculum

S/N	Items	Response categories			Mean
		Yes	Undecided	No	
1	I can teach other science subjects aside my area of specialization	32	2	3	2.778
2	I can teach mathematics and its applications in solving daily life problems	23	11	3	2.528
3	I can teach engineering concepts at secondary school level	11	18	8	2.056
4	I can teach technology at secondary school level	32	5	0	2.861
5	I can incorporate engineering concepts with other science subjects	13	11	13	1.972
6	I can design lessons/modules that can solves real life problem through the integration STEM concepts	20	14	4	2.472
7	I can select related supplementary resources for teaching Integrated STEM concepts	32	3	2	2.806

8	I can easily link all the STEM concepts in solving real life problem in a classroom setting	30	5	2	2.750
9	I can apply multiple teaching strategies for teaching Integrated STEM concepts	18	11	8	2.250
10	Lack of computer knowledge can limit my understanding of how STEM concepts can be interconnected	9	19	9	2.250
	Cumulative mean				***2.503***

Standard/decision mean = 2.000

Table 1 shows that, the competency level of the science teachers on their ability to teach STEM in an interdisciplinary approach was relatively high. This is because their cumulative mean competency level of 2.503 is higher than the standard/decision level of 2.000.

Specifically, majority of the respondents affirmed that they can conveniently teach technology at secondary school because of the qualifications they have. This item had the highest mean response of 2.861, where only 5 of the respondents were undecided while the remaining total of 32 respondents believed that "they can teach technology at secondary school level". Similarly, majority of them agreed that they can select related supplementary resources for teaching Integrated STEM as this item attracted their second highest mean competency level of 2.806 as details shows that while a total of 32 said "Yes", 3 were undecided and 2 that said "No".

Research Question Two: What is the performance of science teachers in teaching Integrated STEM unit on the basis of their area of specialization in the study area?

Table 2. Descriptive statistics on performance of science teachers in STEM concepts when integrated

Science Teachers	N	Mean	Std. Deviation	Std. Error
Biology	11	33.7500	9.79311	3.89656
Physics	7	37.2857	2.42997	.91844
Chemistry	6	38.2353	2.33263	.56575
Mathematics	8	45.1250	5.76783	2.03924
Others	5	73.8675	5.99783	2.09924
Total	37	43.0278	8.95859	1.49310

Table 2 shows that, the computed performance level of biology, physics, chemistry, mathematics and others science teachers are 33.75, 37.28, 38.23, 45.12 and 73.86 respectively. This shows that, differences exist among the science teachers in their performance in the Integrated STEM unit.

Research Questions Three: Are there any differences between science teachers' perceived competency and their performance in STEM when integrated as a unit in the study area?

Table 3. Difference between science teachers' perceived competency in implementing integrated STEM and their performance in Integrated STEM unit

Variable	N	Mean	Std. Deviation	Mean Difference
Perceived Competency	37	67.972	8.603	
Performance	37	43.027	3.958	24.945

Table 3 above shows that there is difference in the mean scores of science teachers' perceived competency and their actual performance in STEM when integrated as a unit. From the result, the mean competency score is 67.972 with Standard deviation of 8.603 as against their performance tests scores with a mean of 43.027 and Standard deviation of 3.958. This implies that science teachers' perceived competency is higher than their performance.

Hypothesis One: There is no significant difference among science teachers' in their performance on the basis of their knowledge of STEM concepts when integrated as a unit.

Table 4. Analysis of Variance (ANOVA) of science teachers' performance on the basis of their knowledge level in Integrated STEM unit

Source of Variance	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1882.860	3	627.620	21.686	.000
Within Groups	926.112	32	28.941		
Total	2808.972	35			

Table 4 reveals that, significant difference exist in the respondents' performance on the basis of their knowledge on STEM concepts when integrated. Reason being that, the calculated p-value of 0.000 is lower than the 0.05 alpha level of significance and the computed F-value of 21.686 is greater than the 2.60 F critical value. Therefore, the study rejects the null hypothesis and concludes that there is significant difference ($P>0.05$) among science teachers' in their performance on the basis of their knowledge of STEM concepts when integrated.

Hypothesis Two: There is no significant difference in the mean scores of science teachers' perceived competency and their performance in STEM when integrated as a unit.

Table 5. Paired sample t-test statistics on difference in the mean scores of science teachers' perceived competency and their performance in STEM concepts when integrated

Variable	N	Mean	SD	df	t-value	t-crit	P-value
Perceived Competency	37	67.972	8.603	36	12.36	1.96	0.00
Performance	37	43.027	3.958				

P > 0.05, t computed < 1.96 at df 36

Table 5 results shows that, the t-value computed is 12.36 and the p-value of 0.00 was observed at the df of 36. Since the p-value of 0.00 is less than the alpha value of 0.05, there is a significant difference between science teachers' perceived competency and their actual performance in Integrated STEM unit. Therefore, the null hypothesis which stated that there is no significant difference in the mean scores of science teachers' perceived competency and their performance in STEM when integrated is hereby rejected.

From the finding in Table 1, the study reveals that science teachers have high confidence in their competence of being able to teach STEM concepts when integrated in order to solve real life global problem that is confronting their immediate environment. This finding could serve as an indication of science teachers' readiness in teaching STEM subjects in an integrated approach. This finding supported Bybee (2013) study, who investigated challenges and opportunities of STEM concept integration. The author found that, teachers revealed high perception of confidence in their competency in implementing Integrated STEM curriculum model. Table 2 shows that, differences exist among the science teachers' performance in Integrated STEM test, which was found to be significant as revealed in table 4. This reveals that, science teacher will tend to put more weight in their respective area of specialization while other STEM concepts outside their subject areas will not be properly taught. Similar result was found by Tsupros et al. (2009) in Pennsylvania. The finding is also affirmed the assertions of Morrison (2006) and Lantz (2009) that, science teachers do better in the area of their disciplines when implementing an Integrated STEM curriculum. Table 3 and 6 compared the perceived competency and performance of the respondents in Integrated STEM unit test, and all the findings in the two tables show a significant difference.

Implications on National and Global Trends

The perception held by science teachers in the study area about their competency and knowledge on Integrated STEM is not supported by the findings of this study. Since, of all the approaches for STEM instruction in schools, integration model is more emphasized globally at present. Therefore, for science teachers in the study area to keep abreast of the global trends in STEM education, they need to be trained on the interrelatedness of STEM disciplines for them to be able to prepare future generation (students) to face 21st century challenges that are complex and requires interdisciplinary in approach. Understanding science teachers' perception and their knowledge about how the world works within the four disciplines to tackle real world problems will help in identifying the intervention needed to keep them on track of what is obtainable globally.

Conclusion

From the findings of this study, it can be concluded that science teachers over rated their competency and knowledge on Integrated STEM since significant difference was found between their perception and actual performance in items designed from an Integrated STEM unit. Science teachers also scored better in items related to their specific STEM disciplines.

Recommendations

The following recommendations are hereby put forward

1. Government should collaborate with science teachers' professional bodies such as STAN to look into the possibility of introducing an Integrated STEM curriculum in Nigerian schools in order to align with global trends.
2. Adequate training and re-training should be provided to science teachers on recent approaches of STEM instruction in a classroom setting that can address national and global challenges.

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Examintion of Integrated Stem Education in Physics: Students' Attitude towards Stem

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Abstract: In this study, effects of STEM Education on the attitudes of students towards STEM education was examined. In the first semester of the 2018-2019 academic year, the study was carried out with 65 students attending the 7th grade of a public school in Istanbul. The experimental group consisted of 31 students and the control group consisted of 34 students. STEM course was conducted between 28 November and 11 January. In this research, pre - test post - test experimental design with control group was used. STEM Attitude Scale was used as data collection tool. This scale was applied to both groups as a pre-test and then a post-test to measure and compare the effect of STEM activities. When the quantitative data were analyzed, it was seen that integrated STEM education had a positive effect on STEM attitudes of students.

Keywords: STEM education, Physics

Introduction

In recent years, the need for individuals who think, question, produce and have critical thinking skills, that is, 21st century skills that can do what machines cannot do, has increased in recent years. 21st century skills include high-level skills and learning dispositions that students need to develop in order to be successful in this age of easy access to information. These skills are deemed necessary by educators, business leaders, academics and government agencies in 21st century society and business.

Especially the applications of advanced technology and advanced science and the training of individuals who will work and produce in these fields are important in terms of country policies. Considering the countries producing in this field, one of the reasons why our country is in the background can be said to be the lack of high level labor force (Cil & Cepni, 2017). In order to eliminate this high level of labor force and to increase global competitiveness, generations capable of producing solutions to the problem and blending technology with their knowledge should be raised. All these needs have led to new reforms in education. STEM training is an approach developed for this need.

The term STEM education refers to teaching and learning in the fields of science, technology, engineering and mathematics (Gonzalez & Kuenzi, 2012). STEM education approach aims to make the students competent in all these disciplines. In order to produce solutions to the daily life problems of the students, they work together in an engineering design process and produce and implement different strategies.

Obama, who was the US president in 2010, also expressed his ideas about how future leadership will be shaped in parallel with how students are educated especially in STEM fields and pointed out the importance of STEM. Dincer (2014) reported that in 2041, our working-age population will increase to 65 million, and that in order to transform this potential into a potential to provide innovation, STEM education in general and overall education should be improved. Corlu, Capraro and Capraro (2014) published articles on the reflections of STEM training on field teacher training and examined the ongoing innovation initiatives in the field of education in Turkey and in the world. They emphasized that the fact that teachers have only knowledge in their own fields will be insufficient to raise the human potential needed for the development of our country. This shows that the traditional teaching approach is not sufficient and there is a need for an STEM approach that links the subject with more than one discipline.

Methodology

The aim of this study was to examine the effects of integrated STEM education on students' attitudes towards STEM and to contribute to the proper implementation of STEM education in our country. Pre-test post-test experimental design with control group was used. The study group consisted of two 7th grade students in a public school in Istanbul. The experimental group consisted of 31 students (19 boys, 12 girls) and the control group consisted of 34 students (19 boys, 15 girls). In the first semester of the 2018-2019 academic year, the study was carried out in two branches in the 7th grade in Anatolian district of Istanbul. STEM course was conducted between 14 November and 11 January. Each STEM course activity was 90 minutes (2 course hours) with four STEM activities. STEM attitude scale was applied to control and experimental groups before and after the STEM integration.

Results

The findings related to the participants' attitudes before and after the STEM education are presented with tables.

Table 1. Experimental group's dependent T-Test results

Group	N	x̄	sd	df	t	p	Cohen's d
Experimental (Pre-Test)	30	4.2798	0.43812	29	3.637	0.001	0.6641
Experimental (Post-Test)	30	4.4929	0.40421				

Table 1 shows the experimental group STEM attitude scale dependent t test results. In this application, the p value of t-test was found to be 0.001 for the related samples which tested whether there was a difference between the STEM attitude questionnaire scores applied before and after STEM training in physics subjects. As $p < 0.05$, a statistically significant difference was observed between the total scores of the pre-test and post-test measurements. Therefore, there was significant difference between the STEM attitude pre-test and post-test scores of the experimental group students in which STEM education was applied.

Table 1. Groups' independent T-Test results before the application

Group	N	x̄	ss	sd	t	p
Experimental	31	4,2753	0,43146	63	0,696	0,485
Control	34	4,2080	0,33818			

When Table 2 was examined, it was found that the p value of the t-test was 0.485 for the independent groups that determined whether there was a difference between the STEM attitude test pre-test mean scores of the experimental and control groups before the application. Since $p > 0.05$, the hypothesis that there was no difference between the averages of the groups was accepted. Accordingly, no statistically significant difference was found between the averages of the groups.

Table 3.Groups' independent T-Test results after the application

Group	N	x̄	ss	sd	t	p
Experimental	30	4,4929	0,40421	62	4,08	0,000
Control	34	4,0910	0,38146			

According to Table 3, it was found that the p value of t test is 0.000 for independent samples which determine whether there was a difference between the STEM attitude test pre-test mean scores of the experimental and control groups before the application. Since $p < 0{,}05$, the hypothesis that there was a difference between the means of the groups was accepted. Accordingly, a statistically significant difference was found between the averages of the groups.

Table 2 .Control group's dependent T-Test results

Group	N	x̄	sd	df	t	p	Cohen's d
Control (Pre-Test)	34	4.2080	0.33818	33	-1.529	0.136	0.2622
Control (Post-Test)	34	4.1891	0.38801				

As it is seen in Table 4, the p value of the dependent sample t test which determines whether there was a difference between the pre-test and post-test scores of the STEM Attitude Questionnaire applied to the control group was found to be 0,136. As p> 0.05. No statistically significant difference was observed between the total scores of the pre-test and post-test measurements.

Table 3. Dependent T-Test results of STEM attitude scale for experimental group

Group		N	x̄	sd	df	t	p	Cohen's d
Experimental	Relationship between Mathematics and Science Learning STEM Post Test	30	4,4722	,44653	29	2,355	,025	0,4299
	Relationship between Mathematics and Science Learning STEM Pre Test	30	4,2833	,46352				
Experimental	Engineering Learning Post Test	30	4,5333	,51118	29	4,778	,000	0,872
	Engineering Learning Pre Test	30	4,1778	,61888				
Experimental	Personal and Social Implications Post Test	30	4,3458	,50609	29	1,773	,087	0,323
	Personal and Social Implications Pre Test	30	4,2042	,62239				
Experimental	Technology Learning Post Test	30	4,4250	,48312	29	1,309	,201	0,2389
	Technology Learning Pre Test	30	4,3167	,54903				

In Table 5, t-test results of STEM attitude scale sub-factors are given. It is seen that there was a statistically significant difference between the pre-test and post-test scores of the experimental group in relation to

Mathematics and Science Learning and STEM (t = 2,355; p <0.05). There was a statistically significant difference between pre-test and post-test mean scores of Engineering Learning and STEM (t = 4,778; p <0.05). A significant difference was found between STEM's Personal and Social Implications and the pre-test and post-test mean scores in favor of the post-test (t = 1,773; p> 0.05).

There was no statistically significant difference between pre-test and post-test mean scores of Technology Learning and Use (t = 1,309; p> 0.05). The highest increase was related to Engineering Learning and STEM, and the least increase was seen in Learning and Use of Technology factors.

Table 4.Dependent T-Test results of STEM attitude scale for control group

Group		N	x̄	sd	df	t	p	Cohen’s d
Control	Relationship between Mathematics and Science Learning STEM Post Test	34	4,0784	,48762	33	-1,391	,174	-0,238
	Relationship between Mathematics and Science Learning STEM Pre Test	34	4,1176	,40728				
Control	Engineering Learning Post Test	34	4,1225	,50803	33	-,387	,701	-0,066
	Engineering Learning Pre Test	34	4,1324	,43958				
Control	Personal and Social Implications Post Test	34	4,1618	,56620	33	-1,719	,095	-0.016
	Personal and Social Implications Pre Test	34	4,1949	,51234				
Control	Technology Learning Post Test	34	4,2206	,47180	33	,442	,661	-0,796
	Technology Learning Pre Test	34	4,2059	,45838				

Regarding Table 6, there was no statistically significant difference between the pre-test and post-test mean scores of the control group Relationship between Mathematics and Science Learning and STEM (t = -1.391; p> 0.05). There was no statistically significant difference between pre-test and post-test mean scores of Engineering Learning and STEM (t = -0.387; p> 0.05). There was no statistically significant difference between the pre-test and post-test mean scores of ‘Personal and Social Implications’ in favor of the post-test (t = -1.719; p> 0.05). There was no statistically significant difference between pre-test and post-test mean scores of Technology Learning and Use (t = 0.442; p> 0.05). When the mean of sub-factors of STEM attitude scale applied in the control group was examined, it was seen that there was no increase in favor of the post-tests.

Conclusion

It was found that there was a significant difference in favor of the post-test between the pre-test and post-test scores of the group before and after STEM training. Accordingly, STEM education positively affects students' STEM attitudes. Findings obtained from voice recordings also support that STEM attitudes of students were positively affected. The most increasing sub-factor of the scale is engineering education and this shows that STEM activities have a positive effect on engineering learning. Other sub-factors positively influenced by STEM activities are mathematics and science learning and their relationship with STEM, STEM personal and social implications, and technology learning and use. Furthermore, it is seen that STEM activities show the least positive increase in technology learning and use of. As expected, there is no change in STEM attitudes of students who do not receive STEM education.

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Critical Reflection in Teaching and Learning Mathematics towards Perspective Transformation: Practices in Public and Private Schools

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Abstract: The study investigated the practices in critical reflection being employed in teaching and learning mathematics in public and private schools for students to achieve perspective transformation in psychological, convictional and behavioral dimensions. There were 1,969 senior high school and college student-respondents selected at random from 33 schools. Process reflection was most commonly practiced in both public and private schools. Convictional dimension of perspective transformation was most frequently achieved. There was no significant difference in practices of process reflection between senior high school and college students. However, there was significant difference in perspective transformation in behavioral dimension achieved by students from public and private schools. Also, there were significant differences in psychological, convictional and behavioral dimensions of perspective transformation achieved by senior high school and college students. There was high and significant relationship between critical reflection practices and perspective transformation of students. The researcher concluded that there were teaching strategies like discovery learning that facilitated critical reflection, and that there were learning activities like technology-based problem solving that altered students' perspective of mathematics as an abstract field. The researcher further concluded that consistent use of appropriate teaching and learning activities could bring about perspective transformation in students with success.

Keywords: Critical reflection, Perspective transformation, Process reflection, Convictional dimension, Teaching and learning mathematics

Introduction

During the school year 2011-2012, the Philippines implemented the Kindergarten Education Act that made kindergarten mandatory for all school children before their entry to elementary. In the following school year, 2012-2013, Grade 7 in the K (Kinder) to 12 Basic Education Curriculum of the Philippines was implemented. Pupils admitted in Grade 7 during the said school year were the first to experience senior high school when it was implemented for the first time in the history of Philippine Education.

Thus, in the school year 2016-2017, Grade 11 was implemented in public and private schools across the Philippines. By the end of the school year 2017-2018, the Philippines produced the first batch of senior high school graduates under the K to 12 Basic Education Curriculum that is very promising in many aspects.

The Department of Education of the Philippines claims that the K to 12 Basic Education Curriculum is value-driven, competency-based, decongested, seamless, responsive, relevant, flexible, contextualized, and Information and Communications Technology-based, among many other features. In particular, pedagogical approaches that teachers employ in the implementation of the said curriculum are constructivist, inquiry-based, collaborative, integrative, and *reflective* (Ocampo, 2014).

Transformative Learning Theory of Mezirow

The researcher thought that the implementation of K to 12 Basic Education Curriculum of the Philippines offers great opportunities for mathematics teachers to transform the perspective of Filipino students towards

- Selection and peer-review under responsibility of the Organizing Committee of the Conference

mathematics as an abstract field of study. From the researcher's own personal experience as mathematics teacher, majority of Filipino students have fear of mathematics and they find it most difficult to overcome what is popularly known as math anxiety. Hence, the researcher was motivated to undertake a study on how the implementation of K to 12 Basic Education Curriculum has helped change the perspective of Filipino students towards mathematics through *critical reflection*.

According to the theory of transformative learning of Jack Mezirow (2000), learners have to be engaged in learning activities that would encourage them to go through critical reflection. It is critical reflection that can bring about perspective transformation among learners, and it is through learning that perspective transformation can be achieved. Hence, it is in the teaching and learning process that teachers can take the significant role of facilitating perspective transformation through the practices they employ in their classes.

Furthermore, perspective transformation can occur in three dimensions, namely, psychological, convictional and behavioral dimensions. Learners who achieve perspective transformation in psychological dimension demonstrate changes in self-awareness and self-understanding; those learners who achieve perspective transformation in convictional dimension demonstrate changes in beliefs; and learners show evidences of changes in habits and actions when they achieve perspective transformation in behavioral dimension.

In the case of teaching and learning mathematics, there are three ways by which leaners can interpret their experiences through reflection with facilitation provided by teacher. These are through content reflection, process reflection and premise reflection. In content reflection, learners should be made to be aware and to understand what they are doing that lead ultimately to their outcome. In process reflection, learners should reflect on strategies they employ that worked and that did not worked. Premise reflection involves questioning the activity itself or the problem itself, where learners should be able to tell why the activity or solving the problem is relevant for them.

Statement of the Problem

Primarily, the study was conducted to probe into the practices in teaching and learning mathematics that employ critical reflection in terms of content reflection, process reflection and premise reflection. By identifying the practices of teachers in teaching mathematics, the study sought to find out how perspective transformation of students was facilitated in learning mathematics in terms of psychological, convictional and behavioral dimensions.

Since student-respondents came from senior high school and tertiary levels in public and private schools, the researcher determined whether there were significant differences in the experiences of student-respondents in terms of perspective transformation achieved in three dimensions, as well as in terms of three types of reflection that facilitate perspective transformation.

Finally, the researcher wished to establish whether there was significant relationship between practices in critical reflection and perspective transformation achieved by student as facilitated by teachers in teaching and learning mathematics.

Method

The researcher employed the descriptive research design that permitted construction and validation of researcher-made questionnaire. The questionnaire was a Likert-scale questionnaire that consisted of six categories of indicators, and each category had five indicators. For meeting the purpose of the study, student-respondents were senior high school and college students. So as not to discriminate among senior high school and college students, actual respondents were selected randomly. Data gathered by survey method were analyzed statistically using Statistical Package for Social Sciences (SPSS).

Respondents of the Study

The study was conducted during the second quarter of the school year 2017-2018 when Grade 12 of the K to 12 Basic Education Curriculum of the Philippines was first implemented. There were a total of 1,969 student-respondents who participated in the study, of which 613 students were from public schools and 1,356 students were from private schools. Moreover, student-respondents came from 33 schools, mostly from the South of Metro Manila, of which 1,232 were senior high school students and 737 were college students.

The sample of college student-respondents were among the last batch of students who entered college without completion of senior high school. On the other hand, the sample of senior high school student-respondents were among the first batch of students who would enter college with diploma in senior high school.

Statistical Treatment of Data

To summarize the ratings of respondents, mean was computed for each indicator and was interpreted accordingly. Using 5% level of significance, independent t-test was utilized to determine if there were significant differences in experiences in content, process and premise reflection between students in public schools and students in private schools. The same parametric test was used to determine if there were significant differences in experiences in content, process and premise reflection between senior high school students and college students.

To determine whether there were significant differences in perspective transformation achieved in terms of psychological, convictional and behavioral dimensions between students from public schools and students from private schools, as well as between senior high school students and college students, independent t-test was also used at 5% level of significance.

The relationship between practices in critical reflection being employed in teaching and learning mathematics and the perspective transformation achieved by student-respondents was obtained by Pearson r Product-Moment Correlation Coefficient. The test for significance of computed Pearson r was carried out using 5% level of significance.

Results and Discussion

In terms of content reflection, use of discovery learning and customized classroom activities with mean rates of 3.79 and 3.77, respectively, are "Often" practiced in public and private schools. Student-respondents said that discovery learning makes them aware of their confusion with mathematical rules; while customized classrooms activities are appreciated by students because they address their individual weaknesses in mathematics.

Common practices for process reflection in public and private schools include allowing students to listen to how others solve problems and allowing students explain their work, with mean rates of 3.81 and 3.78, respectively, which meant that these practices were "Often" employed by teachers. According to student-respondents, listening to other students helped them see the differences in approaches in problem solving; while explaining their work helped them see what they are doing right and what they are doing wrong.

In terms of premise reflection, teachers "Often" practiced students' assessment of mathematical rules in problem solving and students' evaluation of a mathematical activity's significance in real life with mean rates of 3.80 and 3.73, respectively. By assessing the importance of mathematical rules, student-respondents said that it helped them arrive at correct solution; while evaluating the significance in real life what students do in mathematics class help them appreciate mathematics better.

To facilitate perspective transformation in psychological dimension, common practices in public and private schools included the use of team work and active participation of students in group or in class with mean rates of 3.81 and 3.79, respectively, which meant that these practices were "Often" employed in teaching and learning mathematics. In team work, students were assigned task, role and responsibility according to their ability. It was in this way that student-respondents became aware of what they were capable of doing that improved their expectation for success and, consequently, their self-confidence. Through actively participating in class, student-respondents said that this practice made them to think aloud and to be aware of how they think.

For perspective transformation in convictional dimension, provision of proper guidance by either the teacher or responsible peer and use of collaborative learning with mean rates of 3.88 and 3.81, respectively, were "Often" practiced in teaching and learning mathematics in public and private schools. Result implied that teachers could be influential and could have great impact in changing the beliefs of students who only need to be guided properly. Student-respondents confirmed this with their highest appreciation for proper guidance provided to them by their teachers. The impact of collaborative learning could not be underestimated for it could inspire students to think differently when they learn with their peers.

Utilization of technology-supported mathematics exercises and provision of mathematics activities that challenge students to be creative and innovative with mean rates of 3.82 and 3.80, respectively, were “Often” practiced in public and private schools to facilitate perspective transformation of students in behavioral dimension. Learners nowadays are into computer games, gadgets and internet. Teachers’ use of technology was very much appreciated by student-respondents. It helped them develop habits in using technology to better understand and learn mathematics. Student-respondents love to be creative and innovative, and they appreciated activities in mathematics that helped them better express themselves and their thoughts through creativity and innovativeness, that also helped in formation of good habits.

In general, with the highest mean rate of 3.76 process reflection was most commonly practiced in both public and private schools. Among the three dimensions of perspective transformation, student-respondents most frequently achieved perspective transformation in convictional dimension with the highest mean rate of 3.81. More generally, critical reflection, with overall mean rate of 3.74, was “Often” practiced in teaching and learning mathematics in public and private schools. Perspective of student-respondents towards learning mathematics was “Often” transformed, with overall mean rate of 3.78, through practices in critical reflection.

Differences in Practices in Critical Reflection

Table 1 below summarized the comparisons of practices in critical reflection between public schools and private schools. Specifically, Table 1 showed the results of independent t-tests at 5% level of significance for the said comparisons.

Table 1. Differences in Practices in Critical Reflection between Public and Private Schools

Reflection	School	N	Mean	SD	t-value	p-value	Decision on H_o	Conclusion
Content	Public	613	3.74	0.73	-0.38	0.70	Accept H_o	Not Significant
	Private	1356	3.75	0.68				
Process	Public	613	3.72	0.68	-1.63	0.10	Accept H_o	Not Significant
	Private	1356	3.78	0.69				
Premise	Public	613	3.67	0.71	-2.34	0.02	Reject H_o	Significant
	Private	1356	3.75	0.70				
Critical	Public	613	3.71	0.60	-1.71	0.09	Accept H_o	Not Significant
	Private	1356	3.76	0.59				

The results confirmed that process reflection was commonly practiced in both public and private schools. It was shown in Table 1 above that there was no significant difference in practices in process reflection being employed in teaching and learning mathematics in public schools and private schools. Additionally, there was no significant difference in content reflection being practiced in public and private schools. However, results showed that public schools and private schools differ significantly in their practices of critical reflection in terms of premise reflection. Generally, public and private schools showed no significant difference in practices in critical reflection.

Table 2 below summarized the comparisons of practices in critical reflection being employed for senior high school students and college students. In particular, the Table 2 showed the results of independent t-tests at 5% level of significance.

Table 2. Differences in Practices in Critical Reflection between Senior High School and College Students

Reflection	Students	N	Mean	SD	t-value	p-value	Decision on H_o	Conclusion
Content	Senior	1232	3.82	0.70	5.98	0.00	Reject H_o	Significant
	College	737	3.63	0.67				
Process	Senior	1232	3.76	0.69	0.24	0.81	Accept H_o	Not Significant
	College	737	3.76	0.67				
Premise	Senior	1232	3.76	0.73	2.70	0.01	Reject H_o	Significant
	College	737	3.67	0.66				
Critical	Senior	1232	3.78	0.61	3.51	0.00	Reject H_o	Significant
	College	737	3.68	0.55				

There was significant difference between the experiences of content reflection and premise reflection of senior high school and college students. But there was no significant difference in the experiences of process reflection of senior high school and college students. In general, the senior high school students and college students differed significantly in their experiences with practices in critical reflection being employed by their teachers in teaching and learning mathematics. The senior high school students having the higher mean rate of 3.78 than the mean rate of 3.68 for college students. This implied that implementation of Philippine K to 12 Basic Education Curriculum works better for perspective transformation of senior high school students.

Table 3 below summarized the comparisons of perspective transformation achieved in psychological, convictional and behavioral dimensions between student-respondents in public schools and student-respondents in private schools. Specifically, Table 3 showed the results of independent t-tests at 5% level of significance.

Table 3. Differences in Perspective Transformation Achieved between Students in Public and Private Schools

Transformation	School	N	Mean	SD	t-value	p-value	Decision on H_o	Conclusion
Psychological	Public	613	3.75	0.69	-0.75	0.45	Accept H_o	Not Significant
	Private	1356	3.78	0.69				
Convictional	Public	613	3.77	0.67	-1.92	0.06	Accept H_o	Not Significant
	Private	1356	3.83	0.68				
Behavioral	Public	613	3.72	0.91	-2.00	0.045	Reject H_o	Significant
	Private	1356	3.80	0.70				
Perspective	Public	613	3.75	0.63	-1.81	0.07	Accept H_o	Not Significant
	Private	1356	3.80	0.61				

In terms of behavioral dimension, students from public schools and students from private schools differed significantly in perspective transformation achieved, with students from public schools having obtained a lower mean rate of 3.72 than the mean rate of 3.80 for students from private schools. This provided one of the confirmations in the difference in behavior of students from Philippine public and private schools in terms of their habits and actions. However, results showed that, in general, there was no significant difference in perspective transformation achieved by students from public and private schools. In particular, critical reflection could equally and effectively bring about changes in self-understanding and change in beliefs among students from both public and private schools.

Table 4 below summarized the comparisons of perspective transformation achieved in psychological, convictional and behavioral dimensions between senior high school students and college students. Particularly, Table 4 showed the results of independent t-tests at 5% level of significance.

Table 4. Differences in Perspective Transformation Achieved between Senior High School and College Students

Transformation	Students	N	Mean	SD	t-value	p-value	Decision on H_o	Conclusion
Psychological	Senior	1232	3.79	0.71	2.18	0.03	Reject H_o	Significant
	College	737	3.73	0.64				
Convictional	Senior	1232	3.84	0.69	2.13	0.03	Reject H_o	Significant
	College	737	3.77	0.64				
Behavioral	Senior	1232	3.83	0.82	4.33	0.00	Reject H_o	Significant
	College	737	3.68	0.67				
Perspective	Senior	1232	3.82	0.64	3.38	0.001	Reject H_o	Significant
	College	737	3.72	0.57				

As it was shown in Table 4 above, results pointed out that there were significant differences in perspective transformation achieved by senior high school students and college students in terms of the psychological, convictional and behavioral dimensions. The senior high school students were observed to have higher mean rates in all three dimensions of perspective transformation than the mean rates of college students in the same dimensions.

Result implied and constituted one of the early proofs that the K to 12 Basic Education Curriculum may be working in helping students in transforming their perspective about teaching and learning, particularly in mathematics. It was because teachers in implementing the K to 12 Basic Education Curriculum employed pedagogical approaches that are reflective among others.

Relationship between Practices in Critical Reflection and Perspective Transformation Achieved by Students

Table 5 below summarized the computed Pearson r correlation coefficients between perspective transformation achieved in terms of psychological, convictional and behavioral dimensions and practices in critical reflection in terms of content, process and premise reflections.

Table 5. Relationship between Perspective Transformation and Practices in Critical Reflection

Transformation	Practices	Pearson r	Relationship	p-value	Decision on H_o	Conclusion
Psychological	Content Reflection	0.56	Moderate	0.00	Reject H_o	Significant
	Process Reflection	0.62	High	0.00	Reject H_o	Significant
	Premise Reflection	0.65	High	0.00	Reject H_o	Significant
	Critical Reflection	0.72	High	0.00	Reject H_o	Significant
Convictional	Content Reflection	0.54	Moderate	0.00	Reject H_o	Significant
	Process Reflection	0.63	High	0.00	Reject H_o	Significant
	Premise Reflection	0.62	High	0.00	Reject H_o	Significant
	Critical Reflection	0.70	High	0.00	Reject H_o	Significant
Behavioral	Content Reflection	0.51	Moderate	0.00	Reject H_o	Significant
	Process Reflection	0.52	Moderate	0.00	Reject H_o	Significant
	Premise Reflection	0.60	High	0.00	Reject H_o	Significant
	Critical Reflection	0.64	High	0.00	Reject H_o	Significant
Perspective	Content Reflection	0.61	High	0.00	Reject H_o	Significant
	Process Reflection	0.68	High	0.00	Reject H_o	Significant
	Premise Reflection	0.72	High	0.00	Reject H_o	Significant
	Critical Reflection	0.78	High	0.00	Reject H_o	Significant

Results showed that there was positive and direct correlation between the practices in critical reflection being employed in teaching and learning mathematics and the perspective transformation achieved by students. In particular, the correlation coefficient of 0.78 meant that there was high and significant relationship between practices in critical reflection of teachers and perspective transformation achieved by students.

More specifically, practices in critical reflection had high and significant relationship with perspective transformation achieved by students in terms of psychological, convictional and behavioral dimensions, with Pearson r correlation coefficients of 0.72, 0.70 and 0.64, respectively. Practices in premise reflection had significant and the highest correlation coefficients of 0.65 and 0.60 with perspective transformation achieved by students in terms of psychological and behavioral dimensions. Practices in process reflection had significant and the highest correlation coefficient of 0.63 with convictional dimension of perspective transformation achieved by students.

Conclusion

The researcher concluded that there were teaching strategies such as discovery learning that facilitated critical reflection among students. It was further concluded that there were learning activities in mathematics such as technology-based problem solving that altered students' perspective of mathematics as an abstract field.

The researcher also concluded that mathematics teachers from public and private schools employ practices in teaching and learning mathematics that engage students in different types of reflection which bring about, more or less, the same perspective transformation in students from both public and private schools. However, senior high school students were better able to achieve perspective transformation in psychological, convictional and behavioral dimensions than college students, since senior high school students were taught using innovative pedagogical approaches including reflective teaching as it was specified in the Philippine K to 12 Basic Education Curriculum.

Since it was shown that there was high and significant relationship between critical reflection practices and perspective transformation achieved by students, the researcher concluded that consistent use of of appropriate teaching and learning activities that engage students in critical reflection could actually create perspective transformation in students with success.

Recommendations

It was recommended that mathematics teachers in public and private schools incorporate the utilization of technology in teaching and learning mathematics, though students from public schools have less access to technology than students from private schools. Hence, it was also recommended that mathematics teachers continue to be creative, innovative and flexible in the use of a variety pedagogical approaches in their instruction as well as in employing the use of practices to engage students in content, process and premise reflection, and help them attain improved perspective transformation in psychological, convictional and behavioral dimensions.

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Development of Pre-service Middle School Mathematics Teachers' Skills in Interpretation of Student Thinking in the Context of Lesson Study

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Abstract: Mathematics teachers' knowledge of students' thinking has an important effect on the teaching-learning process (Cai, Ding & Wang, 2014; Clarkson & Presmeg, 2008). Teachers who understand student thinking sufficiently can interpret student thinking effectively and can anticipate student misconceptions, difficulties, and errors. Furthermore, they can overcome these challenges with appropriate explanations (An, Kulm & Wu, 2004; Ball, Thames & Phelps, 2008). The research revealed, however, that teachers/pre-service teachers have difficulty interpreting student thinking (Crepso, 2000; 2003). This led to the conclusion that pre-service teachers need to develop skills in understanding and interpreting the student perspective (Hiebert, Morris & Glass 2003). The scope of this study was to improve pre-service middle school mathematics teachers' knowledge and interpretation of student thinking through lesson study. Three senior pre-service teachers participated in this study. Pre-service teachers implemented three practice lesson study cycles in a real classroom. Data was obtained from documents, video recordings, observations, field notes, and reflective papers. In order to analyze data, content analysis was used. Results showed that the pre-service teachers had some challenges knowing and interpreting student thinking at the beginning of the study. As lesson study cycles proceeded, pre-service teachers began to take into account student thinking, design and implement lesson plans according to students' needs and difficulties.

Keywords: Teachers' knowledge of students, Discussion skills, Lesson study

Introduction

The knowledge of the teacher in the effective teaching of mathematics is undoubtedly a key point. Although there are many kinds of knowledge that the teacher should have, the common point on which researchers agree is that the teacher should have a good subject-area and pedagogical knowledge (Ball, et al., 2008; Shulman, 1986). This knowledge has been detailed in itself, and student knowledge has attracted attention as one of the important types of knowledge that teachers should have (Ball et al., 2008; Doerr & English, 2004; Grossman, 1990; Shulman, 1986). Student knowledge includes teachers' knowing students' prior knowledge, ways of thinking, mistakes, misconceptions or difficulties (An, et al., 2004; Ball et al., 2008; Hill, Ball & Schilling, 2008, Shulman, 1986). Both in Turkey and abroad, the teachers' having information about students is considered to be an important competence and it is argued that teachers' having this knowledge directly affects the quality of the teaching process (Ministry of National Education [MoNE), 2017a, 2017b; National Council of Mathematics [NCTM], 2000). Research has shown that teachers who have sufficient knowledge about students can effectively construct their teaching (Carpenter, Fennema, Peterson, Chiang & Loef, 1989; Fennema, Carpenter, Franke, Levi, Jacobs & Empson, 1996; Franke & Kazemi, 2001). However, the existing research has also revealed that both teachers and pre-service teachers have various difficulties related to student knowledge. Some of the difficulties experienced are that they cannot anticipate how their students think, are inadequate in answering students' questions and cannot interpret students' answers (Bergqvist, 2005; Crespo, 2000; 2003; Driel & Berry, 2010; Empson & Junk, 2004; Kılıç, 2011; Hadjidemetriou & Williams, 2002; Nathan & Koedinger, 2000; Tirosh, 2000; Wallack & Even, 2005). Researchers emphasize the need for teachers, particularly for pre-service teachers, to overcome these difficulties experienced in relation to student knowledge

(Crepso, 2000; 2003; Kılıç, 2011; Tirosh, 2000). To this end, training programs have been organized to support the development of pre-service and in-service teachers' student knowledge. In these programs, student thinking has been taken to the centre, and discussion environments have been created through case studies and videos (Berk & Hiebert, 2009; Carpenter et al., 1989; Clarkson & Presmeg, 2008; Fennema, Franke, Carpenter & Carey, 1993; Schorr & Lesh, 2003). It is emphasized that the training programs that will support the development of pre-service teachers' student knowledge should allow interactions with students in the real classroom environment and include reflection on instructional practices (Ball & Forzani, 2009; McDonald, Kazemi & Kavanagh, 2013; McDuffie, 2014). As the lesson study approach includes these features, it can be used to support the development of pre-service teachers' student knowledge. In this connection, the current study aims to develop the pre-service middle school pre-service teachers' student knowledge through lesson study applications.

Method

The current study employed the case study design, one of the qualitative research methods. The case study allows in-depth investigation of the target problem (Cresswell, 2013). The participants of the current study are three senior students attending a state university in the city of Ankara. The pre-service teachers conducted three lesson study. The pre-service teachers planned their lesson as a group and this lesson was delivered by one of the pre-service teachers in a real classroom environment. Meanwhile, the other pre-service teachers, the researcher (1st author) and the teacher took observation notes. After the completion of the implemantation, the lesson was evaluated by the teacher and the researcher. After the evaluation, the pre-service teachers revised their lesson plans and gave their final forms. This cycle is illustrated in Figure 1. In this way, the pre-service teachers conducted three lesson study applications to address the 7th grade course objectives "Form the pie chart of a data set and then interpret it", "Form the line chart of the data and then interpret it", and "Depending on the type of the data collected for the research questions, select a pie chart, frequency table, bar chart or line chart to display the data and then make conversions from one chart type to another chart type", respectively (Mone, 2018). As the data collection tools, the lesson plans prepared by the pre-service teachers, video-recordings of the lessons delivered by the pre-service teachers, observations and field notes were used.

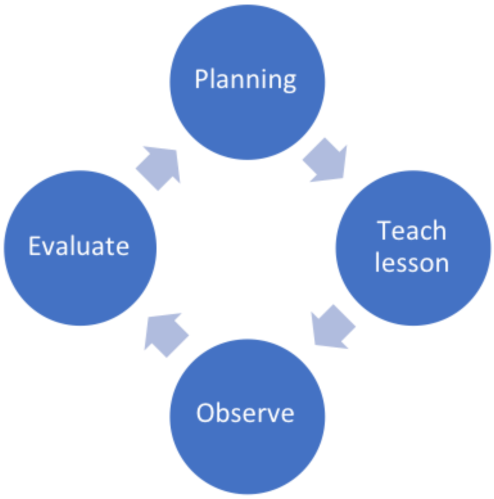

Figure 1. Lesson study process

In the analysis of the collected data, content analysis was used and by analysing the data related to student thinking in the instructions conducted by the pre-service teachers and the lesson plans prepared by them, the changes in the pre-service teachers' student knowledge were observed.

Results and Discussion

The results have revealed that the pre-service teachers have various difficulties in knowing and interpreting student thinking. The pre-service teachers did not pay much attention to student thinking in their lesson plans and implementations and provide inefficient explanations. For example, in the first lesson study, it was found that the pre-service teacher overlooked the difficulties that could be experienced by students in collecting data (see 1st lesson study implementation).

1st Lesson study implementation

"………..

Number of sibling	Number of person
0	3
1	9
2	6
3 and above	2

Gamze: ***Now, do you know how we found these data? As you know, we are studying in University A; I asked a specific number of friends in the class. These data belong to them****….."*

Here, it is seen that the explanation made by the pre-service teacher is insufficient. Moreover, the explanation made can lead to the formation of misunderstandings about the features of data collection.

The pre-service teachers were observed to be making greater effort to understand the students' statements in the 2nd lesson study implementation. On the basis of the students' statements, discussions were conducted on the target concept. For instance, one student gave an example related to the subject. On the basis of this example given by the student, the pre-service teacher drew attention to this target concept (see 2nd Lesson study implementation)

2nd Lesson study implementation

"…….

Student: Can I ask a question? They are using at hospitals, it is used in this way

Şirin: Do you mean EKG?

Student: But, there is not written Monday or Tuesday.

Student: But they are ***for each heart beat; in fact, we do not have to write the day here. I can for example write the time here as well. For instance, here is the heart rate and there is the time or seconds. We can do like this."***

Here, it is seen that the pre-service teacher paid attention to what the student wanted to say and on the basis of the student's statement, she made an explanation about how the scaling should be done during the drawing of graphs. In the second lesson study implementation and particularly in the third lesson study implementation, the pre-service teachers were observed to have constructed their lessons by putting students' thoughts into centre of the class discussion. They addressed the point where the students could make excessive generalization with the activities they prepared (see Figure 2).

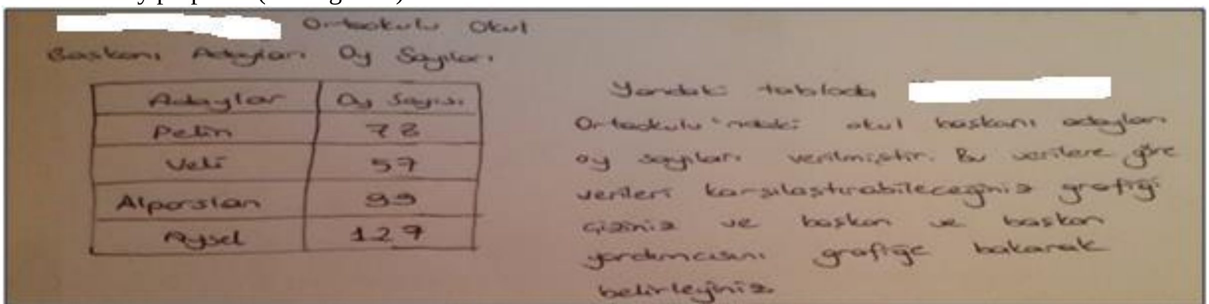

Figure 2 Lesson plan prepared for the 3rd lesson study application

When the pre-service teachers were talked about this activity they had prepared, they said: "*When the numbers of votes are given, it is always thought that a pie chart should be used. We selected this context on purpose and wanted them to learn that when necessary they can express these numbers with a line chart." (The 3rd lesson planning meeting).*

Furthermore, during the implementations, the pre-service teachers observed the students' works and on the basis of the difficulties experienced by the students, they attempted to help the students overcome these difficulties through the questions they asked. For example, Beyza realized that a group of students were comparing the role of the bar chart and line chart in answering the formulated question. Beyza tried to help them overcome this confusion with the questions she asked. The related conversation is given below.

3rd lesson study implementation

"…

Beyza: ***When I draw the bar chart what can I see?***

Student: You can find how many.

Student: How much it increased or decreased.
Beyza: ***Increased, decreased?***
Student: No, it is in the line chart.
Beyza: ***Isn't it, what is in the bar then?***
Student: How many, from example, are there from certain people.
Beyza: ***What can I see there?***
Student: The difference between them
Beyza: ***That is, we can look at the relationship between the bars, them. Then, you can write these. You can write how it is drawn or displayed.***
What can we look at in a line chart?
Student: Weather conditions, increase, decrease…"

When the discussion environment is evaluated, it is seen that some students experienced difficulties in understanding the idea that the question formulated should be taken into consideration while determining the suitable type of graph. Beyza's creating a suitable environment for a group discussion and evaluating the students' opinions led to elicitation of this difficulty. Beyza asked questions to help the student overcome this difficulty and gave students some time to think. In a similar manner, during the implementation, the pre-service teacher asked the question "*….Can show weight with a bar chart?"* The reason for her asking this question is making the students aware of the fact that though the weight is known as the constant variable, it can be displayed with a bar chart when necessary. The related conversation is given below.

3rd lesson study implementation
"….
Beyza: Can we show the weight with a bar chart?
Student: For example, if someone says us that the students in a class, let's say 26 kilograms at most, there are 9 students who are 26 kilograms.."

In the evaluation meeting, the pre-service teachers were talked about why they asked this question. The pre-service teachers stated that the concept of weight might be perceived as a constant variable; thus, they felt the need to ask such a question to prevent this perception to occur. This shows that the pre-service teachers considered the difficulties experienced by the students and carried out their applications to address these difficulties. Another point was recognized while the pre-service teachers were observing the students' works. Observing the works of a group, Beyza recognized that the students confused the angle measures of the slices in a circle with percentage. Then, she provided the following guidance to the students to realize their mistake:

3rd lesson study implementation
"…..
Student: We also multiple all by 5, then they become 20. But it is very small
Beyza: What do we multiply by 5?
Student: Because there are a total of 20 people here and we need to multiple by 5 to obtain 100 [Rather than taking the whole as 360, we think that it should be taken as 100]
Beyza: ***Okay, what are you writing inside the pie chart, now angle. What are we doing in the case of angle?***
Student: 360 then … I did it 100.
Beyza: ***Isn't it, did you realize it? What did your friend do?***
Student: He/she did it smaller.
Beyza: Why did he/she do it smaller?
Student: as 100 rather than 360 was taken.
Beyza: ***Why? Isn't it possible to make it 100?***
Student: as it is 360 degrees, not it cannot."

Here, we can see that the pre-service teacher realizing that while calculating the angle measures of the slices in a circle the students took the whole as 100 rather than 360 provided the necessary guidance for students to correct their mistake.

Conclusion

At the beginning of the lesson study implemantation, the pre-service teachers were observed to be inadequate in anticipating student thinking and in considering their answers. In the lesson planning meeting, they focused on typical student thoughts yet overlooked the points where students could have difficulties, make mistakes and develop misconceptions. It was even observed that the statements used by the pre-service teachers in the applications they conducted could result in misunderstandings on the part of the students. In the literature, it has been revealed that there are some deficiencies in pre-service teachers' student knowledge (Bergqvist, 2005; Kılıç, 2011; Tirosh, 2000). With the progressing lesson study process, positive developments were observed in the pre-service teachers' student knowledge. They planned their lessons by taking the students' thoughts into consideration and they observed the students' works during the implemantations and when they detected a point where the students were experiencing difficulty then they provided guidance for the students to overcome this difficulty. When it was thought about the reasons for these positive developments, a few points came to the fore. First of these is the pre-service teachers' observing the students in a real classroom environment while conducting some applications. In this way, they obtained more detailed information about the students and could make comments on their way of thinking. In the literature, the positive contributions of working with real students to the development of pre-service teachers' student knowledge have been widely emphasized (Masingila & Doerr, 2002). The second one is the creation of an environment of discussion on the pre-service teachers' lesson plans and implemantations. In this environment of discussion, the pre-service teachers pondered and exchanged ideas about the students' ways of thinking. This can be seen as one of the factors triggering the change in the pre-service teachers' knowledge (Guskey, 2003). In light of the findings of the current study, it can be suggested that models such as lesson study should be integrated into teacher training programs to detect and overcome the shortcomings in pre-service teachers' student knowledge.

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Examination of Social Media Usage Disorders of Middle School Students in Terms of Different Variables

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Abstract: Depending on the developments in technology, students' use of social media is increasing. In this study, it is aimed to examine the social media usage disorders of middle school students in terms of different variables. In the study, middle school students who were educated in 7 different state schools in Konya province were used. Social Media Disorder Scale was used to detect social media disorders of the students. The purpose of this study was to investigate whether social media usage disorders were related to variables such as gender, class level, certificate of achievement and settlement. The obtained data were analyzed with SPSS 22 statistical package program and One-way ANOVA test was used in the evaluation of the obtained data. As a result of data analysis, it was observed that social media use disorders of middle school students were at an average level. It has been observed that social media use disorders do not differ according to gender. Social media use disorder at class level was mostly at 7th grade level. Students studying in rural areas as a residential area were found to have fewer levels of social media use disorders. In addition, students who did not receive any success certificates in the previous year had more social media use disorders than other students.

Keywords: Technology education, Social media, Social media usage disorders, Middle school

Introduction

Today, communication technologies provide an environment where sharing and discussion are essential, providing opportunities for individuals to share their thoughts and works. The studies indicate that people spend more and more time in social media, try to meet their real life needs in this virtual environment and live in this virtual environment by establishing a new world. Sometimes it is observed that the boundary between the virtual world and the real life is uncertain. The use of young people in particular shows a rapid rise.

Global social media research report reveals that there are 2.789 billion active social media users around the world as of January 2017 and 2.549 billion people actively use social media from their smart phone. According to the same research findings, 48 million active social media users in our country, 42 million people actively use social media from smart phones have been found. Facebook is one of the most popular social networking sites in the world, with more than 1,871 million active users and more than 63% of Facebook users entering the Facebook site at least eight times a day (Chaffey, 2017). According to Vishwanath (2015), some people spend 8 hours a day on Facebook.

In this study, it is aimed to examine the social media usage disorders of middle school students in terms of different variables. The purpose of this study was to investigate whether social media usage disorders were related to variables such as gender, class level, certificate of achievement and settlement.

Research Problem

What variables affect social media usage disorders of middle school students?

- Selection and peer-review under responsibility of the Organizing Committee of the Conference

Sub-problems

Answer to the following sub-problems related to the problem sentence of the research:

1. What are the general social media use disorders of middle school students?
2. Is there a significant difference in gender differences among middle school students in social media usage disorders?
3. Is there a significant difference in social media usage disorders of middle school students compared to the grade level?
4. Is there a significant difference in middle school students' social media use disorders according to the status of getting a certificate of achievement?
5. Is there a significant difference in social media use disorders of middle school students compared to the settlement?

Method

This study was carried out using a single survey model from the general survey models. In such an approach, the event, matter, individual, group, institution, subject, etc. variables belonging to the unit or situation are tried to be described separately. This description may be limited to the past or present time, as well as as a function of time, as well as developmental. In addition to individual search models and instant status detection, temporal developments and changes can be determined (Karasar, 2003). In this research, 456 middle school students were educated in 7 state schools in Hadim district of Konya province.

Table 1. Number of students in groups

Variables		N	Mean
Grade	5	105	23
	6	110	24,2
	7	127	27,8
	8	114	25
Certificate of achievement	Yes	265	58,1
	No	191	41,9
Gender	Girl	233	51
	Boy	223	46
Settlement	Central	226	49,5
	Village	230	50,5
Total		456	100

In this study, Social Media Usage Disorder Scale was developed by Van den Eijnden, Lemmers and Valdenburg (2016) adapted to Turkish by Sarıçam and Karduz (2018). The Cronbach Alpha internal consistency coefficient was 0.75 and the Guttman two semi-test reliability coefficients were 0.64. The total correlation coefficient of the corrected item ranges from 0.29 to 0.73.

The scale consists of 9 items and has an 8 - point rating between “0=never” and “7= more than 40 times a day”. In this study, the average of students' answers to 9 items was used.

The obtained data were analyzed with SPSS 22 statistical package program and One-way ANOVA test was used in the evaluation of the obtained data. The level of significance was determined as 0.05.

Findings

Sub-Problem 1: What are the general social media use disorders of middle school students?

In the present study, the average score of Social Media Usage Disorder Scale was found to be 3.52. This result shows that middle students have moderate levels of social media use disorders.

Sub-Problem 2: Is there a significant difference in gender differences among middle school students in social media usage disorders?

The mean scores, standard deviations (SD), degree of freedom (df) and p value were given in Table 2.

Table 2. T-Test results about middle school students in social media usage disorders based on gender

Gender	N	$\bar{X}$	SD	df	t	p
Boy	223	3,48	1,76	454	0,56	,572
Girl	233	3,57	1,66			

There was no significant difference when the social media disorders of middle school students were examined according to the gender variable (p>0.05). The average of girl students was greater than the average of boy students.

Sub-Problem 3: Is there a significant difference in social media usage disorders of middle school students compared to the grade level?

Difference of middle school student's social media usage disorder scale scores based on grade level was analysed with one direction variance analysis and given in Table 3 and Table 4.

Table 3. One direction analysis results about middle school students in social media usage disorders based on grade level

	Sum of Squares	df	Mean Squares	F	p
Between Groups	28,987	3	9,662		
Within Groups	1312,56	452	2,904	3,327	0,02
Toral	1341,55	455			

Table 4. One direction analysis results about middle school students in social media usage disorders based on grade level

Grade Level	N	$\bar{X}$	S
5	105	3,38	1,73
6	110	3,45	1,65
7	127	3,95	1,78
8	114	3,32	1,64
Total	456	3,52	1,71

As shown in Table 3, there is a significant difference between the groups (p = .020; p <. 05). The social media usage disorder of middle school students was most commonly found in seventh graders. At least in eighth graders. Social media usage disorder has been observed to increase as grade level increases. But in eighth graders, this ratio was found to be low. The fact that students are preparing for the exam during this period may have lowered this rate.

Sub-Problem 4: Is there a significant difference in middle school students' social media use disorders according to the status of getting a certificate of achievement?

Difference of middle school student's social media usage disorder scale scores based on status of getting a certificate of achievement was analyzed with t-test analysis and given in Table 5.

Table 5: T-Test results about middle school students in social media usage disorders based on status of getting certificate of achievement

Certificate of Achievement	N	$\bar{X}$	SD	df	t	p
Yes	265	3,27	1,64	454	0,12	,000
No	191	3,88	1,75			

As shown in Table 5, there is a significant difference between the groups (t=0.12, p = .000; p <. 05). Students who did not receive a certificate of achievement were found to have more social media usage disorders.

Sub-Problem 5: Is there a significant difference in social media use disorders of middle school students compared to the settlement?

Difference of middle school student's social media usage disorder scale scores based on settlement was analyzed with t-test analysis and given in Table 5.

Table 6: T-Test results about middle school students in social media usage disorders based on settlement

Settlement	N	$\bar{X}$	SD	df	t	p
Village	230	3,23	1,63	454	3,74	,000
Central	226	3,82	1,75			

As shown in Table 6, there is a significant difference between the groups (t=3.74, p = .000; p <. 05). Students living in the district center were found to have more social media use disorders.

Results

In the present study, the average score of Social Media Usage Disorder Scale was found to be 3.52. This result shows that middle students have moderate levels of social media use disorders. In other words, students perform the disorders seen in social media use an average of 4 times a day.

When social media disorders of middle school students were examined according to gender variable, it was found that there was no significant difference (p=0,587, p>0.05). The average of girl students was greater than the average of boy students ($\bar{X}$: 3, 48, $\bar{X}$:3, 57).

When social media disorders of middle school students were examined according to grade level, it was found that there was a significant difference (p=0,02 , p<0.05). The social media usage disorder of middle school students was most commonly found in seventh graders. At least in eighth graders. Social media usage disorder has been observed to increase as grade level increases. But in eighth graders, this ratio was found to be low. The fact that students are preparing for the exam during this period may have lowered this rate.

When the social media disorders of middle school students were examined according to the variable of obtaining achievement certificate, a significant difference was observed ($\bar{X}$: 3,27 , $\bar{X}$:3,88 , p=0,000 , p<0,05). Students who did not receive a certificate of achievement were found to have more social media use disorders. From here on out, it can be said that social media use disorder can have a negative impact on students ' academic achievement.

When the social media disorders of middle school students were examined according to the settlement variable, there was a significant difference ($\bar{X}$: 3,23 , $\bar{X}$:3,82 , p=0,000 , p<0,05). It was observed that the social media use disorders of the students living in the center were higher than the students living in the village.

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Conceptual Metaphor for Teaching and Learning of Prime and Composite Numbers at Primary Grades

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Abstract: Metaphor is a conceptual mapping from one domain to another. It helps student to understand abstract and unfamiliar mathematical content knowledge through their everyday experiences, familiar and concrete objects. The subject of prime and composite number is a very important part of school mathematics curriculum at basic level. Different teachers use several metaphors to assist students' learning and encourage them to understand abstract ideas and concepts of numbers. The main objective of this paper is to provide a glimpse of teaching abstract mathematical content of prime and composite numbers through different conceptual metaphor based on constructivist approaches for teaching and learning. Action research was adopted with three level of interventions, followed and corrected depending on observations and reflections. Different interventions regarding the student experiences and everyday activities were used to communicate the concepts of prime and composite numbers. The color metaphor was applied as the first intervention. Then the area metaphor was applied as the second intervention and finally the teacher used colorful rainbow factore metaphor to analyze the change and improvement in classroom practice of teachers. The pre-class and post class interview with teachers and students were taken. From the classroom observation and interview, it was found that conceptual metaphors used by the teachers in the classroom contributed for the improvement of students' understanding of the concepts.

Keywords: Action research, Composite numbers, Conceptual metaphor, Prime numbers, ZPD

Introduction

Student and teacher consider mathematics as one of the difficult subjects in school. One of the reason of taking mathematics as a difficult subject is not taking account of the out-of-school mathematical knowledge into formal mathematics curriculum. The abstract concepts can be made more meaningful by connecting learners' real-life situations. The different physical apparatus and metaphors mediated to learn abstract mathematical concepts. In this vein, Bonotto (2007) viewed that the extensive use of cultural artefacts makes school mathematics more meaningful. The cultural artefacts and concrete materials introduced into mathematics classroom help in the process of knowledge construction. It is learnt that learners' experiences and knowledge regarding mathematics can help to understand school mathematics. The mathematical ideas and knowledge occurred in out-of-school environment can enable teacher to communicate abstract concepts of school mathematics to students. The out-of-school knowledge of the students can help to understand the mathematical ideas and concepts in learning formal mathematics in cultural friendly environments. The tools for allowing us to connect students everyday practices and experience to formal mathematics is the metaphors.

Metaphors provide as a powerful tool to understand one domain of knowledge in terms of another. The conceptual metaphors help to deal with relatively unfamiliar and more abstract domains of experience in a familiar and tangible way. Metaphor simply means the representation of abstract entities through very simple, familiar and meaningful objects. It can be taken as a mapping that the abstract ideas map into concrete, strong and meaningful images that were developed in different social and cultural context for a different purpose. Thus, metaphors help to understand abstract ideas by mapping them into strong, meaningful images that were originally developed in a different context. English (1997) sees metaphors as tools for creating formal concepts out of image schemas, and of restructuring these concepts in complex ways. Lakoff and Nunez (2000) also argue that the conceptual metaphor's "primary function is to allow us to reason about relatively abstract domains using the inferential structure of relatively concrete domains," (p. 42) with structures of image schemas preserved by this mapping. Thus, metaphor can be considered as a mechanism for connecting two types of knowledge of which the new knowledge is comprehended through already existed familiar concepts.

The conceptual metaphors are tools with which connects students out-of-school environmental activities to understand school mathematics. The out of school mathematical ideas, knowledge, process and practices can be connected to teach and learn school mathematics. The mathematical ideas and knowledge that are practising in the out-of-school environment of children everyday activities can facilitates to understand school mathematics (Pradhan, 2018). The use of conceptual metaphors as a pedagogical tool could help to mathematical knowledge transformation and distribution in classroom teaching. Thus, the conceptual metaphor connects different target concepts through their relationships in the common source domain. Orey and Rosa (2006) argue that it is important to acknowledge contributions of diverse cultural groups who invent mathematical object to understand and solve problem in varied contexts. So, it is urgent to link academic mathematics and student experiences that become central ingredients in the teaching and learning of mathematics.

Research Questıons

The purpose of this study was to explore the contribution of conceptual metaphors in the process of teaching and learning of prime and composite numbers at the basic level of education. To achieve this objective, I have set up the following research questions:

- How conceptual metaphors help for the teaching and learning of mathematical concepts at the basic level of education?
- What effects do conceptual metaphors on teaching and learning of prime and composite numbers at primary grades?

Understanding Conceptual Metaphor

Lakoff and Nunez (2000) define metaphor as a conceptual mapping from one domain to the other. Regarding the metaphorical thought, Lakoff and Nunez (2000, p.5) explain: "…human beings conceptualize abstract concepts in concrete terms, using ideas and modes of reasoning grounded in the sensory-motor system. The mechanism by which the abstract is comprehended in terms of the concrete is called conceptual metaphor". Thus, the conceptual metaphors play a major role for the understanding of abstract mathematical ideas. In this regards, Lakoff and Nunez (2000) created three types of conceptual metaphors and they are known as grounding metaphors, linking metaphors and extraneous metaphors. The grounding metaphors allow us to ground our understanding of mathematical ideas in based on everyday experience. For instance, the abstract mathematical idea of addition as putting things into piles/ bag or adding things to a collection, subtraction as taking things away from a collection, sets as containers, members of a set as objects in a container. Linking metaphors allow us to link one branch of mathematics to other branches of mathematics. For example, the metaphor "Numbers is a point on a Line" links arithmetic to geometry. Thus the linking metaphors allows to conceptualize the ideas of arithmetic in terms of geometry.

Lakoff and Nunez (2000) discussed another type of metaphor called extraneous metaphors. According to them "…extraneous metaphor or metaphors that have nothing whatever to do with either the grounding of mathematics or the structure of mathematics itself. Unfortunately, the term metaphor when applied to mathematics has mostly referred to such extraneous metaphors" (p. 53). The staircase is an example of extraneous metaphor of the "step function" because when graphed the step function can look similar to a staircase. Likewise, "Function is a machine" is a metaphor. The source domain of this metaphor is "machine" and the target domain is the mathematical concept of "functions". The image of staircase has nothing whatever to do with either the inherent content of the grounding of the mathematics, although the visual is a helpful reminder of how this function would look when graphed (Lakoff & Nunez, 2000). Extraneous metaphors can be eliminated without any substantive change in the conceptual structure of mathematics, whereas eliminating grounding or linking metaphors would make much of the conceptual content of mathematics disappear.

Lakoff and Nunez (2000) claim that "Metaphors are an essential part of mathematical thought, not just auxiliary mechanisms used for visualization or ease of understanding" (p.6). Barton (2005) uses boats as a metaphor for mathematics. He claims that different boats can be used for different purposes, the fishing boat can go to rocky places where the ferry cannot navigate and the ferry can travel under conditions too hard for the fishing boat. "It is the same world, but it is a different understanding. Neither is the truth" (p. 100). The metaphors have two important role. First one is to contribute for the development of mathematical content knowledge. The defining theme of the interaction perspective (Ortony, 1993) is that metaphors play a constitutive role in creating new knowing. Metaphors are not just connecting old ideas in new ways, but changing both source and target ideas. Sometime as time passed the source domain may detach from the target domain. For instance, 'kite' was concrete device to conceptualize the geometrical quadrilateral but it has now become the name of this quadrilateral. This poses the question of what happens when a metaphor becomes a mathematical concept (Parzysz, Pesci, & Bergsten, 2005). Secondly, it is a tool for the understanding of one thing in terms of another. Thus, metaphor contribute as the pedagogical knowledge for the understanding of abstract concepts of mathematics. Consider the metaphors that "Numbers are points on line". The conceptions of numbers are not geometrical. The number line is one of the fundamental concepts in different branches of mathematics. Fyhn (2007) viewed that patterns in snow are examples of linking metaphors. Fyhn further maintained that "Some Sami mittens have the pattern grouse footprints on their edges. These repeating patterns show a connection between embodied experiences and ornamentation. Ski trails as well as animal footprints perform patterns in the snow, patterns with different symmetry properties" (p. 246).

From the study of the various literature on metaphors, I have come to know that metaphors contribute in the process of teaching and learning of mathematics. It was observed that many of the researchers who studied metaphors argue that all of our thinking is fundamentally metaphorical: "the way we think, what we experience and what we do every day is very much a matter of metaphor" (Lakoff & Johnson, 1980, p. 3) even though metaphor may remain largely unnoticed. Metaphors are used not only for communication purposes but also can be considered as thinking devices intended for teaching and learning abstract mathematical ideas.

In this study, I took Lakoff and Nunez conceptual metaphors as the working definition of metaphors, which enable to support mathematics teaching and learning. In this vein, Bonotto (2007) viewed that the extensive use of cultural artefacts makes school mathematics more meaningful. For him, the cultural artefacts, introduced into mathematics classroom are concrete materials, which children typically meet in real life situations. Those concrete materials can be the suitable tools to transfer from one domain to another domain of knowledge. In this paper, I used physical apparatus like different colors, geoboard and other instructional materials that mediated the teaching and learning of the abstract concepts of prime and composite numbers.

Framework of the Study

Our learning is intimately associated with our connection with other human beings, our teachers, our peers, our family as well as casual acquaintances. The term Zone of Proximal Development (ZPD) is probably one of the most widely recognized and well-known ideas associated with Vygotsky's scientific production. The common conception of the ZPD presupposes an interaction on a task between a more competent person and a less competent person, such that the less competent person becomes independently proficient at what was initially a jointly accomplished task (Chaiklin, 2003). Vygotsky's notion of ZPD is a crucial precept which is central to all of social constructivist learning theory. The ZPD was described by Vygotsky (1978) as

> The Zone of Proximal Development is the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers (p. 86).

Appropriate and timely interventions in the course of learning within an individual's ZPD has become an essential strategy for teachers. Understanding mathematical ideas, concepts and knowledge is socio-cultural activities. With this regards, van Harmelen (2008) viewed that the social constructivism has a central precept that knowledge is created by learners as a result of social interaction. Thus, the social constructivist believes that the knowledge is social product and the learning is a social process (Pritchard and Woollard, 2010). The lessons

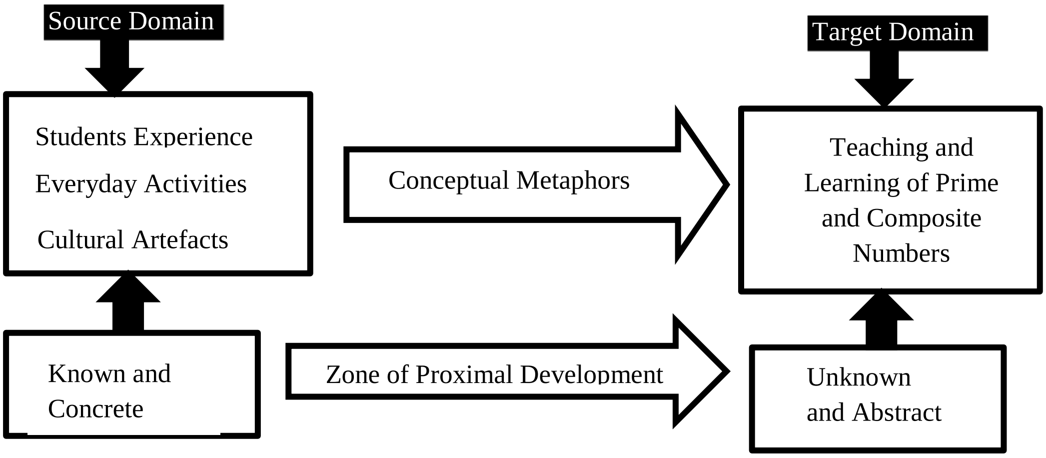

Figure 1. Theoretical framework of the study

were implemented in a student-centred approach to creating a learning environment in which students were encouraged to construct their knowledge through interactions with the cultural environment, community/ peers, the researcher and the regular classroom teacher. In this framework, cultural artefacts were used as a metaphor to communicate abstract ideas of prime and composite numbers.

The figure 1 indicates that the meaningful mathematics teaching and learning provide the means for connecting two conceptual domains. This framework is based on the theory of conceptual metaphor that indicates the connection between source domain and the target domain for meaningful mathematics teaching and learning (Pradhan, 2018). The source domain is the students' experience, everyday activities, and different cultural artefacts regarding mathematical ideas, concepts and knowledge embedded in their out-of-school context. The connection of these concepts and ideas in the teaching and learning to enhance school mathematics is target domain (learning objectives) of the conceptual metaphor theory.

In this framework, different primary colors, mixing of two or more colors, area of rectangle, and factors of the numbers were the source domain which mediate teaching and learning of abstract concepts of prime and composite numbers (target domain). The contextualization of school mathematics that enables them to successfully accomplish the rewarding task of facilitating their students' learning. The understanding of learners' culture, their everyday activities and experiences not only enables teachers to gain a greater understanding of their students, but provides rich material to incorporate into classroom learning activities (Stringer, Christensen, & Baldwin, 2010). It also provides an opportunity to teachers learn to understand their students in a richly meaningful way, and in the process develop relationships that enable them to accomplish their work more effectively. The students participated in the construction of mathematical knowledge through activity. In this framework, students were encouraged to investigate different mathematical ideas based on their experience and everyday practices (Pradhan, 2018). The interactions with cultural activities and with peers are important aspects of this framework.

Methods and Procedures

The main objective of my study was to analyze the contributions of conceptual metaphors in the process of teaching and learning of school mathematics. The particular paradigm I adopted to conduct my research was interpretative which assumes a relativist ontology, a subjective epistemology and a naturalistic set of methodological procedures (Denzin and Lincoln, 2005). The term interpretative research refers to a set of approaches where the central research interest is the meaning that humans give to their experiences and social interactions. Interpretative research involves long-term participation in a field setting and careful recording and collecting of data. This is followed by reflection and writing using rich description, narrative descriptions and direct quotations (Erickson, 1986). The contribution of cultural metaphors in the process of teaching and learning of school mathematics was analyzed through the collaborative action research. The effective change in the practices in teaching and learning of school mathematics and improving students understanding on the concepts were gather from the model of collaborative action research model (Somekh, 2006).

I developed detailed plan to conduct Teacher Facilitation Program (TFP) to acquaint about the knowledge of conceptual metaphors for the teaching and learning of school mathematics. Thus, my intention to conduct the TFP was to provide the answer of questions of the teachers' participants based on What are the conceptual metaphors? How cultural metaphors plays the important role to communicate abstract mathematical ideas? How the cultural metaphors incorporate to in the process of teaching and learning of school mathematics at the basic level of education? After conducting two day's teacher facilitation program, I provided the open-ended questions and blank sheet to write the perceptions and their reflections on TFP. Only 15 out of 22 participants provided me their written reflection about the TFP. About seven teacher participants were not interested to write their views and they did not provide me the written sheets. I collected the reflection notes of fifteen participants of two day's TFP and analyzed their written documents with the collaboration of my research supervisors. I took oral interview to the same fifteen teachers. The teachers who had keen on conceptual metaphors and practices on mathematics classroom was selected. The only six teachers were ready to participate and committed for the collaborative action research.

I provided the information sheet and explained orally about the purpose, nature and possible effect of the study to fifteen participants to gain access for collaborative action research. The nature of the data collection instrument and their rights and responsibilities as participants have been explained to them, individual consent was obtained from six participants included in the study. The researcher convinced them to safeguard the confidentiality of collected data and the privacy of each participant as well.

Selectıon of Teaching Unit and Conceptual Metaphors

During the teacher training cum workshop programme, in our Collaborative Action Research (CAR) project, we had listed out some mathematical concepts that were comparatively difficult for the teachers to teach in the classroom. Among the teacher participant, Pooja and Deepa (pseudo name used) both asked about the way of teaching prime and composite number in an easier method rather than definition method they are using since long.

I put this issue in the group of CAR project. Then for the teaching of prime and composite number, we discussed about the method of teaching in the group of many teachers.Is definition method only permissible in the teaching of prime and composite number? If not true, what other ways there may exist in course of teaching this concept? And as result, we arrived at a conclusion that different metaphors can be used in the teaching to make it simpler and effective. And the metaphors could be "Sieve of Erathosness", Color Metaphor, Area Metaphor and so on. Then, Deepa mentioned that she would use the area metaphor and Pooja would use colour metaphor and "Sieve of Erathosness" in the future class of prime and composite numbers.

The mathematical ideas and practices in out-of-school culture and possible to connect school mathematics were explored. To assess the effectiveness of the conceptual metaphor, the mathematics lessons were developed to teach the concepts of prime and composite numbers at grade four. The cultural artefacts the geoboard, chart board materials regarding mathematical ideas are considered as the source domain for the teaching and learning abstract concepts of mathematics at the basic level of education. The lesson was developed and based on constructivist design. The students were encouraged to investigate the mathematical relations in activity based instruction design.

Metaphors for Teaching-Learning of Prime and Composite Numbers

There are different metaphors to communicate the ideas of prime and composite numbers. My teacher participants use three metaphors such as color metaphor, area metaphor and rainbow factor metaphor to conceptualize prime and composite numbers.

First Intervention: Color Metaphor

The traditional colour theory states that there are three types of primary colours. These are the colours of red, yellow and blue. The primary colour is that colour which cannot be created by any combination of other colours.

They are the colour equivalents of mathematical prime numbers. Like prime numbers, the basic three colours cannot be reduced to more fundamental colours. They form the building blocks of all other colours. Color is one of the common metaphor that can help to conceptualize the concepts of prime numbers and composite numbers. Then we together developed the lesson plan according to constructivist teaching framework. Deepa had prepared a chart board as shown in the figure. The figure represents a Venn-diagram showing the intersections of three primary color sets; Red, Yellow, and Blue. The chart was put in the flannel board and explained about the formation of different colors when the primary colors were mixed with each other. Then the whole class was divided into four small interactive groups each of eight members. Each group was provided with a color pad with three primary colors; Red (R), Blue (B) and Yellow (Y) and a blank painting sheet. They were asked for mixing the colors R+B, R+Y, B+Y and R+B+Y.

Image 1. Colors in Venn diagram

Image 2. Displaying the composite colors

After few minute for the task, she asked each group to share their result with the whole class. Then, Deepa asked the students if all of them got the same outcome as per discussed before. All the students had the reply of having the same outcome as per her teaching of the formation of those colors. Then she concluded that the color mixing can be compared with the prime and composite numbers. She further described the prime numbers as those primary colors which are not a mixture of any other colors, and the colors like orange, grey, green and violet formed as a mixture of more than a color were compared to the composite number. After this discussion, the teacher then encouraged to write the definition of prime and composite numbers.

Image 3. Students participations in the learning process

After some time, the teacher gave an opportunity to each group leader to share their definition with the whole class. Encompassing all the concepts, prime number can be defined as a number which has just a factor, itself other than the factor 1. For further clarification, the prime number can be considered as a primary color, a unique item. For instance, if we take yellow color, then its mixing item, if considered as the factor, is just single color i.e. yellow is an independent item with a single factor concluding that yellow is a prime color. Likewise, composite number can be defined as a number which has two or more factors other than the factor 1. For further illustration, composite color can be directly connected with the secondary colors composed of two or more color items. For instance, if we take orange color, then its mixing items if considered as the factors are of 2 colors i.e. two factor concluding that orange is a composite color. At the end of the classroom, I asked the students near to me:

Researcher: Students, what did you find about today's class? Was it interesting?

Students: Yes. Today's class was the most interesting class till date.

Researcher: What made you feel that interesting about today's class?

Students: Madam, brought so many interesting items like colors and charts. This really made us feel fantastic about the class today.

Researcher: Did not she brought those items before in the class?

Students: Actually, not sir. Mam, always used to teach textbook directly and solve the problems from the exercise.
Researcher: Did she made you to solve some of those problems or not?
Students: Yes. She made us to do that.

Seeing that keen participation of the students in today's class, I could find that the teacher had never used this way of teaching approach till now. She always used chalk and talk methods during her teaching.

Researcher: Did you enjoy in learning the concepts?
Student: The class was the really enjoyable and interesting today. We learnt those bookish concepts with a simultaneous playing as if those were games. This class will be really memorable for us.
Researcher: That's good. Thank you for your compliments.

Studnets enjoyed to play with the colors. The color metaphor help to conceptualize the meaning of prime and composite numbers to most of the students. But some studnets not clearly understand the concepts and then she used another metaphor know as Area Metaphor.

Second Intervention: Area Metaphor

Area is one of the common metaphor that can help to conceptualize the concepts of Prime numbers and composite numbers. The area can be visualized as the small square unit in the geoboard. It is one of the common visual instructional material for the teaching and learning of mathematical concepts. It is equally important to teach prime and composite numbers. Then we together developed the lesson plan according to constructivist teaching framework. The whole class was divided into five small interact groups of members six. Each group was provided with a geoboard and rubber bands of different colours. Each groups were assigned with two numbers, one prime and other non-prime(Composite). For example; the numbers 5 and 6 are given to group A, the numbers 7 and 8 are given to another group B and so on. Each group has requested to form possible rectangular plot with the help of rubber bands in the geoboard. After few minutes to discuss within the group, she asked each group's reporter to share their answer with the whole class.

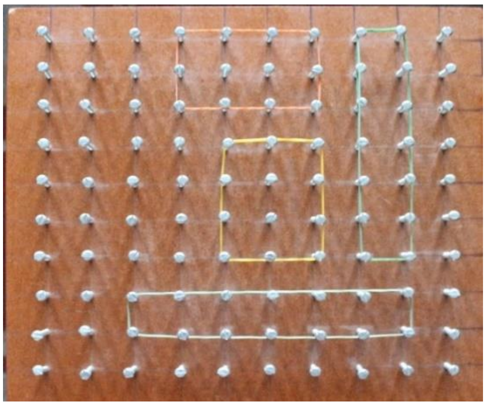

Image 4. Artefacts showing the rectangular area

Deepa: Are you finished with your task?
Reporter of each group replied yes madam.
Deepa: Good, my children. If so, please tell your answer to the class turn by turn.
Students: Okay madam.
Deepa: At first, who is the reporter of Group A?
Reporter of Group A: Yes, madam, me Rohan.
Deepa: Its okay. Please tell me your numbers in task.
Rohan: We have two numbers 5 and 6, madam.
Deepa: Then now tell me how many possible rectangles did you get for the number 5 and 6?
Rohan: Madam, for 5 we could make only 2 rectangular plots but for 6 we could make 4 rectangular plots.
Deepa: What were the sizes of rectangle you could prepare?
Rohan: We could prepare 1×5 and 5×1 in case of 5 and 1×6, 2×3, 3×2 and 6×1 in case of 6 Madam.
Deepa: Okay sit down! Can other group tell me if any other sizes of rectangular be made for 5 and 6?
Groups: Madam, Rohan is probably correct.
Deepa: That's good. Now one of you from group B, stand up!
Reporter of Group B: Yes Miss.
Deepa: So, Sharwin. Talk about the same in your task.
Sharwin: Yes, Madam. We had 7 and 12 as two numbers given to us and we found that there were only 2 for 7 and 6 rectangular plots for 12.
Deepa: And Group C and D. Which numbers did you get with just 2 rectangular plots?

Reporter from Group C: Madam, among 3 and 8, 3 had just two rectangular plots.
Reporter from Group D: And Miss, out of 2 and 9, 2 had just two rectangular plots.
Then, Deepa enlisted those numbers having only 2 rectangular plots in board as said by her students.

Then she asked if there were other numbers that could have similar result. And she concluded that these numbers can be called as prime numbers and the numbers that can have more than 2 rectangular plots can be called as composite numbers.

Image 5. Students are exploring mathematical relations

Then she asked her students if they could write the definition of prime numbers and composite numbers. Then comprising the answers from her students she modified it and wrote it as: A prime number is a natural number that is greater than 1 and has only two factors i.e. 1 and itself. Then she gave some examples to check whether the numbers were prime or composite.

From the observation of her classroom activities and the discussion with her, I have come to conclude that the area metaphors really contribute to the teaching and learning of prime and composite numbers. The connection of students' familiar context made to teach the school mathematics can make the regular mathematics class very interesting, and meaningful. The constructivist teaching approach provides the classroom activities more interactive and participatory. The students engages in symbolic play to explore the sources to understand the target (Chiu, 2000). Children involved in collaborative task and engages in finding the areas of given numbers and this activities mediated to connect the target domain. They conceptualized the concepts of prime and composite numbers in connection to the areas of rectangle seems to be effective in the process of knowledge construction.

Third Intervention: Rainbow Factor Metaphor

For teaching prime and composite numbers, she used the colorful rainbow factor metaphor for the better understanding. She further mentioned that; For a prime number, there would be only two factors "I and Me factor metaphor" which means 1 and itself. For a composite number, she created another beautiful colorful rainbow factor metaphor "I, Me and My factor metaphor" suggesting 1, itself and all other factors of the number in a colored rainbow pattern.

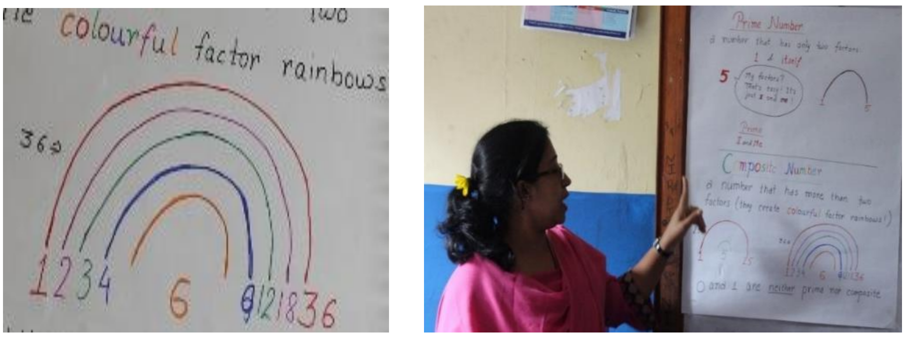

Image 6. Rainbow factors metaphor for teaching of prime and composite

For example, in case of a number 36, it has the factors 1,2,3,4,6,9,12,18 and 36. Then she gave some examples to check whether the numbers were prime or composite.

Then the bell rang and we jointly came out of the class. Then I asked her about how she felt about today's class. She replied the class to be very interesting, participatory and as a whole meaningful. Regarding the effectiveness of incorporation of cultural artefacts in the classroom teaching, she speaks:

> I have been teaching for 10 years, and I always had to think about the class to be a successful class during the time of teaching prime and composite numbers as I really felt difficult to express its essence. I directly used to give definition to the students and instantly jumped to the exercises. This was rather easier for me to end up the class but still I did not found any interest both in me to teach this and in the face of students to learn it. But today after the use of metaphors in teaching of prime and composite numbers I felt really gratified during the teaching of this prime and composite numbers in fact after 10 years of my teaching.

From the interaction to her, metaphor plays significant role in the process of knowledge construction. The cultural artefacts facilitates students to develop the mathematical relation and helps to understand the concepts of prime and composite number. Metaphors contribute to the teaching and learning of abstract concept of mathematics. The connection of students' familiar context made to teach the school mathematics can make the regular mathematics class very interesting, and meaningful.

With the interaction with Deepa, I found that there is a need of providing workshop and training to the teachers of mathematics. She was heartly convinced about the contribution of the metaphors in the teaching and learning of abstract concept of mathematics. Mathematics is not so abstract concepts. It can be made concrete by connecting it to the familiar contexts of the students. The connection of students' familiar context to the school mathematics can make the regular mathematics class very interesting, and meaningful. There are different metaphor for teaching and learning of abstract concepts of mathematics. But the teachers of matheamtics should know the students household activities to contextualize the school mathematics.

After the class, I asked about the effectiveness of cultural artefacts in the process of learning with the group member of each group. The reporter of group A viewed that

> This class seems very interesting. We are working collaboratively. This is providing us the opportunity in learning together. The collaborative learning situations and group discussions enhance the level of confidence.

From the above view of student participants, I have come to conclude that the constructivist learning situations encourages in learning mathematics. The collaborative work provides ample opportunities for social interaction and self-expression. They also make their students develop a sense of their active roles as producers not only consumers of knowledge. The learning pedagogy that was used denied the rote and memorization of the definition of prime and composite numbers. The member of another group views that:

> We are having a real fun today. We are learning mathematical concepts just like by playing games. We feel this learning environment to be perhaps student friendly. Our teacher is providing us a great opportunity to work in a group. In fact, the cultural artefacts provides us to understand more mathematical concepts.

From the conversation, I have come to realize that mathematics teacher need to provide opportunity to students for active participation in learning process. Playing games is common to everyone. Games has some sort of rules, procedures and structure, as in the mathematics. The incorporation of games and puzzles play important role to achieve aesthetic sprit of mathematics and to increase mathematical creativity and curiosity. The above mentioned conversation is good evidence that the cultural artefacts mediated for the construction of mathematical ideas and enhance the level of students understanding.

The "Area is Numbers" metaphors link the area of rectangle and the prime and composite numbers. The use of geoboard can be the suitable tools to transfer the concepts of prime and composite numbers and convey the "Area is Numbers" metaphor. The prime and composite numbers can be conceptualized through the different cultural artefacts. The above mentioned conversation is good evidence that the cultural artefacts mediated for the construction of mathematical ideas and enhance the level of students understanding. From the observation in student group work, I have come to see that the more capable student facilitates to learn the prime and composite numbers by manipulating the physical artefacts geoboard and link between area of rectangle to the prime and composite numbers. This was how the concepts of ZPD in the socio-cultural theory of Vygotsky comprehends the teaching and learning in socio-cultural context.

Mathematics teacher need to provide opportunity to students for active participation in learning process. The student friendly learning environment and project based instructional pedagogy encourages them to construct mathematical meaning. From the observation of students group work while they were engaged to solve mathematical problem, I have agreed with the line of van Harmelen (2008) who argued that the social constructivism has a central precept that the knowledge is created by the learners as a result of social interaction. Thus, the constructivist learning pedagogy encourages students to create mathematical knowledge and develop creativity and curiosity to solve mathematical problem.

From the interaction with students participants, it was found that some teachers generally lack in the understanding of children's psychology. Every teacher to gain a successful career must take care of the thing that is the knowledge one is providing being effective to the learning of the class or not. The teacher must use child-centered pedagogy for applying those bulks of theories in the teaching. This can really uplift the level of understanding of students to a great extent. As the teacher used special approaches while she taught prime and composite numbers today, the students were really pleased as they could understand those concepts so easily. She had never used this way of teaching approach till now. She always used chalk and talk method only inside the classroom. But after this special approach i.e. the use of metaphors in teaching today, I could see the active participation of the students and constructivist learning framework flourishing in the classroom environment. The children were really pleased. İt was found that different metaphors help to conceptualize the concept of prime and composite numbers. The metaphors help teachers to teach concepts effectively and meaningfully and students appeal the approaches of teacher's teaching with the use of metaphors.

Concludıng Remarks

Metaphor is a communication tool and hence mediate to link with the abstract mathematical concepts. Different artefacts like geoboard, chart board materials regarding mathematical ideas are considered as the conceptual metaphors for the teaching and learning abstract concepts of mathematics. The constructivist lesson provides a great opportunity to students regarding to the knowledge construction and to solve mathematical problems. The students were encouraged to investigate the mathematical ideas in activity based instruction design. The series of interventions regarding students everyday practices and experience were used to communicate abstract concepts of prime and composite numbers at basic level of education. The color metaphor, area metaphor and colorful factor rainbow metaphor were intervented in the classroom on the basis of observations and reflections. Pre-class and psot-class interview was taken both to studnets and teachers . From the observation of the classroom and interviewed with teachers and students, it was concluded that the incorporation of conceptual metaphors in mathematics classroom can be mediated in the process of teaching and learning, and develop mathematical concepts.

Acknowledgement

This paper is the outcome of field visit in collaborative action research project during my Ph. D. study. I would like to acknowledge my supervisor Prof. Dr. Hari Prasad Upadhyay, Co-supervisor Prof. Dr. Bidya Nath Koirala for their continuous and untiring support until this stage. I like to give special thanks to headmaster of my cooperating school Mr Nati Kaji Maharjan for providing me huge space to conduct my study. I also like to extend my thanks to my critical friend of our CAR project and the participated students.

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Effects of Formative Assessment in Inquiry-Based Learning on High School Students' Attitudes towards Physics

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Abstract: This research study aimed to investigate the effect of formative assessment used in inquiry-based instruction on 10th grade students' attitudes towards physics. For the study, a quasi-experimental with matching only pretest-posttest control group research design was adopted. An answer was searched for the question "Is there a significant difference between the experimental group students who are exposed to formative assessment in inquiry-based instruction and the control group students who are not exposed to formative assessment in inquiry-based learning in terms of their attitudes towards physics?". The participants of the study consisted of 41 students in the 10th grade of a public high school in the spring semester of 2017-2018 academic years. In this study, "Physics-Related Attitudes Scale" was used as quantitative data collection tool. These were applied twice as pre-test and after a five- week treatment period as a post-test to both groups to assess and compare the effectiveness of formative assessment utilized in physics. Quantitative data collection tools were found to having of high reliability. The effect size of the applications (Cohen's d) were large according to the calculations. When the data were analyzed, a significant difference was found between the experimental group and the control group in favor of the experimental group in the final test of Physics-Related Attitudes Scale. The statistical results of the study show that formative assessment in inquiry-based instruction has a positive effect on students' attitudes towards physics course.

Keywords: Inquiry-based instruction, Formative assessment, Physics education, Attitude

Introduction

"If a single word had to be chosen to describe the goals of science educators during the 30-year period that began in the late 1950s, it would have to be inquiry." (DeBoer, 1991). Inquiry-based education has been a part of innovative science teaching for the past ten years (Grob, Holmeier & Labudde, 2017). In the innovative approach of science teaching, inquiry-based learning and assessment methods that should be used in this teaching have created question marks. Inquiry-based learning is incomplete when it is taken in one hand. One of the missing points is about the evaluation method that will be used in education. Nowadays, there are research results that indicate that formative assessment practice can be the most important factor in increasing the academic achievement of all students and especially low success students (Black & Wiliam, 1998). Feedback used in the formative assessment is not a necessary aspect of inquiry-based education but is an important point. Formative assessment is very suitable for inquiry-based learning which aims to develop a scientific understanding of students through a direct interaction with real situations and materials. The importance of inquiry and formative assessment into learning, which have increasing value from day to day, and the results obtained after the application are important for the education system and the teaching to be performed. When the literature is examined, some studies related to inquiry-based learning and formative assessment have been found. However, it is noteworthy that the number of studies, dealing both of them, was very rare. Besides, most of these studies were conducted with the students in primary and secondary schools. It is thought that this study will have an important contribution to the field in the light of the answers to the question about whether the formative assessment used in the inquiry-based learning has an effect on the students' attitudes towards physics. Based on this, a research question was determined as the following:

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- Is there a significant difference between the experimental group students who are exposed to formative assessment in inquiry-based learning and the control group are not exposed to formative assessment in inquiry-based learning in terms of the attitudes towards physics?

Methodology

A quasi-experimental approach with pre-test post-test control group (Creswell, 2014) was used as the design of the study. The control group (Group A) and the experimental group (Group B) were selected without random assignment.

Participants and Settings

Participants of the study consisted of 10th grade students studying at an Anatolian High School. One of the 10th grade branches was assigned as a control group and the other one as the experimental group. The study was conducted in five weeks with 41 students. The participants were taught geometrical optics in two hours a week. While guided inquiry-based instruction was applied in both groups, formative assessment was utilized only in the experimental group. In both groups, shadow and plane mirror, refraction, lenses, lens-eye and optical instruments and color concepts were taught as a part of Optics unit. Before the beginning of the implementation process, lesson plans for guided inquiry-based instruction were prepared for each lesson with the contents appropriate for the curriculum acquisition.

Role of the Researcher

In this study, the researcher was also the teacher and the observer during the implementation. While she was a teacher, she stayed away from her role of researcher and approached both groups impartially and equally. She created a classroom environment in both groups to make them comfortable and express their thoughts without hesitation.

Data Collection Tools

Physics-Related Attitudes Scale was used as a data collection tool in this study. In order to determine the attitude towards physics in Günay (2008) study, the term “science” in the TOSRA (Test of Science-Related Attitudes) scale was changed into “physics” and it was called the Physics-Related Attitude Scale. TOSRA was developed by Fraser (1978). The scale consisted of 70 statements in a 5-point Likert scale type. It included the following seven sub-dimensions: social implications of science, normality of scientists, attitude to inquiry, adoption of scientific attitudes, enjoyment of science lessons, leisure interest in science and career interest in science. The Cronbach Alpha reliability coefficient value of the scale was found as 0.939.

Data Analysis

Descriptive statistics were performed to analyze the data. The effect of formative assessment in inquiry-based learning was examined by using both dependent and independent t-tests. Effect size were also calculated.

Results and Discussion

The effects of formative assessment in inquiry-based instruction on high school students’ attitudes toward physics was investigated in the study. There was no significant difference between the groups’ pre-tests (see Table 1). The findings based on the attitude scale revealed that there were significant increases within the groups pre-and post-tests and between the groups’ post-tests (see Table 2, Table 3 and Table 4).

Table 1. Control and experimental groups' independent sample t test findings for the attitude scale pre-tests

Group	n	x̄	SS	Min. Point	Max. Point	sd	t	p
Control Group (Pre-Test)	21	260.85	26.80	70	350	39	-0.327	0.746
Experimental Group (Pre-Test)	20	263.55	25.93					

According to Table 1, there was no significant difference between the scores obtained from the attitude test of the control and experimental groups ($t_{(39)}$ =-0.327, p>0.05). According to these findings, it was understood that both groups were similar before the implementation.

Table 2. Control group's dependent sample t test findings for the attitude scale

Group	n	x̄	SS	sd	t	p	Cohen's d
Control Group (Pre-Test)	21	260.85	26.80	20	-6.53	0.000	0.31
Control Group (Post-Test)	21	268.76	23.78				

A significant difference was found between the pre-test and post-test scores of the control group students according to Table 2 ($t_{(20)}$ = -6.53, p<0.01). This finding showed that the inquiry-based instruction which was used in the control group made a statistically significant increase in students' attitudes towards physics. When related literature was examined, it was observed that both domestic and international studies supported the findings (Altunsoy, 2008; Gibson & Chase, 2002; Johnson & Cuevas, 2016; Keçeci, 2014; Keçeci & Yıldırım, 2017). In some studies, it was recognized that students had more positive attitudes towards science courses where inquiry-based instruction was implemented.

Table 3. Control and experimental groups' independent sample t test findings for the attitude scale post-tests

Group	n	x̄	SS	sd	t	p	Cohen's d
Experimental Group (Pre-Test)	20	263.55	25.93	19	-15.24	0.000	0.82
Experimental Group (Post-Test)	20	284.60	24.94				

A significant difference was found between the pre-test and post-test scores of the experimental group students according to Table 3 ($t_{(20)}$ = -15.24, p<0.01). This finding showed that formative assessment and inquiry-based instruction applied in the experimental group resulted in a statistically significant increase in students' attitudes towards physics.

Table 4. Control and experimental groups' independent sample t test findings for the attitude scale post-tests

Group	n	x̄	SS	Min. Point	Max. Point	sd	t	p
Control Group (Post-Test)	21	268.76	23.78	70	350	39	-2.08	0.044
Experimental Group (Post-Test)	20	284.60	24.94					

Table 4 supported the finding that formative assessment increased the students' attitudes towards physics ($t_{(39)}$ =-2.08, p<0.05). Ainsworth (2006) addresses the differences between tests and evaluations, and draws attention to the fact that assessments encourage learning, help students develop positive attitudes toward a topic, and provide feedback on what they know and do. After examining the effect of formative assessment used in science lessons on academic achievement and attitude, Casey (2005) claims that there is a relationship between the use of formative assessment and attitudes towards the usefulness of science. Similar studies support the findings that formative assessment positively affects students' attitudes towards science.

Table 5. Findings on the comparison of the sub-dimensions of the physics-related attitude Scale of control group

Sub-dimensions of Physics-Related Attitude Scale	Control Group Pre-Test Mean	Control Group Post-Test Mean	Control Group Mean Difference	
Social Implications of Physics	40,09	41,19	1,10	
Normality of Physicists	35,58	37,86	2,28	*
Attitude to Inquiry	39,00	40,57	1,57	
Adoption of Scientific Attitudes	40,33	40,71	0,38	
Enjoyment of Physics Lessons	37,91	39,48	1,57	
Leisure Interest in Physics	34,71	35,19	0,48	
Career Interest in Physics	33,23	33,76	0,53	

*: It represents a meaningful difference is the sub-dimensions.

According to the findings shown in Table 5, the control group showed a significant increase only in normality of physicists sub-dimension.

Table 6. Findings on the comparison of the sub-dimensions of the physics-related attitude scale of experimental group

Sub-dimensions of Physics-Related Attitude Scale	Experimental Group Pre-Test Mean	Experimental Group Post-Test Mean	Experimental Group Mean Difference	
Social Implications of Physics	40,85	43,50	2,65	*
Normality of Physicists	37,15	40,05	2,90	*
Attitude to Inquiry	40,15	43,75	3,60	*
Adoption of Scientific Attitudes	42,40	44,35	1,95	*
Enjoyment of Physics Lessons	35,75	40,45	4,70	*
Leisure Interest in Physics	35,10	39,25	4,15	*
Career Interest in Physics	32,15	33,25	1,10	

*: It represents a meaningful difference is the sub-dimensions.

According to Table 6, the experimental group showed a significant increase in almost all the sub-dimensions except for career interest in physics.

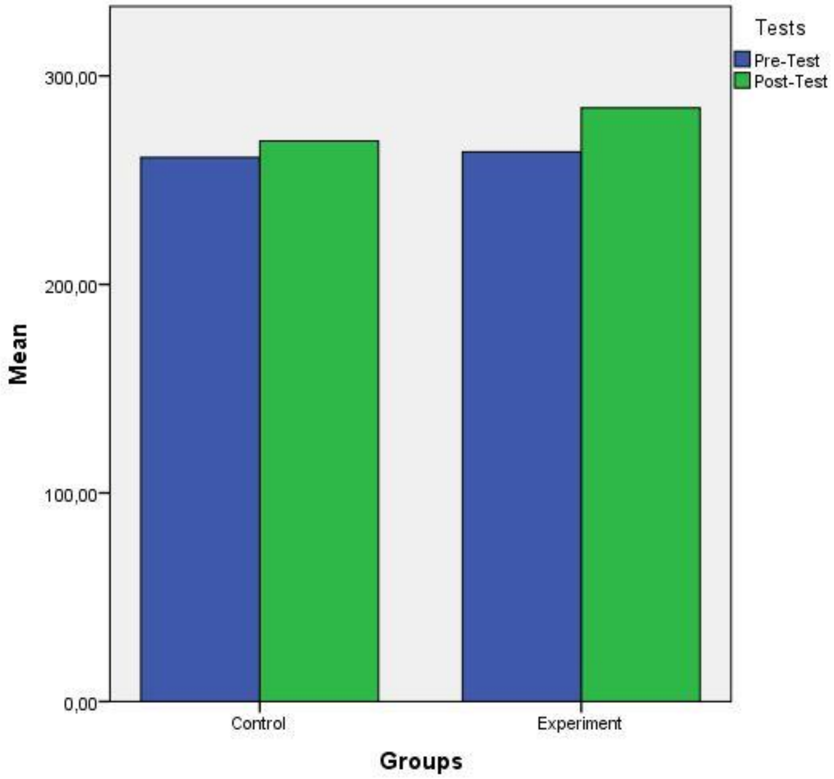

Figure 1. The comparison graph of control and experimental groups' Pre-Test and Post-Test about attitude towards physics

Figure 1 is a summary of all the above findings, where the pre-tests and post-tests of the control and experimental groups were given comparatively. Reviewing the literature indicates that the findings about effects of the formative assessment on students' attitudes are supported by other studies. In some of the studies there is evidence that formative assessment has positive effects on students' attitudes (Ozan, 2017; Tekin, 2010; Yalaki, 2010;). In some other studies, it is mentioned that after using formative assessment practices, students' participation in class has increased, they have found the lesson fun and exciting, students are more interested in the lesson and they are motivated to learn (Bulunuz & Bulunuz, 2013; Cauley & McMillan, 2010; Elmahdi, Al-Hattami & Fawzi, 2018; Günel, 2014; Weurlander, Söderberg, Scheja, Hult & Wernerson, 2012).

Conclusions

This study concludes that inquiry-based instruction has a positive effect on students' attitude towards science. The study also concludes that formative assessment correctly completed and supported in the inquiry-based teaching and learning has more positive effects on students' attitudes towards science.

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Project to Train 6th And 7th Grade Students in Math Olympiads

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Abstract: In Brazil, the teaching of mathematics present itself in a decontextualized, inflexible and immutable way, it being the product of privileged minds. The Brazilian Mathematical Olympiad (OBMEP) is a national project directed to the public and private schools, it carried out by the National Institute of Pure and Applied Mathematics, with the support of the Brazilian Society of Mathematics and it is promoting by the Ministry of Education and the Ministry of Science, Technology, Innovation and Communications. This project came about in order to improve the interest of mathematics in children and adolescents, and also, to solve difficulties that for many people turn out to be something frustrating. In addition, it contributes to a higher classification of them in OBMEP, which it's an important competition to discovery of new talents. Voluntarily, students from various engineering courses were instructed and trained to teach classes to 99 students enrolled in the 6th and 7th years, with 52% belonging to public schools and the other 48% of private schools. Contents in the areas of Arithmetic, Combinatorial Analysis and Geometry were addressed, on Saturdays, at the Federal University of Technology, Parana, for free and didactic. The approximation of the academic community to society, together with the constant participation of the family and the encouragement of the teachers, it contributed significantly to the success of the project. Besides to presenting a greater number of classified in relation to previous editions, statistics point to satisfactory results, not only in the educational area, but also in the social context, once the students have come into contact with children of the same age, but different realities. Students dropout rates were lower for public school (42%), it be confirming the need for more attention in education and it be reinforcing the relevance of this work.

Keywords: Elementary school, Mathematics, Obmep

Introduction

The posture of the math teacher in the classroom has beeing evolved a lot in the last decades. Today, these are always in the search of the approach of the learning to the daily of the students, it making the content more pleasant. However, there is still a lot of difficulty in how to maintain attention and the enthusiasm when it comes to this subject.

The teaching of mathematics was introduced in Brazil in mid-1550 by the Jesuits, in order to approach the arithmetic operations, reason, proportion and euclidean geometry (Valente, 1999). In his studies, Bravo (2007) states that our brain has a genetically imprinted numerical capacity. In this way, we are advised the teaching of

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mathematics through the development of intuitive reasoning, manipulation of materials and the use of play in the presentation of activities.

With the purpose of a differentiated approach and in order to reinforce the content taught in the classroom to the students of the 6th and 7th years of elementary school, from the public and private schools in the city of Apucarana - PR - Brazil, it was emerged the project "Train 6th and 7th grade students in math olympiads (OBMEP)". Its main objective is to encourage and improve students' logical reasoning and enable the highest number of students in the Olympiad.

OBMEP is a national project directed to Brazilian public and private schools, carried out by the National Institute of Pure and Applied Mathematics (IMPA), with the support of the Brazilian Society of Mathematics (SBM), and promoted with resources from the Ministry of Education and the Ministry Science, Technology, Innovation and Communications (MCTIC). In the quest for new talents and future scientists, this Olympics promotes a healthy dispute between elementary and middle school students, encouraging them to study mathematics. It is held in two phases, the first classifier and eliminatory, held in the school itself, and containing multiple choice questions. The second phase is performed only by those selected and has discursive questions, raising the level of difficulty.

Method

The teaching project aims at the largest possible number of elementary students in the city of Apucarana and region, which it requires the performance of a large team to organize and carry out the activities.Faced with this situation, the first step was to divulge a proposal among all the teachers and students enrolled at the Federal Technological University of Paraná - Câmpus Apucarana, in a search of interest in participating. One scholar and seventeen volunteers, who could be able to work and help the children, they have been selected. The second stage involved the dissemination of the project to an outside community, where an application form was communicated and attached to be passed on to students interested in all public and private schools in the last week of 2018.

Three groups of studies for division of tasks were formed, each responsible for the following themes: Combinatorial Analysis, Arithmetic and Flat and Space Geometry. Next, the criteria for the formulation and resolution of lists of exercises based on previous editions of OBMEP were established, according to each topic and group, and later applied to the children. The first meeting with the students was held in the second week of March, 2018. On that day, the interested parties were registered and a brief meeting was held with those responsible for clarification. From then on, according to the schedule, activities were performed on Saturdays (Figure 01 and Figure 02), conducted by volunteers always under the supervision of the coordinator.

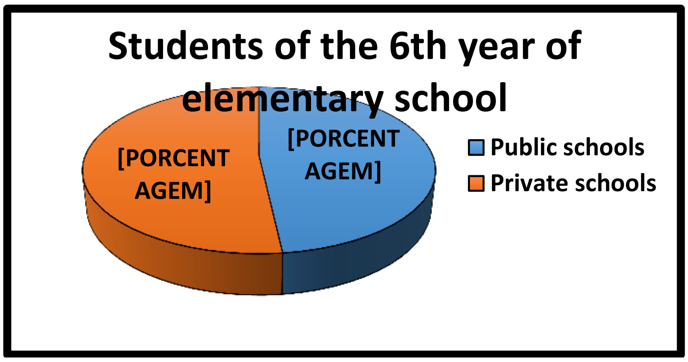
Figure 1. Activities worked by the volunteers in the 6th grade class
Source: Author data (2018)

Figure 2.Activities worked by the volunteers in the 7th grade class
Source: Author data (2018)

In June 2018, the first phase of the OBMEP was held and the project activities continued, both for those students who were approved for the second phase and those who were simply interested in continuing. The difference was in the way of working the lists, and the approach was directed to the second phase of the Olympiad, using instead discursive rather than objective questions. As the degree of difficulty increased, the doubts of the students became more frequent, consequently, demanding more attention from the volunteers.

Results and Discussion

In all, 99 student enrollments were made, among which there was no significant difference of interest between public and private schools, both for the 6th grade and the 7th grade (Figure 03).



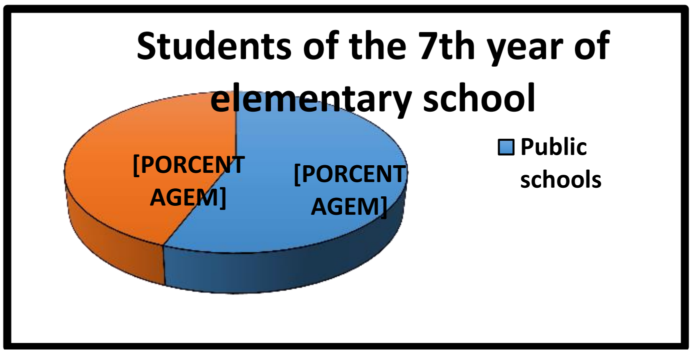


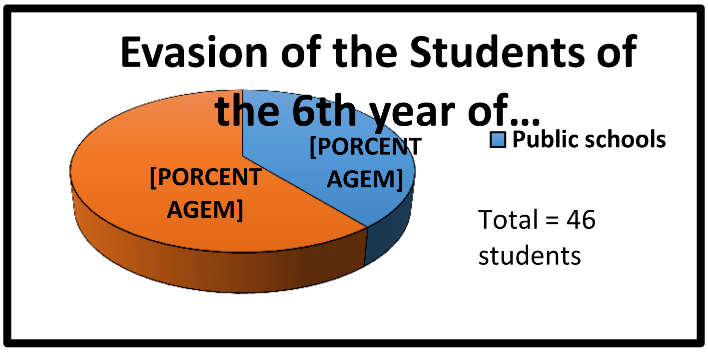
Figure 3. Number of enrollments of students from 6th and 7th
Source: Data of the author (2018)

Two classrooms of the Universidade Tecnológica Federal do Paraná - Câmpus Apucarana were used, with the purpose of dividing the classes by level of education: 6th and 7th grades. In this way students from public schools and students from private schools of the same period began to share the same study environment and to have egalitarian learning opportunities. As expected, this factor had no influence on the conduct of activities and no less the interaction between children. However, the difference in prior knowledge acquired among these students is striking, with public school students presenting a considerable deficit of content, making them more difficult than those coming from private schools. Whenever they have had some opportunity, they would help each other and exchange information about the content and the routine of the school. In this way, the project also contributed to the personal growth of the students, showing that, even when they lived different school realities, all were there with a common goal: the search for more knowledge.

In addition to approaching more of a discipline considered complex, as mathematics is designated by many, it during the meetings it was possible to notice the animation of the students in being able to participate in activities in the physical space of the UTFPR and also the parents' satisfaction in being able to present a university , with quality and free education, to the children, so early.

In the period from March to June the classes remained full, and the absences, when they happened, it were justified by those in charge. In addition, several reports of improved grades in school subjects were pointed out by the parents who accompanied their children in the meetings.

In July, due to the recess of UTFPR classes, the classes were suspended, as was already stated in the schedule. However, after that vacation, there was a certain dropout of students from both public and private schools (Figure 04).



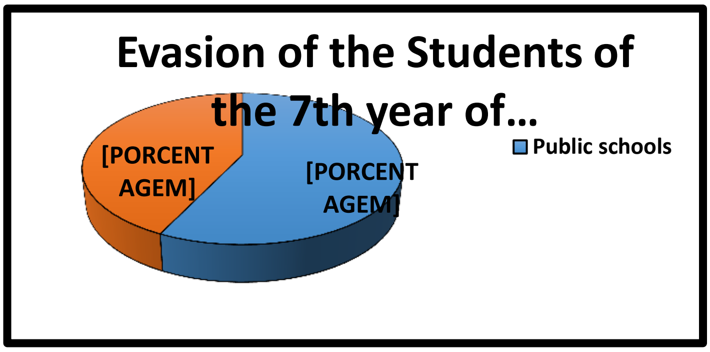


Figure 4. Number of students dropout in grades 6 and 7 Source: Author data (2018)

In relation to those approved for the second phase of OBMEP, the results reached expectations and caused an impact on the public served, demonstrating that the students who participated in the project learned during the activities carried out. Among the students enrolled in the 6th year, 3 were classified for the second phase, one of them being a public school student. In relation to the 7th grade students, 5 were classified, and all of the private education network. After the announcement of the results of the second phase, it was verified that the students of the city of Apucarana obtained a very satisfactory result, since, 12 students from public schools were awarded and 6 students from private schools. Of these, three effectively participated in the project, it winning two bronze medals an honorable mention.

Regardless of the classification or not, the students continued to attend the project, and they admitted a greater interest in mathematics and also reported that their grades had been better than in previous years. This fact indicates the social relevance that the work developed causes in the community.

Conclusion

It is noteworthy that the project contributed to the improvement of the logical and mathematical reasoning of the students who attended UTFPR activities, and also allowed a significant number of approved ones. The way in which it was developed allowed a constant contact between UTFPR students and teachers with the community, thus being able to better meet and understand the individual expectations of each one.

In addition to contributing to the training of children, the project also contributed to the professional growth of undergraduate students, who acquired maturity and responsibility during the preparation of the material and also in the execution of the proposed activities.Aiming at improving and taking into account suggestions, some changes regarding the enrollment of students from the private network and the production of material are being analyzed.

Aiming at improving and taking into account suggestions, some changes regarding the enrollment of students from the private network and the production of material are being analyzed.Due to the high impact and positive satisfaction, the project aims to continue the activities carried out, seeking to be more efficient and above all, always it willing to serve students who seek knowledge and dream of making a difference in the world.

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The Effect of Augmented Reality Applications on the Attitudes of Middle School Students towards Astronomy

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Abstract: In this study, the effect of augmented reality applications on students ' attitudes towards astronomy was investigated. In this study, seventh grade students studying in two different classes in a public school were used. One of the classes was determined as a control group and the other class was determined as an experimental group. Astronomy Attitude Scale was used as data collection tools. For 4 weeks, the Solar System and Beyond Unit were processed in the control group in accordance with the curriculum, while the experimental group was supported with augmented reality applications. The Astronomy Attitude Scale was applied as a pre-test to both groups before the application started. After the application, the same test was applied as a post-test to both groups. The obtained data were analyzed with SPSS 22 statistical package program and t-test was used in the evaluation of the obtained data. According to the results of the post-test scores of Astronomy Attitude Scale, a statistically significant relationship was found in favor of the experimental group. Accordingly, it has been shown that augmented reality applications improve the attitudes of middle school students towards astronomy.

Keywords: Agumented reality, Astronomy education, Attitude, Solar system unit

Introduction

The age in which we live is a time when computers and the internet have become completely central and digital applications occupy more space in everyday life and the communication styles of the masses are changing (Arslan and Elibol, 2015). The way students' access and present information in educational and instructional environments is influenced by technological changes in this digital age. One of the possibilities that arise in the direction of these technological changes is the Augmented Reality (AR) applications.

AR is used for education in the fields of environment, construction, electrical engineering and architecture with courses such as geometry, mathematics, geography, anatomy and visual arts. It is not limited to the field of education but also in many fields such as military, design, sports and health. For example, the medical industry can operate using virtual reality glasses; the location and color of the objects can be changed by using barcode readers in the field of construction and architecture; the objects can be touched and even heard by the help of gloves and glasses in the field of advertising. Many applications have been designed to be used in Science Education recently on the dissemination of the idea that AR can be used in educational environments (Kırıkkaya and Şentürk, 2018).

Examples of these applications include Anatomy 4D, which provides learning of human anatomy in the interactive 4D experience, Quiver 3D, which enables the study of objects, organelles in cells, Animal 4D+, which allows the introduction of animals, Elements 4D, which allow the four-dimensional representation of elements ' symbols, atomic numbers, and physical states, Octaland 4D, which enables the promotion of professions. The first of the AR applications used in the study is Space 4D, which allows the study of planets in the solar system in a four-dimensional way. The other is the Spacecraft 3D developed by NASA, which promises a fun experience, allowing you to have a portable, realistic experience on the table of many spacecraft, including curiosity. Another is Star Tracker, an application to study celestial objects such as stars, comets, and constellations (Kırıkkaya and Şentürk, 2018).

- Selection and peer-review under responsibility of the Organizing Committee of the Conference

Research Problem

What is the impact of Augmented Reality (AR) applications on students ' attitude towards the astronomy in science lesson?

Sub-problems

Answer to the following sub-problems related to the problem sentence of the research:

1. Do the astronomy attitude scores of the experimental and control groups differ in the pre-test?
2. Do the astronomy attitude scores of the control group differ from pre-test and post-test?
3. Do the astronomy attitude scores of the experimental group differ from pre-test and post-test?
4. Do the astronomy attitude scores of the experiment and control groups differ in the post-test?

Method

In this study, the effect of augmented reality applications on students ' attitudes towards astronomy was investigated. In the research, quasi-experimental design with pretest-posttest control group has been used. In this quasi-experimental study, the experiment and control group were determined as neutral but the subjects in the groups were not identified as neutral. Because the study was carried out on formal students and the assignment of students to experimental and control groups was not created artificially, as it would cause disruption of the educational process that is currently underway. The research consists of 56 students studying in the seventh grade of a middle school affiliated to MoNE in Hadim District of Konya Province.

Table 1. Number of students in groups

Group	Male	Female	N
Experimental	16	12	28
Control	13	15	28
Total	29	27	56

In order to measure the students ' attitudes towards astronomy, The Astronomy Attitude Scale was used. The scale refers to 15 expressions with 10 negative and 5 positive expressions in five Likert type. Each expression is numbered from 1 to 5, from the students' negative attitudes towards astronomy to their positive attitudes. The applied astronomical scale has been evaluated over 75 points.

It was developed by Zeilik, Schau and Mattern (1999) and adapted to Turkish by Bilici, Kılıçan, Çakır and Yürük (2012). The internal consistency and sub-factors of the scale were determined in the study. Reliability coefficient was found to be α =.80. It is important to note that the reliability coefficient is more than .70, so it is assumed that the measurement tool has sufficient reliability and is used to collect data (Büyüköztürk, 2011).

"Solar System and Beyond " unit topics were lectured in both groups for 4 weeks. The subjects were explained to both groups by the researcher. In this way, individual differences in teaching skills of the teacher were eliminated and the teaching was made more effective. The subjects were explained to the experimental group using Augmented Reality applications. The control group was told by using the experiments and activities in the textbook according to the Science Curriculum.

The Astronomy Attitude Scale was applied to the experiment and control group as both pre-test and post-test. Data obtained from the study were analyzed by SPSS 22 statistical program. The level of significance was determined as 0.05.

Before starting the study, "independent t-test" was used to compare two independent groups, whether there was a significant correlation between the experimental group and control group's test results of the Astronomy Attitude Scale applied to both group. The Control and Experimental Group's Astronomy Attitude Scale was determined by applying the "dependent t-test" used to compare two measurements from a single group to determine whether there is a significant relationship between pre-test and post-test results. The "independent t-test" was used to compare two independent groups to determine whether there was a significant correlation between the post-test results applied to the experimental and control groups.

Findings

Sub-Problem 1: Do the astronomy attitude scores of the experimental and control groups differ in the pre-test?

Astronomy Attitude Scale applied to control and experiment groups after analysis of pre-test results, pre-test score averages, standard deviations (SD), degree of freedom (df) and p values were given in Table 2. The Astronomy attitude test applied as a pre-test is close to each other ($\overline{X}_{control}$=30, 21; $\overline{X}_{experimental}$=30, 60).

Table 2. Astronomy attitude scale control and experimental groups Pre-test data

Group	N	$\overline{X}$	SD	df	t	p
Control group pre-test	28	30,21	10,06	54	0,14	,886
Experimental group pre-test	28	30,60	10,40			

As shown in Table 2, there is no significant difference between the groups (t=0, 14, p=, 886; p>, 05). This result shows that the pre-study Astronomy attitudes between the experimental group and the control group are close to each other. According to this, the scores of both groups ($\overline{X}_{control}$=30, 21; $\overline{X}_{experimental}$=30, 60) are close to each other and since there is no significant difference between them, it can be said that the purpose of the research is appropriate.

Sub-Problem 2: Do the astronomy attitude scores of the control group differ from pre-test and post-test?

After the analysis of pre-test and post-test scores applied to the control group, the mean scores, standard deviations (SD), degree of freedom (df) and p value were given in Table 3. The mean of pre-test scores of the control group students was $\overline{X}_{control}$=30, 21; the post-test scores were $\overline{X}_{control}$=36, 35.

Table3. Astronomy attitude scale control group Pre-test and Post-test data

Group	N	$\overline{X}$	SD	df	t	p
Control group pre-test	28	30,21	10,06	27	8,96	,000
Control group post-test	28	36,35	11,59			

As shown in Table 3, there is a significant difference between the groups (t = 8, 96, p =, 000; p <, 05). It is understood from these results that the Science Curriculum produced a statistically significant difference in the students' attitudes toward the astronomy at the end of the control group.

Sub-Problem 3: Do the astronomy attitude scores of the experimental group differ from pre-test and post-test?

After the analysis of pre-test and post-test scores applied to the experimental group, the mean scores, standard deviations (SD), degree of freedom (df) and p value values were given in Table 4. Students in the experimental group pre-test average score on the $\overline{X}_{experimental}$=30, 60; post-test average score on the $\overline{X}_{experimental}$=40, 21 as were found.

Table 4: Astronomy attitude scale experimental group Pre-test and Post-test data

Group	N	$\overline{X}$	SD	df	t	p
Experimental group pre-test	28	30,60	10,40	27	6,16	,000
Experimental group post-test	28	40,21	13,30			

As shown in Table 4, there is a significant difference between the groups (t = 6.16, p = .000; p <. 05). It is understood from these results that there was a statistically significant difference in the attitudes of the students towards the astronomy in the experimental group in which Augmented Reality applications were applied.

Sub-Problem 4: Do the astronomy attitude scores of the experiment and control groups differ in the post-test?

Astronomy Attitude Scale are applied to the experimental and control groups' post-test scores of "independent groups t-test after analysis, the mean score, standard deviations (SD), degree of freedom (df), and p value are given in Table 5.

Table 5. Astronomy attitude scale control and experimental groups Post-test data

Group	N	$\overline{X}$	SD	df	t	p
Control group post-test	28	36,35	11,59	27	3,98	,000
Experimental group post-test	28	40,21	13,30			

Students in the control group post-test average score of $\overline{X}_{control}$ =36, 35; students in the experimental group post-test average score on the $\overline{X}_{experimental}$ =40, 21 as were found. There was a statistically significant difference between the scores of the two groups (t=3, 98, p=, 000; p<, 05).

Results

The study found that the use of augmented reality applications improved students ' attitudes toward astronomy. In addition, in the renewed science curriculum, it was observed that the students ' attitudes towards astronomy are at an adequate level.

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Analysis of Teacher Candidates Perception of Learning Theories in the Light of Anthropological Theory of Didactic

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Abstract: This research aims to determine the perceptions of prospective teachers of learning theories and the factors affecting the development of these perceptions. For this purpose, institutional and individual recognition (in termes of Antopological Theory of Didactic) related to university-level learning theories of prospective teachers were determined based on anthropological theory and the relationship between them was investigated. In this context, firstly, the sources belonging to the courses about the learning theories (lecturers' lecture notes, books, etc.) were analyzed using ecological and prakseological approaches. Then, in order to determine the knowledge level of the prospective teachers about learning theories, a success test consisting of open-ended questions developed by the researchers was applied.As a result of the study, it was determined that candidate teachers internalize behavioral learning theories but they have important difficulties related to other theories . According to this, the basic problems encountered in the individual definitions of these theories have been revealed and comporaed with the institutional definitions.Please use 14-point bold for your article title, with an initial capital letter for any proper nouns. Please margin the article title to the center. Please use one blank line between all author names on the first page. All the authors of a paper should include their full names, affiliations, postal addresses, telephone and fax numbers and email addresses on the last page of the manuscript. One author should be identified as the Corresponding Author and has a contact email. An informative 10-point abstract (100 to 300 words) presenting the main points of the paper and conclusions. Please include descriptive keywords (up to 5). Separate keywords with a comma. Capitalize the first letter of each keyword (e.g., Science education, Survey development). Add your abstract here. Add your abstract here. Add your abstract here. Add your abstract here. Add your abstract here. Add your abstract here. Add your abstract here.

Keywords: Anthropological theory of didactic, Teacher candidates perception, Learning theories

Introduction

One of the most important properties putting mankind at a distinct place among the wider set of living things is its ability to learn. Yet, there are no universally accepted and all-encompassing theories on how the learning skill was developed. A glance at the literature, academic or otherwise, reveals numerous hypotheses and theories on this topic. Behavioralist theories have the distinction of being the first ventures into understanding learning in a historical perspective, and explain learning with reference to stimulating behaviors, focusing on the changes in observable behavior, rather than on mental processes (Duman, 2006). It is assumed that learning occurs by establishing a connection between the stimulant and the behavior, while reinforcements lead to the acquisition of the behavior. The lasting marks left by the interaction the individual has with the environment constitute the experiences of the individual. Learning, in turn, is the product of such experiences. According to behavioralist theories, reinforcement, repetition and motivation are the principle elements of learning (Ulusoy, 2006). Studies on learning revealed that the behavioralist theory's shortcomings in explaining complex cognitive processes such as perception, personality, problem-solving, and attention, sparked the transition from behavioralism to cognitive approaches (Ün Açıkgöz, 2003).

The cognitive theory considers learning a mental process, and refers to unobservable cognitive processes going beyond observable behavior in order to explain how it occurs (Fer, 2011). One can go into further detail in terms of categorizing cognitive theories, however: "discovery" theories arguing that learning is about discovering, "information-processing" theories focusing on the memory process, and "significant learning" theories claiming that learning can be achieved in a meaningful way (Fidan, 1985).

The constructivist theories which drew substantial attention in recent years in the cognitive theories scene, and which emphasize the act of discovery, can be considered a perspective with a rich background, rising on the research and thoughts of numerous researchers. This perspective is built on the views of a number of household names in education sciences, such as Bruner, Vygotsky, Piaget, and Dewey, who in turn can be considered distant students of Socrates, Kant and Rousseau, and thus combines the outlooks of various schools of thought in education sciences in particular, and positive social sciences in general (Yurdakul, 2004).

Constructivism is based on a number of principles whereby social interaction entailing unique learning tasks for seeking, interpreting and analyzing knowledge, enhancing the thought-provoking process, integrating past and new experiences, and finally meaningful learning, plays a crucial role (Şaşan, 2002, quoted by Yeşilyurt, 2012).

Purpose

Pre-service teachers, who would go on to assume a huge responsibility in the learning process at the school, should have some robust ideas on how to achieve the most effective form of learning, and thus be aware of the theories covering various dimensions of the learning process. In this context, the present study aims to understand the pre-service primary school teachers' perceptions regarding learning theories, and identify the factors playing a part in the development of such perceptions.

In the light of this goal, the study is based on the anthropological theory of didactics, emphasizing teaching's impact on learning. The anthropological theory of didactics is built around the hypothesis that learning on part of the individual takes place under the influence of institutions. This theory states that the individual's perception of a piece of knowledge is directly associated with the contexts the individual faces (with respect to the knowledge in question), and is even a reflection of such contexts (Chevallard, 1989). In that case, any setbacks in the individual's perception of the knowledge (such as misconceptions or faults) would be associated with the systems teaching that knowledge, rather than circumstances arising from the individual herself. Against this background with significant references to the anthropological theory of didactics, this study aims to answer the question "what is the pre-service teachers' level of familiarity with learning theories, on an individual basis?"

Method

The research method employed in the study was case study survey, one of the descriptive methods of research. Descriptive research methods enable research without any interruption of the existing natural conditions during the analysis process, and without causing any change in the environment analyzed (Çepni, 2010). The present study's focus on learning theories and learning state at the 4th year of the program, marked by an absence of intervention in the existing environment during the study, makes it clear that the research perspective exhibits the characteristics of descriptive research. The study analyzes the features of institutional recognition and the associated development of recognition on part of the student. In other words it aims to describe a certain existing state of affairs. In this context, the research model chosen was one of surveying, namely the "Case Study Survey Model".

In the study, a competence test composed of open-ended questions was developed to assess the pre-service teachers' perception of learning theories (their individual recognition levels), followed by the content analysis of the data thus gathered. The following questions were asked to the participants:

- Please define learning. Provide a brief explanation of your answer.
- State the most important factor affecting learning.
- Which learning theory is most effective in explaining learning, in your view? Why?
- Which theory and/or theories of learning will be serving as the foundation of your classes in the future? Please provide a brief course description to exemplify your answer.

Results and Discussion

The pre-service teachers' answers to the questions aiming to reveal the general characteristics of their individual recognition levels concerning learning theories are summarized in Table 1.

Table 1. Teachers' answers to open-ended questions

Definition of learning		
Answers	**Frequency**	Descriptions
Behavioral approach	18	-
Cognitive approach	1	-
Factors affecting learning		
Conditions that encourage learning	9	The environment affects the individual's learning (6)
Rudiments	5	-
Repeat	2	Repeat is required for permanent learning (1)
Rudiments Conditions that encourage learning	1	Preliminary information is important for configuring new information and the environment is effective in learning (1)
Unanswered	2	-
Learning theory that explains learning in the most effective way		
Constructivism	8	It is important to establish a link between old knowledge and new information in learning (2) Student-centered teaching strategies enable effective participation,(2)
Cognitive approach	3	Environmental factors affect the learning (2)
Unanswered	8	-
Learning theories that teacher candidates plan to use in future		
Modern Theories	12	Students are actively involved in the learning process. (3) Individual differences are taken into account in the teaching process (3) Provides effective learning (2)
Classical theories	1	Learning takes place by memorization (1)
Modern and classical theories	4	The process of structuring knowledge is important (2)
Unanswered	2	-

Table 1 presents the distribution of the pre-service teachers' answers to the questions included in the data gathering tool, along with a categorization of the answers. The pre-service teachers' answers were categorized under four main categories, with reference to the essence of the questions.

The table above reveals that 18 pre-service teachers defined learning in the light of the behavioralist perspective, while one pre-service teacher embraced a cognitive perspective in defining learning. It is also evident that the pre-service teachers did not provide any details to justify their answers. Below are a few direct quotes from the pre-service teachers' statements regarding the definitions by pre-service teachers.

S6: "*Scientifically speaking, learning is a state of the brain, occurring through intensive repetition*."
S8: "*It is a change of behavior with lasting impression, occurring with the student*."
S12: "*It is a change of the individual's behavior with relatively lasting impression, occurring through experience*."

Table 1 reveals that the pre-service teachers refer to just three factors as elements affecting learning, among many others identified in the context of learning theories, albeit with certain variations: preliminary knowledge, conditions encouraging/enabling learning, and repetition. Nine pre-service teachers were observed to emphasize the conditions encouraging/enabling learning, while five focused on preliminary knowledge, and two underlined repetition among the factors affecting learning. One pre-service teacher underlined two factors, while two pre-service teachers did not answer the question, as witnessed from the table. Some answers provided are quoted directly below:

S1: "*Availability is the most important factor affecting learning*."
S17: "*The individual's attitude, interest and the environment are the most predominant elements affecting learning, in my view*."

Within the framework of the study, pre-service teachers were asked 'which learning theory offers the best explanation of learning', with eight pre-service teachers mentioning constructivism, while 3 referred to the cognitive theory. Eight pre-service teachers left the question unanswered. Two pre-service teachers who referred to the constructivist theory noted the connections this theory established between the old and the new knowledge through the process of learning, while two others mentioned an association between effective participation and an embrace of the teaching strategies putting the student to the center stage. Below are some quotes from pre-service teachers:

S1: "*It is constructivism, for it establishes connections between the old knowledge and the new knowledge, and connects the knowledge to daily life.*"
S4: "*People do not easily forget what they had learned on their own. Each individual (self) should achieve learning through active participation.*"
S8: "*It is the social learning theory. I believe the environment factor plays a major part in learning on part of human beings. People learn more and easier in a social setting*."

In response to the last question of the data collection tool, asking about the theories the pre-service teachers intend to use once they take up teaching positions, more than half of the participants mentioned modern theories (Table 1). Among the justification provided for the use of these theories, pre-service teachers referred to their advantages in ensuring effective participation by the student, taking individual differences into account, and ensuring lasting learning. Four of the remaining pre-service teachers expressed their will to embrace modern and classic theories in conjunction, and one pre-service teacher noted the intention to adopt the classic theories. The answers provided by some of the participants are as follows.
S5: "*I would use the conventional learning theory. For the system based on memorizing is the most effective one. It can be coupled with cooperative and life-long learning as well*."
S12: "*It would be the constructivist learning theory. I can manage the process as a guide, taking the process into account along with the product itself, and attaching importance to individual differences. It would make me aware of the interests of the students, as well as multiple intelligences they have*."

Conclusion

The analysis of the data gathered within the framework of the present study carried out to identify the individual recognition characteristics pre-service teachers exhibit with respect to learning theories leads to certain fundamental results. The pre-service teachers who took part in the study often refer to a behavioralist definition of learning, claiming it is "a change of behavior with lasting impression", but fail to provide any further discussion of this definition. On the other hand, the pre-service teachers state that cognitive theories provide the most effective explanation of learning, and intend to employ these theories once they start teaching through their careers. This is proof that the pre-service teachers have embraced new perspectives towards learning, but have not yet engaged in scientific learning regarding these issues.

Recommendations

In line with the conclusions reached through the present study, one could recommend organizing the contents of undergraduate courses with a specific focus on the learning outlooks embraced by the existing learning programs, and a marked emphasis on applied practices to complement the theoretical insights in the courses.

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Development of Pre-service Teachers' Perceptions of Using Metacognitive Skills in Teaching and Learning Mathematics

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Abstract: In the present research, we educated mathematics pre-service teachers in using metacognition in their teaching of mathematics. This education was performed in one-year and was part of the participants' practical training in the training schools and in the frame of a reflection-based course related to the practical training. We studied the development of pre-service teachers' perceptions of using metacognition in teaching and learning mathematics. Twenty four pre-service teachers participated in the preparation. They were in their third academic year majoring in teaching mathematics and computer science in middle schools. We held interviews with the participating pre-service teachers twice, once at the beginning of the preparation and once at the end of it. To analyze the interview transcripts, we used inductive and deductive content analysis. The research results indicate that the participants developed their perceptions regarding metacognition and its use in students' learning, but at the same time, due to the time pressure, they intend to use mainly the 'planning skill' in their teaching of mathematics.

Keywords: Metacognition, Metacognitive skills, Mathematics teachers, Pre-service teachers

Introduction

One aspect of students' learning which researchers are taking care of in recent years is the metacognitive aspect. Metacognition makes students aware of their learning, where this awareness supports the internalization of what one learns (Belet & Guven, 2011). This awareness makes students consider how to answer problems posed in the classroom. The advantages of metacognition for students' learning make it necessary that colleges attempt to prepare pre-service teachers, so that they develop their knowledge of applying metacognition for teaching. This development is expected to develop also their perceptions of metacognition in teaching and learning. In the preparation that the present research reports and assesses, we intended to develop the metacognitive skills of mathematics pre-service teachers in addition to their use of metacognition in teaching mathematics. It is our intention to assess, through interviewing the participating pre-service teachers, the development of perceptions of metacognition for the teaching and learning of mathematics.

Literature Review

Researchers considered metacognition as cognition about cognition or knowledge about knowledge (Flavell, 1976; Panaoura, Philippou & Christou, 2003; Veenman, Van Hout-Wolters, & Afflerbach, 2006). Flavell (1976) was the first to use the term 'metacognition', which refers to the individual's awareness and control of his/her

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cognitive processes and strategies. Du Toit and Kotze (2009) argue that the various definitions of metacognitive processes in the literature, including that of Schoenfeld (1992), emphasize the monitoring and regulation of cognitive processes. Flavell (1999) described metacognition as 'knowledge that takes as its object or regulates any aspect of any cognitive endeavor' (p. 8). Furthermore, Panaoura et al. (2003) say that it coordinates cognition, affecting it and, as a result, affecting students' academic success. All the definitions and descriptions consider metacognition as the management of cognition.

Veenman et al. (2006) argue that the most common distinction in metacognition distinguishes between metacognitive knowledge and metacognitive skills. Flavell (1999) defines metacognitive knowledge as the knowledge about the factors that act and interact to affect the course and outcome of cognitive enterprises. These factors include the person, the task and the strategy. The person factor concerns what a person believes about himself/herself and other people as cognitive processors. The task factor concerns the information about the object available to a person during a cognitive enterprise, where different tasks entail different mental operations. The strategy factor involves knowledge about effective strategies in achieving goals and their cognitive undertakings.

Metacognitive skills in which the present research is interested refer to a person's procedural knowledge for regulating one's learning activities including problem solving (Brown & DeLoache, 1978; Veenman, 2005). Moreover, these skills are implied in Flavell (1976) referring to metacognition as the active monitoring, the consequent regulation and orchestration of processes performed on cognitive objects. They are also implied in Bonds, Bonds and Peach (1992) statement that metacognition is the regulation, evaluation, and monitoring of one's thinking. So, generally speaking, metacognitive skills are concerned with planning, monitoring, evaluating, orchestrating, reflecting on and controlling one's learning and cognitive processes.

In addition, researchers suggested ways to encourage students to use metacognitive processes (e.g., Spiller & Ferguson, 2011). Flavell (1979) emphasizes that metacognition improves with practice. Schoenfeld (1992) describes ways that students can practice to monitor and evaluate their performance on math problems. For example, pause frequently during problem solving to ask themselves questions such as "What am I doing right now?" Spiller and Ferguson (2011) say that if we want students to use metacognitive processes, we need to encourage them to consider the nature and sequence of their own thinking processes. Chauhan and Singh (2014) say that as students become more skilled at using metacognitive strategies, they become confident and more independent as learners. This independence leads to ownership as students realize their ability to answer and pursue their own academic needs.

Metacognition in Learning Mathematics

Metacognition has attracted the attention of mathematics education researchers. Schoenfeld (1992), as described above, suggests ways that students perform to use metacognition in mathematical problem solving. Barbacena and Sy (2015) examined university students' use of metacognitive skills in mathematical problem solving and found that the students exhibited metacognitive awareness, metacognitive evaluation and metacognitive regulation that operated as pathways from one to another metacognitive function. Moreover, Awawdeh-Shahbari, Daher and Rasslan (2014) investigated the relationship between mathematical knowledge and cognitive and metacognitive processes exhibited by students from Grades 6, 7, and 8 who engaged in a set of model-eliciting activities. The results of the study showed that the highest percent of cognitive processes and lowest percent of metacognitive processes occurred amongst the Grade 6 students, while the lowest percent of cognitive processes and highest percent of metacognitive processes occurred amongst the Grade 8 students. The Grade 6 students' metacognitive processes were more awareness than regulation and evaluation skills. Conversely, the Grade 7 and 8 students employed more regulation and evaluation processes. Furthermore, Daher, Anabousy and Jabarin (2018), studying the relations between the social aspect, the metacognitive aspect and the cognitive aspect of students' learning found that most of the means of claiming leadership were metacognitive in nature and were performed to enable the advancement of the group learning of the mathematical topic. The contribution of the metacognitive skills and knowledge to students' learning makes it necessary for educators to educate pre-service teachers to value and use these metacognitive knowledge and skills in their learning and teaching. Baya'a, Daher, Jaber and Anabousy (2018) report the educating of mathematics pre-service teachers to use metacognitive skills. This preparation encouraged the participants to use these skills as learners, where this use utilized the mobile technologies. In a later phase, the pre-service teachers used these skills as teachers to encourage their students to use metacognitive skills collaboratively (Baya'a et al., 2018).

Research Question

How would mathematics pre-service teachers develop their perceptions of metacognition in mathematics teaching and learning as a result of one year preparation?

Methodology

Research Context and Participants

The preparation was held for a full academic year 2016-2017. Twenty four pre-service teachers participated in the preparation. They were in their third academic year majoring in teaching mathematics and computer science in middle schools. Two of the authors, who were the pedagogical supervisors of these pre-service teachers, accompanied them in two middle schools in the frame of the practical training. Our preparation of the pre-service teachers in metacognitive knowledge and skills was based on the work of Davidson and Steinberg (1998) with special emphasis on using mobile technologies for solution strategies. In addition, special attention was given for collaborative learning among the pre-service teachers' students groups.

The preparation of the pre-service teachers went through the following phases (Daher, Baya'a, Jaber & Anabousy, 2018): (1) Theoretical preparation of metacognitive thinking, (2) designing activities that encourage metacognitive thinking, (3) implementing the metacognitive activities as learners and as teachers, (4) reflection and evaluation of the whole preparation process.

Data Collection and Analysis

We held interviews with the participating pre-service teachers twice, once at the beginning of the preparation and once at the end of it. The interviews were focus group. We stressed at the beginning of each interview that there are no wrong answers but rather differing points of view (Krueger, 2002). We also directed the participants to feel free to share their perceptions of metacognition and metacognition in teaching even if it differs from what others hold.

Examples on the interview questions are:

1. What is the difference between metacognition and cognition?
2. How can the mathematics teacher encourage her students to use metacognitive skills in their learning of mathematics?

To analyze the data (the interview transcripts), we used inductive and deductive content analysis which is a process designed to condense raw data into categories or themes based on valid inference and interpretation that use inductive and deductive reasoning. The goal of deductive reasoning is generating concepts or variables from theory (Patton, 2002). Using the deductive reasoning we looked for themes related to the metacognitive skills as described in Davidson and Steinberg (1998). Using the inductive reasoning, we tried to find out if additional metacognitive skills, not given in the literature, are described by the pre-service teachers.

Findings

Perceptions of Metacognitive Skills

In the pre-interview, some of the pre-service teachers knew theoretically what metacognition is. They knew that (1) it involves thinking on thinking, (2) it involves skills as evaluating and modifying the solution process or method, and (3) these skills come in a series. Some of the students' descriptions were the following, where the participants' descriptions targeted the three previous issues.

"Metacognition involves thinking about thinking", "We start a solution, we think about difficulties in this solution and think about other strategies to solve, then we decide what to do", "We start a solution, we monitor our solution method for effectivity, we modify to a more effective solution method", and "Sometimes, I discover during the solution that I make the solution more complicated, so I change to a different solution method".

In addition, some of the participants associated metacognition with transferring to a new domain, especially real life. For example, one participant said: “To find the tree height from the length of its shade is metacognition because I used mathematical thinking in a different context, that of real life”.

In the post-interview the participants elaborated their perceptions of the construct metacognition. They described it as thinking about the thinking in which they were previously involved. In addition, they pointed at the element of time as important in metacognitive engagement: “metacognitive thinking means taking time to manage your thinking, to arrange your thoughts, to assess your thoughts, to take decisions”.

The pre-service teachers, in the post-interview, gave more examples on using metacognition in teaching and learning mathematics. One pre-service teacher emphasized: “metacognition means encouraging the student to think about her previous thinking. It means encouraging her to manage her learning before solving through planning her solution and giving her time after the solving to evaluate the solution” One of the participants gave an example of learning mathematics using metacognition: “Let us take for example a student who comes to solve a problem. She first plans the solution by writing down the givens of the problem; she comes afterwards to solve the problem. She puts down in her head the different solution methods of the problem. She decides upon the most effective method and engages in it. Here comes my role as a teacher. To encourage metacognition, I ask the other students to evaluate the problem solution. I ask: what do you think about your solution method? Do you have a different method? Do you have a better method? Why?”

In addition, in the post-interview, the participants described metacognition in more specific terms, differentiating between writing the givens, representing the problem, decomposing the problem, planning, choosing a solution strategy, monitoring, modifying and evaluating solutions. Specifically, in the pre-interview the participants did not differentiate between writing the givens and representing the problem, while, in the post-interview they did that. One pre-service teacher, in the post-interview, said: “To write the givens sometimes needs knowing how to do translation from one representation to another, but the student needs to know that representing the problem is one step further. Writing the givens could be done by steps, as in a geometric problem, while representing the problem results in a whole representation of the problem”.

Differences between Cognition and Metacognition

In the pre-interview, the participants mixed between cognitive and metacognitive skills. Doing that, their statements were sometimes ambiguous. Some of the participants considered requesting a student to describe how she solved a problem as requesting her to perform metacognitive skills. In the same way, they considered experimenting with the solution of a problem as a kind of metacognition. Other participants said that directing students to solve mathematical problems encourages their use of metacognition. In addition, some participants said that the difference between a student who uses metacognition and one that does not is that this who uses metacognition can generalize. Requesting the participants to elaborate more, they did not succeed to do so. All the previous sayings indicate vague sense of metacognition.

In the post-interview, the participants were more aware that describing how, does not guarantee alone that the process is metacognitive, and that metacognition is related to managing the learning process. One participant said: "Now we understand that writing how we performed the solution is not necessarily metacognitive. Metacognition is knowing why we used a solution and not another".

Furthermore, in the post-interview, some of the participants still mixed between cognitive and metacognitive skills. For example, they considered comparing and proving metacognitive skills. One participant said: “When we use the ‘compare’ and ‘prove’ processes, this is metacognition”. In addition, some of the participants still talked generally about metacognition. For example, one participant talked about using more than one solution method to solve a problem as metacognitive skill.

In addition to the said above, in the post-interview, some of the participants still considered metacognition related to connecting mathematical knowledge to real life situation. They did that without further elaboration, as if this connection alone is enough for considering the mathematical process metacognitive.

Functions of Metacognition in the Mathematics classroom

In the pre-interview, the participants' perceptions of the functions of metacognition in the mathematics classroom were general. These perceptions were:
Lessening the students' boredom. One participant said: "It lessens the students' boredom for it is a new practice for them, they are not accustomed to it".

Bringing up independent students. One participant said: "You bring up students who are able to learn, to think and to develop her thinking alone". Another participant said: "You bring up independent students who can learn alone".

In the post-interview, the participants' perceptions of the advantages of the teacher's use of metacognition in the mathematics classroom were less general. Here, the participants talked about the following advantages:
Getting used to evaluating one's own solutions. One of the participants said: "In our group, we suggested three problems that would encourage students to think metacognitively. We were aware that we should go through a metacognitive skill, which is choosing one of the problems to implement with the middle school students. This metacognitive skill involved many cognitive processes, as comparing and classifying. I mean that metacognitive skills make use of many cognitive processes. Through the metacognitive processes, we get to evaluate our own solutions".

Internalizing the mathematical concepts. One of the participants said: "The metacognitive processes make the students internalize the mathematical concepts. In the course of these processes, we need to think, evaluate, decide, modify, and prove. This way we understand deeper".

Effective solving of mathematical problems. One of the participants said: "Planning makes the solution process more effective. There is difference between solving after planning and solving without planning. When we plan, starting from writing the givens, we are able to choose among different solution methods. This ensures that the solution is effective". Another participant said: "mathematics is the science of strategies, so metacognitive skills are needed to solve effectively mathematical problems. Choosing the most appropriate strategy ensures effective solving".

Advancement of the Metacognitive Skills of Students

In the pre-interview, the participants suggested the following methods to encourage students' metacognition: Giving the students a series of problems that gradually get more complicated, giving the students mistaken solutions for evaluation and thinking aloud about a problem's solution. These methods are further described below.

Giving the students a series of problems that gradually get more complicated. For example, one participant said: "We can teach students metacognitive skills by giving them a series of problems where these problems advance gradually in their difficulty. This gradual progression teaches students how to think about solving mathematical problems". Another participant said: "Directing students to solve encourages metacognition".

Thinking aloud about a problem's solution. For example, one participant said: "When I, as a teacher, solve a problem, I think in a loud voice how I think, how I decide which solution method to choose, how I assess the solution method, etc. This shows students how to think".

Giving students mistaken solutions for evaluation. For example, one participant said: "We can give students mistakes that the students make and request them to find the mistake. This encourages them try to avoid these mistakes".

In the post-interview, the participants gave the previous three methods in addition to two additional methods: Requesting students to evaluate their solutions and challenging them with new problems.

Requesting the students to evaluate their solutions. For example, one participant said: "After the students solved a problem, I request them to think about their solution and to make sure that the solution is correct". Another participant said: "After the students solved a problem, I request the students to look for another solution, or an unconventional solution or a more effective solution method, to decide which the most effective solution method is".

Challenging the students with new problems. For example, one participant said: “New problems could lead to metacognition: We show students some solution methods, then we give them a problem that could be solved according to the method, then give them a challenging problem that could not be solved according to the same method. This causes students to think about another way of solution. This is metacognition”.

Metacognition in Lesson Preparation

In the pre-interview, the participants’ suggestions regarding how to take care of metacognition in the preparation of lessons were related to their perceptions of metacognition, as connecting to real life and as introducing the mathematical activities in a series. Some of the students descriptions were the following: “I use real life problems to make students transfer their mathematical knowledge” and “I use a series of problems that advance gradually in their difficulty”.

In the post-interview, most of the participants expressed a favorite attitude towards taking care of metacognition in lesson preparation. Most of the participants said that they would utilize the planning phase of metacognition in their lesson preparation. One participant said: “The planning phase serves the solution so much, especially how to arrange the givens. I would use it, but not the other phases, because these phases take a lot of time that the teacher does not have”. Another participant said: “If all the teachers in the school teach traditionally, how would I alone use metacognition in my teaching? This is impossible”.

Discussion

The present research intended to examine the development of mathematics pre-service teachers’ perceptions of metacognition and metacognition in teaching mathematics as a result of their participation in one-year preparation. The research results indicate that the participants developed their perceptions in some aspects of metacognition and its use in mathematics teaching, but they did not develop these perceptions in other aspects of the studied issue.

The participants developed their perceptions regarding the metacognitive strategies. This development was present in the terms and descriptions that they used after the preparation. Before the preparation, their terms and descriptions were general and not specific, but after the preparation these terms and descriptions became more specific: ‘She first plans the solution’, ‘She does so by writing down the givens of the problem’, ‘She puts down or in her head the different solution methods of the problem’, ‘She decides upon the most effective solution method’, etc. This use of more specific terms related to metacognition, as in Davidson and Sternberg (1998), indicates deeper understanding of what metacognitive skills are, which indicates a development of the participating pre-service teachers’ perceptions of metacognitive skills. In addition, in the post-interview, the pre-service teachers talked about metacognition as a tool in the hands of the mathematics teachers who use it to encourage the metacognitive engagement of their students, which points at the influence of the preparation in which they participated on their identity as teachers of mathematics. The pre-service teachers became teachers of mathematics who conceptualize metacognition as helping them manage the cognitive and metacognitive aspects of their students’ learning.

Another issue that needs to be taken care of is the pre-service teachers’ differentiation between cognitive and metacognitive skills. The results of the present research implied that the participants got more aware of these differences as a result of their one-year education, but they have not overcome their misconceptions regarding this area totally. It seems that what make this differentiation problematic are the participants’ perceptions of metacognition as high order thinking, so they associate it with high order thinking skills.

A third issue of the participants’ perceptions of metacognition is their perceptions of the functions of metacognition in the mathematics classroom, where the one-year education led the participants to be less general, mentioning the metacognitive processes needed in each function. This development of their perception is expected since they underwent different experiences in the preparation year and in which they performed, more than once, metacognitive processes. This result agrees with previous studies which reported significant development of metacognitive skills of pre-service teachers as a result of education (e.g., Erskine, 2009).

A fourth issue of the participants’ perceptions of metacognition is their perceptions of methods to encourage students’ use of metacognitive skills. The participants after one-year preparation were aware of more of such methods, where this awareness probably resulted from the one-year preparation, especially from the designing and implementation phases (Daher et al., 2018).

The last issue concerning the participants' perceptions of metacognition is their intention to use metacognition in their students' learning. Here the issue of time pressure influenced the participants' intention, where they claimed that this time pressure could prevent them from implementing metacognitive teaching and learning. In any case, most of them expressed their intention to use planning in the mathematical problem solving in their classes, which shows that they valued this metacognitive skill more than other skills. In addition to the time pressure, it also could be that the participating pre-service teachers, after working with metacognitive learning and teaching got aware that teaching students to be metacognitive requires a complex understanding of both the concept of metacognition and metacognitive thinking strategies (Wilson & Bai, 2010).

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The Effects of Invention of Photography on Illustration

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Abstract: It is an undeniable element that technological developments bring about a rapid and dynamic change in all areas and the necessity of compulsory development. As in all kinds of art, technology has led to radical changes and innovations in plastic arts and has brought diversity and difference to art production techniques too.The birth of photographic technology has provided an invaluable opportunity to capture and document the moment. Many visual documents and visual evidence, which were previously made in cooperation with painters and printmakers, have now become available as subjective, without the need for mediation of these craftsmen. This visual revolution in photography has profoundly influenced many methods of visual art production, and the production of photographic images without photographs has now required the production of photographic technology. As it was the moment, and without any commentary by any illustrator, it directly replaced the traditional illustration production techniques and illustrative drawings in terms of photography, credibility, and reliability as the highest visual material, leading to a decrease in the demands on illustrators. The illustration, which is an indispensable communication and graphic material in terms of supporting the text, strengthening the expression and visualizing the subject, has become a kind of unfashionable art which has been disrupted in the early stages of the spread of photography.In this study, it has been examined that the negative effects of the photography's invention in its early period to on illustration art and it has been researched that illustration having its glory again by starting commonly apply collaborations of photography and illustration.

Keywords: Illustration, Photography, Technology, Art

Introduction

The production of materials and tools that contribute to the creation of the work depends on the cultural production of societies. Technological changes and developments affect the social production of art. For example; The widespread use of the printing press and the increase in use, due to the use of paper, not papyrus nor parchment. Thanks to the books that became reproducible and easily accessible following the expansion of the printing press, the literacy rate in the society gained momentum and paved the way for a rapid flow of information (Tezcan, 2018, p:40).

Illustration art, which is one of the plastic arts fields, has been used in many fields from past to present and has enabled many aims to be realized. In its historical progress, the art of illustration has shown different changes with technological advances like many other plastic art disciplines.

With this study, positively and negatively affects the results of effects and the way of effects of photograph technology which affected almost all branches of fine arts to illustration art which has been existing before the photography, have been researched.

The aim of this study is to present the development and the effect of the illustration, which is an artistic expression that can now exist independently of the book and the text, against the dominant effect of the photographic technology and to present a written resource for the researches in this field.

The study covers the art of illustration and its current state during the historical process in which photography emerged and became widespread.

Defining and History of Illustration

The term illustration is literally a drawing, a picture or even a diagram that accompanies, adorns a book article or ad text (Borgman, 1979, p:8). There are different views in the researches about the birth and the first appearance of the art of illustration which aims to explain the text to the reader or the viewer through a more effective and efficient communication method.

In fact, it is known that many branches of art that exist today are from ancient times. The cave drawings in the south of France and northern Spain are believed to have been made 30,000 to 60,000 years ago. These illustrations, which invalidate elements such as lack of technical and material, with great anatomy knowledge, observation, and visual memory, and exhibit great talent by depicting wild animals while flying or resting, are among the first examples of ancient art products embroidered on the insurmountable depths and rough walls of caves and their purpose is still unknown (Cleaver, 1969, p:11). We can say that the art of illustration started with the line (Loomis, 2012, p:19).

There is a disagreement between the experts who associate the birth of illustration art with these cave paintings and the experts who argue that illustration is a book illustration art and that history can only begin with the appearance of the book. According to Cleaver (1969); The ancient Egyptian civilization was a civilization that believed in life after death and cared very much for the existence of this life. The ancient Egyptians described the life they predicted after their death in sarcophagi and parchment (Cleaver, 1969, p:11).

When we associate the emergence of illustration with books, and therefore with the emergence of paper, we encounter corn parchment and papyrus with the first examples of illustration.

These papers which were thought to belong to the date range of 1000-945 B.C. , which were named "P-apu" by the ancient Egyptian civilization were derived from Greek and Latin languages and turned into today's is "Papyrus" and used by these civilizations as text and painting surface (Smith, 1901, p:142). The first examples close to today's concept of illustration are the parchment rolls called Ramesseum Papyrus and Egyptian Book of the Dead, which has survived to the present day. These works, which are the oldest examples of manuscripts, are also parchments that form the basis of contemporary illustration art (Dalley, 1982, p:10). The mentioned examples are recorded in books and articles as the first example that has illustrative works on papyrus. The invention of modern paper obtained from fibrous structures and cotton pulp belongs to a different civilization and a different time period.

According to some sources, the paper formed by the processing of fibrous materials and cotton was first produced in ancient China. "Ts'ai Lun" who has been a statesman in Ancient China, is mentioned as the inventor of the paper made by this technique. Therefore, sources refer to his name as the ancestor of today's modern paper. The first appearance of the modern paper in this way, occurred in 105 B.C. (Smith, 1901, p:143).

The art of illustration has gone through different technical and technological phases until its present state. The art of illustration, which is connected to a book or a written text, has been able to adapt to these reproducible literary materials by the development of reproduction techniques. Especially according to the innovations in the field of printing and printworks, the illustrations which were first processed as manuscripts later became reproducible by printing techniques.

The first illustration works produced by printing method were made with woodcut printing technique. (Eczacıbaşı, 1997, p:841). High printing techniques were followed by metal printing (engraving), lithography (stone printing) and serigraphy, and the works including illustrations in history were reproduced in this chronology followed up too.

The technical developments up to the present day have made affect the illustration art as well as in all plastic art fields with their ability to reproduce and ease of material. Until the invention and diffusion of photography, the art illustration was used for visual document creation, historical events, visualized important moments and has become a method of communication against the public or targeted individuals. The illustration as a visual document, reflecting the text and a detailed workable visual expression method has gained a great mission in this regard and continues this mission today.

The invention of photography has affected many areas and created a whole new channel for presenting visual data to society. This situation has changed the perspective of the art of illustration as in every field.

Defining and Invention of Photography

Whether the camera or photography machine, indiscriminatingly digital or film, we can say is basically a dark box that sealed and not let leak the light. A front lens allows light to penetrate, while the photosensitive material inside captures the image (Richter, 2006, p:5). The basic operating principle of cameras is in this direction. The concept of photography is the name of the image captured through this mechanism.

1826 is the year commonly mentioned for the invention of photography (Ertan, 2005, p:57). Through his intense and long experiments, Nicephore Niepce explored ways to print the traces of the images he had projected on a stable surface by using chemicals in a dark room. In 1826, with his portrait he managed to expose and stabilize, Niepce went down in history as the inventor of photographic technology (Özer, 1976, p:20). Image transfer to the surface covered with chemical solutions has been replaced by devices that work with digital sensors called "d-slr" in today's digital age.

With the cameras, the objective world is recorded as reflected. The light reflected from the object leaves a mark like a footprint left in the sand as a physical trace, and this principle differs from other visual expression techniques with a sharp boundary. The photo reflects the truth and promises an objective view and reminds us of the passing time as “this was there”. (Turan, 2014, p:1). Photography has become an irresistible competitor in reflecting the truth to the illustration artists that they produce by adding their own interpretations and styles with the objective images it presents and was used predominantly in the period when it became widespread.

As a branch of art, photography began to be used in many fields in the period when it emerged with its very short and dynamic development. It has evolved in many areas from daily life to art, following historical events, scientific studies and experiments. Nowadays, photography, which has gained an artistic quality in general, weighed in with this quality (Ertan, 2005, p:57).

Although photography was devoid of color and presented black and white images in the early stages of its use, the idea that it reflects reality was not harmed by the society and black and white images in the face of this great invention, the fact that the colors reflect the exact truth took second place by society. According to Bodur (2006); Peter Henry Emerson (1856-1956), one of the pioneers of Impressionist and realistic art style, stated that photography technology is the most creative invention. However, in the first period of its use, photography was insufficient to reflect the colors of nature and to determine as it is, and this was seen as a deficiency. The image presented by the photograph was reflecting the naturalness with reducing it. In order to avoid this lack of perception by the demanding individuals, the photographs were tried to be colored manually. This sometimes led to the use of pigment that was so intense that it would distort the photographic quality of the photographic image (Bodur, 2006, p:79).

The Effects of Photography on the Art of Illustration

Socially important developments and technological advances have led to compulsory changes in every field. In the face of the innovations and conveniences brought about by the era, an effort has been made to rearrange and adapt to these innovations in many techniques.

In spite of individuals who are saturated with innovations at today's cultural level and less astonished with new inventions, photography has had a huge repercussion at the time it was invented, caused people to mislead that it is an invention between science and witchcraft. The physical and chemical process that takes place in a dark box or a dark room remains a mystery that cannot be deciphered and difficult to understand for a society that does not have access to pre-digital information that easily.

Many image reflection techniques such as camera obscura and camera lucida are tried to be conveyed to individuals with technical illustrations, thus making this mysterious process understandable. Likewise, technical illustrations were used to explain the invention of photography, exposure and stabilization processes to individuals.

Photography became an outstanding art field than the other fields with its physical and chemical steps in the process of creating an image (Satkın, 2015, p:7). The fact that photography is a window to the concrete world has also made it more convincing than other branches of art. The society, which has previously followed important developments, historical events, and inventions with the art of illustration, has started to give less value to the art of illustration by adopting a more realistic image with the photography.

Despite the difficulties of photography due to the long and complex processes, many artists saw it as a short way to produce art. It would no longer be necessary to spend many years in art education and it would not take as much effort to produce works that reflect the truth. Other group of artists saw this reality as a threat. Paul Delaroche, in response to the invention of photography, declared that painting has died from today. He and the other artists who against this new technology that Daguerre said about “with this technology, the people can be able to create the most detailed images in just a few minutes without any chemical and physical knowledge” in 1838, saw it as a threat for the art (Encyclopaedia Britannica, 2019).

Ironically, the art of illustration, although threatening its own existence at that time, has visualized photographic technologies and experimental stages and has become a visual window that provides the audience with information about the process. Although it is an objective imaging method of how the camera and photographic materials work, photography has been insufficient to show the detail of the illustration and the visible surface of the illustration and has had difficulty in replacing the illustration especially in technical and scientific fields.

Photography has taken its place in human life with its practicality and has caused the unemployed artists who earn money and earn their living through the art of painting in Continental Europe. On the other hand, by taking this mission of the artists who are obliged to reflect reality, it freed them and this situation suppressed the current of realism and enabled the creation of different alternative currents. In this way, it can be said that photography has contributed to the formation of great changes in the field of art and culture. The fact that photography destroyed realism in painting by presenting realistic images caused painters, who no longer demanded to make realistic paintings, to create artistic movements that emphasize the artist's interpretation rather than reflecting the reality such as impressionism, pointilism, fauvism and Dadaism (Bingöl, 2017, p:4).

The art of collage, which emerged with the increase of printed visual materials, also benefited from printed photographs. This later led to the use of collage technique in the art of illustration. Illustration artists and designers who use traditional illustration production techniques, especially in the field of fashion illustration, frequently use collage technique. On the other hand, digital collage technique can be applied in digital illustration production techniques. With the introduction of digital photography, the ability to process images in digital media has enabled these reproductions to be reproduced as manipulations.

Conclusion

The art of illustration, which is frequently used as a visual expression tool for scientific experiments, historical events, new discoveries and new places discovered, has been freed from these tasks with the invention of photography. Individuals who demanded a detailed and realistic picture of the idea they want to visualize preferred the ease of photography to the art of illustration. The art of illustration, which is suitable for detailed craftsmanship and detailed narration, came to the end of his reign with the ability to present one-to-one images of the photograph and lived a stagnant period.

We cannot say that the invention of photography completely hindered the art of illustration and caused it to decline. Although it was a great competition for illustration artists at that time, photography took the mission of documenting the reality as visually with its existence and caused the liberation of illustration art like many other branches of art. Illustrators, who continued their works according to the demands of the past, searched for more aesthetic interpretation forms in terms of artistic aesthetics in this period when they could be free and tried to observe the effects of different currents and styles in their works.

As a result, with the emergence of the art of photography briefly caused the illustration artists to become unemployed and provided the illustration art to enter a short pause. On the other hand, this negative process has greatly contributed to the shaping of today's illustration art, and the concept of artistic illustration has emerged instead of the illustration understanding which serves only a specific purpose and is dependent on the text.

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Instructor Opinions about the Problems That the New Graduated Graphic Designers Experienced in Sector

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Abstract: Graphic artists had an important place in the art world with their own efforts and later with the help of organized schools and institutions. William Morris pioneered the movement began, Arts and Crafts school in England was followed by the Bauhaus in Germany. Famous artists such as Gropuis, Moholy Nagy, Kandisky, Klee have found new ways of expression by utilizing the unlimited possibilities of all kinds of techniques in art education schools and workshops, and have served the graphic art by transferring it to their students. In our country, there are many Faculties and Schools affiliated to the State and Foundation Universities providing education in the field of graphics. In this study, the views of faculty and high school students who took graphic education at higher education level after the graduation were included in the lecturers about the problems they experienced in the sector. It has been examined whether the course gains in the courses of schools can produce sufficient solutions to the problems that students may experience in their sectoral adaptation. The aim of this course is to provide the students with the suggestions and suggestions of the graphic designer candidates on the issues of printing and printing technologies. The study was carried out with the help of designer academic staff from the state and foundation universities which provide education in Ankara. The participants were asked about the problems related to the new graduate graphic designer candidates, whether the courses in the curriculum programs are sufficient, whether there are new course proposals, graphic terminology, prepress printing and post-printing processes and printing technology. The answers were evaluated and the results were evaluated.

Keywords: Graphic designer, Graphic education, Design, Professional qualification

Introduction

In this century when scientific and technological developments affected our lives completely, developments in technology directly affected the field of graphic design as it was an important design branch. One of the techniques of artistic production is graphic; because it can be reproduced more than one by etched or carved plates, it has the chance to reach a wide audience. In graphic art, the artist uses printing techniques in order to reproduce her works, and uses mass media such as television, newspapers and magazines to present to the audience.

Graphics were accepted in our country especially after 1950 and some of the artists were producing prints in addition to the works of penture, while some of the artists were able to produce directly in the field of graphics. Many graphic designers in Turkey and abroad are teaching in the graphic departments of newly established art education institutions. There are many art education institutions that have graphic departments today. The courses of these departments include classes on graphic production technologies and printing (Artut, 2013).

In art, graphic is the projection of visually perceived beings-objects with images, colors, and shapes. Its most important function of its; to communicate any message to the community, to advertise a product or service (Becer, 1997:33, Artun, 2004:119). Graphic arts affect the development level of a society. The most important pillar of this branch of art, the printing stage is rapidly developed and continues to develop with new

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Technologies. Qualified art programs should be prepared according to the conditions of society, technological and artistic developments, physical characteristics of individuals and scientific methods. In fact, the qualification of the art programs is a subject all students interest in (Boydaş, 2004:11).

Graphic production technologies are an integral part of graphic design. In today's graphic design education, especially in the higher education level, it is important to explain the technological developments related to this field to the needs of the graduates for the name of answering the problems of the sector and sector needs. The achievements towards graphic production technologies cannot be obtained sufficiently while teaching artistic printmaking techniques in the courses such as printmaking and printing which placed in the school programs. It is very important in terms of the quality of graphic design education whether the courses related to printing and printing technologies are at the level that can meet the needs of the sector in the curriculum of the faculties and schools that provide graphic education.

The following questions were sought in this research:
1.What is the level of knowledge of the graphic design studies of the students?
2.What is the level of knowledge of graphic design students at the pre-press stage of their designs?
3.What is the level of knowledge of graphic design students at the printing stage?
4.What is the level of knowledge of graphic design students in the post-print stage of their designs?
5.To what extent is printing education included in graphic education schools?
6.To what extent are graphic production technologies training in faculties and colleges providing graphic education?

Method

In this study; The opinions of the faculty and high school students working in the sector about the problems they face in the sector after graduation are given. In this context, designer faculty members working in the field of graphics from the state and foundation universities in Ankara were employed.

The participants were asked whether the courses included in the curriculum were sufficient, whether there were new course predictions, graphic terminology, pre-printing and post-printing processes, and what kind of problems they might encounter with printing technology. In this respect, the research is a descriptive study in the general screening model. A total of 10 questions, 4 of which were multiple choice and 6 were open-ended, were asked to the instructors who participated in our survey. The research was carried out by analyzing the data obtained from the survey.

Results and Interpretation

Graphic design is a process that aims to convey a message, visualize thought and explain the problem to the masses in the simplest way. For a good design, it is especially important for this area to perceive and interpret the environment well. It is necessary to make observations, research and information in a correct, realistic and complete perception. Growing up as intellectual, researching, reading, traveling and seeing designers is important for sectoral adaptation. It is not possible to say for sure how much this kind of non-educational activities can be done in the design process or in business life in our country. But the benefits are more that can not be discussed. In our study, starting from the problems experienced by the graduating graphic designers, the subjects such as whether the courses in the curriculum are sufficient, whether new course suggestions can be proposed, graphic terminology, pre-press and post-press processes and the problems related to printing technology are examined and in this context, the following findings have been reached:

The demographic information of the faculty members participating in the research with their opinions are as follows:

Participants are 30 persons; 9 of them are female and 21 of them are male. It is seen that 30% of the age groups of participating faculty members are between 22-31 years, 53.3% are between 32-44 years, 10% are between 45-53 years and 6.7% are in 54 years and over. 3.3% of them were from the Academy of Fine Arts in Madrid, 15% from Gazi University, Faculty of Vocational Education, 18.3% from Gazi University, Gazi Education Faculty, 10.0% from Selçuk University Education Faculty, 26.7% from Gazi University Institute of Educational Sciences, 13.3%. Bilkent University Faculty of Fine Arts Design and Architecture, 3.3% of them are Pratt Instıtute, 6.6% of them are Ondokuz Mayıs University Institute of Educational Sciences and 3.3% of them are graduated from Ankara University Faculty of Education. It is seen that 40.0% of the faculty members have graduated from Fine Arts Education, 20.0% from Applied Arts Education, 30.0% from Graphic Design and 10.0% from Communication Design. 6.7% for 1 year, 6.7% for 2 years, 16.7% for 3 years, 6.7% for 4 years, 10.0% for 8 years, 23.3% for 9 years, 10.0% for 10 years,% 3.3 of them have been working as graphic educators for 12 years, 3.3% for 14 years, 3.3% for 15 years, 3.3% for 28 years and 6.7% for 30 years.

The opinions of the faculty members who participated in the research on the competence of graphic students in the field of printing technologies are as follows: 6.7% of the participants stated that their students were very competent in the field of printing technologies, while 16.3% stated that their students were inadequate in the field of printing technologies, 77.0% of them thought that their students were partially qualified in the field of printing technologies.

Table 1. Instructors' views on what ınformation generally should graphic designers have in printing field

	f	%
Getting to know the printing house in general terms	18	60.0
Understanding paper	7	23.3
Designing suitable for printing	10	33.3
Paint and color knowledge	8	26.7
Understanding binding	3	10.0
Knowledge of packaging design	3	10.0
Knowledge of printing technologies	14	46.7
Pre-printing, printing and post-printing processes	22	73.3
Production flow and shape in printing	3	10.0
Computer design programs used in printing	5	16.7

In the light of the data in Table 1, it is seen that the instructors working in different schools have different opinions about the qualifications that students should have in the printing field. Although the schools where the academic staff work are educating students in the field of graphics, not all of these schools aim to train graphic designers in the graphic industry and printing houses. The fact that schools provide services in different areas led to differences in their programs. Therefore, there may be differences of opinion among the schools regarding the qualifications that students should have in the printing field.

Table 2. Instructors' opinions on the challenges of newly graduated or trainee designers on pre-print, print and post-print ıssues during their adaptation to work

	f	%
General printing knowledge	15	50.0
Understanding paper	5	16.7
Designing suitable for printing	9	30.0
Paint and color knowledge	3	10.0
Understanding binding	3	10.0
Knowledge of packaging design	1	3.3
Assembly, color separation, film information	12	40.0
Protective processes after printing	4	13.3
Prepress calculations (crop field, decimation, form)	12	40.0
Able to fast and trouble-free work	5	16.7

When the data given in Table 2 is taken into consideration, it is seen that the faculty members working in different schools have different opinions about the information they should have about pre-press, press and post-press issues during the adaptation of new graduates or trainee designers. The fact that schools provide services to educate students in different fields caused differences in their programs. The opinions of the faculty members who participated in the research about the problems of new graduates or interns in the sector can be solved as follows: while the 56.7% of the respondents stated that they could “mostly removable”, 40.0% “partially” and 3.3%% “cannot removable“ all of the participants stated that it would not be possible to completely eliminate the deficiencies in the school. Participants; it is seen that the thoughts of the new graduates or interns about the effects of the deficiencies in printing technologies on their employment are as follows: 40.0% of the participants stated “Affects”, 43.3% “Partially Impacts” and 16.7% of participants stated “Non-Affects”.

Table 3. The views of the ınstructors about the problems that students may encounter when they start to work in a graphic related work

	f	%
Lack of printing knowledge	11	36.7
Designing suitable for printing	6	19.8
Inability to follow technology	10	33.3
Lack of human relations and communication	3	10.0
Inability to thinking creative	3	10.0
Lack of general design knowledge	4	13.3
Inability to use design programs to design at computer environment	15	50.0
Monetary values are more important than professional ethics	3	10.0
Inability to work at the tempo and quality required by the sector	13	43.3
Inability to communicate well with customers	4	13.3

When Table 3 is examined, the opinions of the faculty members involved in the research on the problems that the students may encounter when they start to work in a graphic related are as follows: 36.7% of the participants stated lack of printing knowledge of graphic designers, 19.8% were unable to follow the design, 33.3% could not follow the technology, 10.0% lack of human relations and communication, 10.0% could not think creative, 13.3% lack of design knowledge, 50% not being able to use design programs to design in computer environment, 10.0% taking money in front of professional ethics, 43.3% being unable to work in the tempo and quality required by the sector, 13.3% not having good communication with customers.

Table 4: Instructors' views on the methods followed in the courses related to graphic design education

	f	%
The teaching method which the student is active	13	43.3
Work-based teaching method	3	10.0
Teaching method using real instructional materials related to graphic design	6	20.0
Teaching method that varies according to the subjects	16	53.3
Training at work method	1	3.3
Interactive teaching method	2	6.7
Computer supplied teaching method	2	6.7

When the data in Table 4 is considered, the opinions of the instructors participating in the research on the methods followed in the courses related to graphic design education are as follows: %43.3 of participants stated they took education about graphic designing in the teaching method which the student is active, %10 of them stated they had work-based teaching method, %20 of them stated they have been learned with teaching method using real instructional materials related to graphic design, %53 of them stated they took teaching method that varies according to the subjects, %3.3 of them stated they trained at work, %6.7 of them stated they used computer supplied teaching method. It is seen that the majority of the participants adopted the idea that the teaching method should be determined according to the subject.

Table 5: Instructors' views on the adequacy of the courses taught in relation to graphic design education in the departments

SCHOOL	f	%
Very Sufficient	0	.0
Partly	22	73.3
Very Little	5	16.7
Insufficient	3	10.0
None	0	.0
TOTAL	30	100.0

When Table 5 is examined, the opinions of the instructors participating in the research on the adequacy of the courses taught in the departments of graphic design education are as follows: %73.3 of them stated “partially adequate”, %16.7 of them stated “slightly adequate” and %10.0 said that the courses taught were “inadequate”.

Table 6. Instructors' opinions on the suggestions of new courses related to graphic design education they want to be taught in the departments

CLASSES	f	%
Printing Knowledge	10	33.3
Printing Technologies	13	43.3
Techno-Art	1	3.3
Illustration	6	19.8
Computer Based Graphic Design	8	26.4
Web Design	2	6.7
Interactive CD Design	1	3.3
Video Fiction	1	3.3
Writing Script	2	6.7
Animation	2	6.7
Art Critism	1	3.3
History of Turkish Graphic Desigg	2	6.7
Communication and Public Relations	1	3.3
Typography	5	16.5

As can be seen from Table 6; 43.3% of the participants stated that a course about printing technologies should be included in their program while 33.3% of them stated a printing knowledge class should be included in their program. This evaluation shows that there are not enough courses on printing technologies and printing in the curriculum of institutions that provide graphic design education at the university level. Graphic designers required by the advertising and printing industry should have sufficient equipment in printing and printing technologies. To this end, the idea is to include more diverse and content-oriented courses on production technologies.

The views of the participating faculty members about the points not included in the survey questions are as follows:

3.3% of the participant faculty members stated that employers may vary in many ways while choosing graphic designers to work in their companies. Gender, graduation school, undergraduate education courses and companies studied before may be effective in managers' choices. 16.7% of the participants reported that a lack of resources related to printing directly affects graphic design education. 13.3% of them said that scientific follow-up of national and international designs is very important in terms of education process. They reported that it is important for the graphic design education to follow the world-renowned domestic and foreign graphic designers and their designs by the instructor and the students. 16.7% of the participants used Adobe Photoshop, Macromedia FreeHand, Adobe Illustrator, Adobe InDesign, Quark XPres etc. programs and graphic design, such as which computer programs are used for what purpose they need to know. 10.0% of the participants stated that the minimum configuration of the computer that the designer can use should be known. 23.3% of the participant faculty members stated that graphic designers should give more space to typographic elements in their work and therefore typography education has an important place in graphic design education. The participants reported that typographic elements had a very high impact on graphic designs to be more powerful and remarkable in terms of design. 3.3% of the participants stated that the presence of a permanent technician in the computer labs would enable the student to find more work opportunities. 10.0% of the participant faculty members are responsible for the advertising agency, television, printing house, design office, photo studio, etc. they said that the duration of their internship is important for the education process of the student. Therefore, students reported that they have to do internship at least twice in the graphics sector and in the printing press during different periods of their education. 13.3% of the participants stated that the adequacy of graphic education in universities is very important for graduating designer candidates to find jobs in the sector and adapt to the jobs they find.

Result

Graphic designer is a designer who can search for solutions to the designs needed in the field of graphic design, can make alternative designs to create the solution, bring these designs to the printing stage in the computer environment and develop himself in the desired quality of the sector. Accordingly, the graphic designer; In the process of graphic design, a job should be familiar with pre-printing, printing and post-printing issues. Graphic designers in the printing industry in the field, to recognize the general outline of printing, design to be able to print, paper information, color information, binding information, packaging design information, printing technology information, pre-press, printing and post-printing process information, printing flow and shape information have knowledge about computer design programs used in printing.

New graduates or interns face many problems during the adaptation of graphic designers to work, and some of these problems cannot be solved during the training phase. In particular, the deficiencies in printing technologies affect graduates' employment in the sector to a great extent. For this reason, candidates have to take courses such as printing knowledge, printing technologies, production technologies in the fields of printing industry and printing technologies in their education stages. For this reason, the schedules of the institutions providing graphic tasting training should be arranged in line with the data to be obtained as a result of sectoral analyzes, taking into consideration the demands and needs of employers.

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Views of Primary School Teachers about Smart Board A Sample from Ağrı

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Abstract: Smart boards are the important material of today's educational technologies. With the recognition of the contribution of smart boards to education, its usage has started to increase in our country as well. The numbers of the studies about the education technologies are also increased. In the related literature, there are studies about the use of smart boards in the lessons but there are few researches that reflect the opinions and experiences of primary school teachers about smart boards. The aim of this study is to examine the views of primary school teacher about smart board usage. Descriptive method was preferred in the study and a questionnaire including open-ended questions was used. The study included 30 voluntary primary school teachers from Doğubeyazıt, Ağrı. The data obtained from the responses of the teachers to the questions grouped based on their common points; the frequencies and percentages of these responses calculated. The findings of the study showed that the smart board is a useful technological material, it facilitates students' learning and positively affects the students' attitudes to the subject. It activates the students and attracts the attention of them. It is also seen that teachers' knowledge about effective use of smart board is limited. They use the smart board as a projector. It is suggested that teachers should be given an in-service training course to teach different methods to use smart board.

Keywords: Education, Technology, Smart boards, Primary school teachers

Introduction

Technological developments have an impact on all areas of our life one of which is education. They influenced the organization of teaching process. One of the leading tools of today's educational technology is smartboard. Smartboard is an interactive whiteboard which exhibits the image on a touchable and writable screen. By the aid of smartboard (SB) student can watch and listen teaching material (such as animations, videos, power point presentation or graphics), the teacher can save information for future use (for example class discussion at the end of the lesson) (Preston & Mowbray, 2008).

There are many advantages of the SB. It is possible to connect SB to the internet easily and to access information from different resources. By the aid of the internet connection, field experts' opinions from different countries can be obtained easily. It is not necessary to be in the same place to reach an information from a person. The teacher can scan any part of the text in the book and display it on the screen with the help of SB. This provides both time and material economy for the teacher (Starkings & Krause, 2008).

The smartboard (SB) was started to use in 1990s in European countries and USA. In Turkey the use of SB in the classes has become widespread with FATİH Project (MEB, 2011). The aim of equipping classrooms with smartboards is to increase the effectiveness of teaching and to provide better learning environment. Because todays learners are growing up with iPad, computer, android phone and tablet. Teachers should be informed and encouraged for the effective use of technologies to meet the students' need.

- Selection and peer-review under responsibility of the Organizing Committee of the Conference

There are many factors for effective usage of any technology, one of them is teacher. If teacher does not know how use SB, s/he will not use it during learning process (Tor & Erden, 2004). In this respect, the opinions of teachers on their usage of SB are important to determine the problems of teachers and to solve them. Studies have showed that instructive innovations were not successful when users have not been supported with suitable skills for effective usage (Pelgrum, 2001).

In the literature there are studies examining teachers' or students' views about SB (Bulut & Koçoğlu, 2012; Akgün & Koru Yücekaya, 2015; Çoklar &Tercan, 2015; Karakuş & Karakuş, 2017). Teachers and the students emphasized mostly three points; ease of use, useful material and positive attitude (Adıgüzel, Gürbulak ve Sarıçayır, 2011). Other studies searched the usage of SBs in learning environment and their effects on education (Yıldızhan, 2013; Özenç & Özmen, 2014). The studies presented that SB increases students' motivation and attitude and contributes to academic achievement. It enables importing various resources, offers greater lesson planning (Alghamdi & Higgins, 2015).

In conclusion there are studies searching teachers' *perceptions of educational technologies*; *technology competencies; use of technologies in the class.* However, there are limited study conducted with primary school teachers and searching current situations in the primary school classes. Primary education is very important for formation of basic knowledge of the students. Students' meaningful learning is important for further learning. But lessons such as math and science have concrete concepts. New educational technologies are useful to overcome these teaching problems. So that teachers' perceptions of these innovations are important for effective teaching. Because of that this kind of study was prepared to determine the primary school teachers' opinions about the SB.

Method

Research Model

In this study, it was tried to describe the opinions of primary school teachers about the SB. It was aimed to reveal existing situations in the classes and to answers the question "what is happening in the class?". So that survey research model was preferred.

Sample

The sample of the study consisted of 30, primary school teachers working in different primary schools, in Ağrı, Doğubeyazıt. These teachers participated to the study voluntarily.

Instrument

A questionnaire consisting open-ended questions was used to collect the data. It included four items in order to attain the objective of the study. At the end of the study, students' opinions also searched with a question. The questions were designed based on an expert about assessment. After designing of the questions, it was conducted a pilot application with a primary school teacher. The questions were revised in the light of this pilot study.

The questionnaire was given by hand to the subjects. Teachers wrote their answers on the sections left on the paper. The papers were collected by the researcher.

The answers of the teachers were grouped according to their similarities and were analyzed with Microsoft Office Program, "Excel 2010". Their percentages were calculated and then transformed into tables to increase the readability.

Results

In this part, the findings related to the responses that teachers gave for the survey questions are discussed and presented as tables.

The first question in the survey asks teachers about their condition and reason for using the smart board. The findings related to the teachers' responses are presented in Table 1 and 2.

Table 1. Teachers' opinions about their condition of using the smart board

Given responses	Frequency (F)	Percentage (%)
Yes	30	100
No	0	0

As it is seen in Table 1, all teachers stated that they use the smart board in their courses. The reasons related to teachers' responses are presented in Table 2.

Table 2. The findings related to teachers' reasons for using the smart board

REASONS	F	%
It facilitates teaching.	**29**	**96,6**
It increases my productivity in teaching.	**29**	**96,6**
It increases my classroom performance.	**27**	**90**
I think that the smart board can be used as multifaceted.	**27**	**90**
It increases my efficiency in my profession.	23	76,6
I can realize my desires (within the scope of education) quickly.	20	66,6
The people I am influenced in my profession believe the necessity of using a smart board.	9	30
My students think that I need to use a smart board.	9	30

As it is seen in Table 2, the teachers indicated that smart board is increasing the productivity in teaching and facilitating teaching.

In the second question of the survey, teachers were asked what word or words smart board evokes in their minds. The findings related to the given responses are presented in Table 3.

Table 3. The findings of what smart board means for classroom teachers.

Given responses	F	%
Technology	**16**	**53,3**
Visuality	**14**	**46,7**
Simplicity	7	23,3
Productivity	6	20
Being scientific	5	16,7
Internet	4	13,3
Accessing	3	10
Education	3	10
Others	7	23,3

When Table 3 is analysed, it is seen that teachers mostly use the word "technology" related to the smart board. Besides, they also use visuality, simplicity, internet, productivity, being scientific, education, access, multifaceted material and activity. It was determined that teachers use the words fictional, sharing, communication, ECN (Education, Computer Network), voice, speed, multiple intelligence education, interesting, and clear material under the title "others".

In the third question of the survey, teachers were asked about their level of using the smart board. The findings related to their responses are presented in Table 4.

Table 4. The findings related to teachers' level of using the smart board

Given responses	F	%
Good	**13**	**43,3**
Medium	**10**	**33,3**
Very good	4	13,3
Frequently	3	10

As it is seen in Table 4, teachers stated that their use of the smart board is at a reasonable level. It was established that the number of the teachers who use a smart board at a medium level is close to a reasonable level and the number of those who use a smart board at a very good level and frequency is less.

In the fourth question of the survey, teachers were asked in which courses they use the smart board. The findings related to teachers' responses are presented in Table 5.

Table 5. The findings related to course or courses in which classroom teachers use the smart board

Given responses	**F**	**%**
All Courses	**16**	**53,3**
Mathematics	**13**	**43,3**
Turkish	**11**	**36,7**
Free Activities	6	20
Social Studies	3	10
Music	3	10
Science	3	10
Others (English, Visual arts)	3	10

According to the data in Table 5, most of the teachers use the smart board in each class. The classes in which the smart board is frequently used are Mathematics and Turkish. It is determined that they do not use smart board much in Free Activities, English, Science and Social Studies courses. Based on the teachers' responses, it is seen that they prefer using the smart board least in Visual Arts course.

By teachers' opinions, students were also asked to state their ideas about the smart board. Themes were created for the students' responses, and these themes are presented in Table 6.

Table 6. Students' opinions related to the smart board

Given Responses	**F**	**%**
Enjoyable	**13**	**43,3**
Lecturing	**11**	**33,3**
Television	5	16,7
Video	4	13,3
Wise Board	4	13,3
Image	3	10
Learning	3	10
Others	10	30

It was found out that students mostly mentioned that smart board is enjoyable. They stated that the smart board is used in lecturing. Few numbers of students stated the words video, very good, wise board, learning, touch-operated, television and music. Under the "Others" title, there are statements such as seeing, hearing, watching, writing, image, smart, colour display, book, remarkable, understanding well, and information.

Discussion

According to the findings of this study, it was established that teachers adopt smart board positively. The teachers who use smart board stated that using smart board increases students' academic success, makes students active, provides visual learning, and increases positive attitudes. This finding has parallels with the results of the researches done by Çoklar and Tercan (2014) and Erduran and Tataroglu, 2009. In the relevant research, it is mentioned that smart board has advantages such as making student active, increasing students' positive attitude, motivation and academic success, enabling continual and effective learning and using time efficiently. In the educational sense, smart board is an education technology with which computer and projector can be carried or fixed, in which teachers can convey their own materials in a multifunctional way via a specific software and which provides material richness via the internet support, and it is increasingly used by teachers (Adıgüzel, Gürbulak & Sarıçayır, 2011). Altınçelik (2009) stated that smart board provides students with a flexible learning environment by providing visual, audial features, it plays a vital role in enabling effective and productive learning environment.

The results showed that primary school teachers use a smart board at a good or medium level. The usage of smart board requires from the teacher both technical and pedagogical knowledge (Al-Faki & Khamis, 2014). Korkmaz and Cakıl (2013), also stated that teachers have limited knowledge about how to use smart board. Therefore, maximum level of success can be achieved with the in-service training that will be provided for teachers about both how to use the smart board with new teaching theories and how to benefit from the features of smart board efficiently. If teachers think that the use of the smart board is beneficial in education, they will use a smart board more effectively in their courses.

The primary school teachers indicated that they use smart board in all courses, especially math and Turkish language lessons. Teachers reflect the math problem and the text of the Turkish language book on the board easily. They do not waste time to write them. But they use smart board limited in the science lesson. Erduran and Tataroğlu (2009) also examined the teachers' opinions who use smart board in science and mathematics courses, and they determined that the smart board has a positive effect on the learning environment and by increasing students' interest it makes them more participant.

The findings also revealed that, students believe that the smart board is useful and enjoyable. Visual and audial elements are effective on more than one sensory organ. In a study done by Kaya and Aydın (2011) at the primary school level, it was revealed that students understand lessons better with smart board applications, they can absorb more quickly thanks to multimedia properties enabling subjects to be presented more visual and audial. Besides, connecting the smart board to the internet affects the lesson positively. In addition to them, in the study, it was stated that the smart board increases the interest in the lesson, so students' participation in the course becomes positive.

Conclusion and Recommendations

In conclusion, primary school teachers from Ağrı, Doğubeyazıt, who participated in the study voluntarily use smart board in their classes. The sample is limited. Different studies may carry out with larger subjects and obtain data related to primary school teachers' opinions, skills, knowledge on the use of the smart board, and the contribution of the smart board to primary school students.

Like other studies the data of this paper showed that the smart board is beneficial both for teachers to teach and for students to learn. Therefore, as well as schools in the centre, the smart board needs to be popularised in schools in towns, villages and hamlets. Accordingly, the opportunity of infrastructure for the internet needs to be provided for the places where the internet infrastructure is absent or little.

The internet infrastructure in schools needs to be improved. With a high-speed internet infrastructure, more online course activities can be applied on the smart board. Smart boards in schools should be checked regularly in order to avoid crashing so interruptions in education in schools where the smart board is used can be prevented.

One important point is that primary school teachers cannot use smart board, professionally. Teachers may be supported with trainings by the experts on using smart boards. In-service training courses can be popularised and held frequently in order to increase the level of using a smart board. Moreover, lesson contents can be developed in for teachers to make a course presentation on smart board. By this way, teachers do not spend more time to prepare material for the smart board.

Technological developments and changes affect the structure and function of educational institutions. Learners' needs also changes. The institutions which train teachers should hold continuously renewed courses to teach teachers different, the most effective and economical use of information technologies (Akpınar, 2003).

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