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Antimicrobial effects of Apexit Plus, Epiphany, MTA Fillapex and Dorifill sealers on Enterococcus faecalis at different time intervals

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Abstract

Introduction: *The aim of the present study was to evaluate the antimicrobial effects of Apexit Plus, Epiphany, MTA Fillapex and Dorifillsealers at different time intervals on Enterococcusfaecalis using the agar diffusion technique.*

Materials and methods: *Standard suspensions of E.faecalis (1.5×10^8 CFU/mL) were inoculated on 10 Mueller-Hinton agar plates. Then ametallic punch was used to create 5 wells on the plates at regular intervals from each other. Four wells were filled with freshly mixed sealers of MTA Fillapex, Apexit Plus, Epiphany and Dorifill. The fifth well was left empty to serve as a control. The bacterial inhibition zones were measured around the sealers after incubation for 3,5 and 7 days. The two-way ANOVA was used to evaluate the effects of sealer type and time on antibacterial activity. Post hoc Tukey tests were used for two-by-two comparisons of the groups. Statistical significance was set at P<0.05.*

Results: *MTA Fillapex exhibited the highest antibacterial activity in a statistically significant manner (P<0.05), followed by Epiphany (P<0.05). At 3-day interval all the sealers exhibited significant antibacterial properties (P<0.05), which decreased gradually; there were no significant differences in antibacterial activity between 5-and 7-day intervals (P<0.05).*

Conclusion: *MTA Fillapex exhibited effective antibacterial activity against E.faecaliscompared to other sealers.*

Key words: Apexit Plus, Epiphany, MTAFillapex, Dorifill, antibacterial, *Enterococcus faecalis*.

1. Introduction

The chief aimof endodontic treatment is to eliminate the microorganisms within the root canal system as the main etiologic agents for pulp and periapical diseases[1]. Several bacterial species have a role in such diseases. Although *Enterococcus faecalis* does not constitute a large proportion of the microbial flora in the initial endodontic infections, it is the most commonly isolated species from the endodontically failed root canal systems because it is resistant to the unfavorable conditions of the root canalsystem, the majority of intracanal medications and root canal irrigation solutions; as a result, it has been the focus of a large number of studies on the microbiology of endodontic infections(Bodrumlu & Semiz, 2006; Kayaoglu & Orstavik, 2004). Given the fact above, one of the techniques to improve the results of endodontic treatments is to use root canal obturation materials with proper antibacterial activities. Grossman believes that root canal obturation materials should have at least bacteriostatic properties similar to endodontic sealers (Grossman, 1980).

Several endodontic sealers have been introduced with different bases, including Dorifill with a zinc oxide-eugenol base, which has antibacterial properties due to its zinc content. Calcium hydroxide-based sealers, such as Apexit, are well-known due to their alkaline properties. They mediate the disintegration of bacterial lipopolysaccharide and induce the formationof hard tissues(Neelakantan & Subbarao, 2008). Resin-based sealers are newer sealers compared to the two sealers mentioned above. Epiphany is a resin-based sealer with a methacrylate base (Ravi et al., 2014). In previous studies on Dorifillsealer,it has exhibited less antibacterial activity against *Staphylococcus aureus* and *Streptococcusmutans* compared to resin sealers (Tabrizizadeh & Mohammadi, 2005).

MTA Fillapex, an MTA-based endodontic sealer, has recently been introduced. Based on manufacturer's report, the sealer consists of MTA, salicylate resin, natural resin, silica and bismuth after mixing(Braga, Oliveira, Martins, & Ribeiro Sobrinho, 2013). Some of the superb properties of the sealer include radiopacity, low solubility and long working time. In addition, it is bioactive similar to MTA(Camilleri, 2009; Camilleri, Gandolfi, Siboni, & Prati, 2011). The sealer releases calcium to create an alkaline environment.Use of highly alkaline materials assists in the mineralization of hard tissues, in addition to antimicrobial properties. Based on recent studies, MTA Fillapex has antibacterial activity against *E.faecalis* before it sets(Kok et al., 2014). However, despite its high alkalinity, it does not have antibacterial activity after setting(Morgental et al., 2011).

At present, no published studies are available on the comparison of antimicrobial effects of Apexit Plus, Epiphany, MTA FillapexDorifill sealers on *E.faecalis* at different time intervals. Therefore, the present study was designed to compare the antimicrobial effects of these sealers at different time intervals.

2. Study design

2.1. Reparation of bacteria and transfer to culture media

The reference *E.faecalis* bacteria (ATCC 29212), which were kept in the freezer at-20°C, were thawed and cultured on brain heart infusion agar plates, enriched with sterile 7% sheep blood and then incubated for 24 hours at 37°C under 5% CO_2gas. The resultant bacterial colonies were transferred to Mueller-Hinton broth and incubated for 24 hours at 37°C under aerobic conditions. Then a spectrophotometer was used to prepare a standard suspension of *E.faecalis* in Mueller-Hinton broth containing 1.5×10^8 CFU/mL equivalent to 0.5 McFarland solution. This standard suspension was spread homogeneously on the surface of Mueller-Hinton plates using a sterile cotton swab.

2.2. Preparation of study samples and evaluation of antibacterial properties

A standard metallic punch was used to create 5 wells measuring 4 mm in depth and 6 mm in diameter at equal distances from each other on the culture media surfaces. Wells 1□4 were filled with freshly mixed endodontic sealers of MTA Fillapex((Angelus SolucoesOdontologica, Londrina, PR, Brazil), Epiphany (Pentron Clinical Technologies LLC, Wallingford, CT), Apexit Plus (Vivadent; Schaan Liechtenstein) and Dorifill (Austria, Dorident Company), respectively. The fifth well was left empty as a control. The plates were incubated at 37°C in a moist environment under 5% $CO_2$for 1 week. Then the diameters of halos created around the wells containing the endodontic sealers were measured in mm; the diameter of the halo was defined as the distance from the edge of the sealer to the bacterial growth line, which was infact the bacterial growth inhibition zone around each sealer. The halo diameters were measured at 3-day (72 hours), 5-day (120 hours) and 7-day (168 hours) intervals using a transparent ruler.

2.3. Analysis of data

The means and standard deviations of the diameters of bacterial growth inhibition zones around the different sealerswere calculated at the three time intervals with the use of descriptive statistical methods. Two-way ANOVA was used to evaluate the effect of the sealer type and the duration of the contact between the sealer and bacteria on the antibacterial activities of the sealers. Since data were distributed normally, post hoc Tukey tests were used for the two-by-two comparison of the groups in relation to the sealer type and study intervals. Statistical significance was set at $P<0.05$. SPSS 18 was used for statistical analyses.

3. Results

Based on the results, the maximum and minimum mean bacterial growth inhibition zone diameters were observed with the MTA Fillapex and Apexit Plus sealers at all the three time intervals, respectively. Table 1 presents the mean bacterial growth inhibition zone diameters in the study groups. Two-way ANOVA showed significant effects of both independent variables of the study, i.e. time and the sealer type, on the antibacterial activity ($P<0.05$).

Two-by-two comparison of the groups with post hoc Tukey tests showed that the diameter of bacterial growth inhibition zone around MTA Fillapex sealer was significantly higher than that around other sealers ($P=0.001$). However, the difference between the Apexit and Dorifill sealers was not significant ($P=0.6$).

In all the sealers a decrease in the antibacterial activity was noted over time. Therewere significant differences in the means of bacterial growth inhibition zones between 72-hour and 120-hour intervals ($P=0.01$), with no significant differences between 120-hour and 168-hour intervals ($P=0.30$).

Table 1.Means ± standard deviations of bacterial growth inhibition zone diameters in the study groups

Sealer type	Interval	Mean ± SD
MTA Fillapex	72 hours	17.1±1.7
	120 hours	18±1.2
	168 hours	18.4±1
Epiphany	72 hours	9.3±1.6
	120 hours	10.1±1.1
	168 hours	10.9±1.5
Dorifill	72 hours	6.7±1.9
	120 hours	7.9±1.4
	168 hours	8.1±1.4
Apexit	72 hours	6.6±1.3
	120 hours	7.2±1
	168 hours	7.6±1.3

4. Discussion

An ideal endodontic sealer should have some properties including biocompatibility, dimensional stability, sealing ability and strong and persistent antimicrobial activity. The antibacterial activity of sealers results in the elimination of residual microorganisms after chemical and mechanical cleaning steps; therefore, they increase the success rate of endodontic treatment(Bodrumlu & Semiz, 2006).

In the present study, the antibacterial activity of MTA Fillapex, ApexitPlus, Dorifill and Epiphany endodontic sealers on *E.faecalis* was evaluated at 3-, 5- and 7-day intervals. MTA Fillapex exhibited the greatest antibacterial activity at all the study intervals. In addition, the antibacterial activities of all the sealers decreased over time, consistent with the results of previous studies(Gomes et al., 2004; Neelakantan & Subbarao, 2008) .In the present study, agar diffusion technique was used to evaluate the antibacterial effects of the sealers under study on *E.faecalis*. *E.faecalis*, a facultative anaerobic microorganism, was used in this study due to its role in endodontic treatment failures and in initial infections of the root canal system as shown in various previous studies(C. R. Pinheiro, Guinesi, Pizzolitto, & Bonetti-Filho, 2009; E. T. Pinheiro et al., 2003). This bacterial species is resistant against elimination from the root canal and can even survive in obturatedcanalswithout any support from other bacteria, with meager nutrients(Love, 2001; Prestegaard et al., 2014).

MTA Fillapex is an MTA-based sealer and has recently been introduced to endodontics. The sealer contains 13% MTA, consisting of calcium oxide which is converted to calcium hydroxide upon contact with tissue fluids and water; calcium hydroxide is converted to calcium and hydroxide ions in itself, increasing the pH value. In a study, MTA retarded the growth and proliferation of *E.faecalis*, which was attributed to its high pH value. In addition, Tonomaro et al carried out a study on the antibacterial properties of endodontic sealers and cements containing MTA and Portland cement, showed the antimicrobial activity of MTA andattributed it to the high pH value of MTA(Tanomaru-Filho, Tanomaru, Barros, Watanabe, & Ito, 2007). Studies on the antibacterial properties of this sealer have shown that despite the high pH of the sealer, its antibacterial activity decreases after setting(Morgental et al., 2011). *E.faecalis* is completely destroyed at pH values over 11.5 but the pH of this sealer is 7.9□9.83(Mandava et al., 2014).

Epiphany is a resin based sealer with higher antibacterial activity compared to ZnO-based sealers and calciumhydroxide. The results showed that its antibacterial activity decreased with time, consistent with the results of a study by Tabrizizadeh, in which the antibacterial activity of resin-based sealers was reported to be higher than that of sealers with a base of zinc oxide-eugenol(Tabrizizadeh & Mohammadi, 2005).

In the present study agar diffusion technique was used, which is appropriate for the evaluation of antibacterial properties of materials before they set but it is not suitable for such a purpose after the sealers set. On the other hand, this technique is under the influence of solubility and diffusion of the materials in the culture medium. Therefore, for betterevaluation of the antibacterial properties of the sealers under study, it is suggested that this study be repeated with the use of direct contact test. Direct contact test can evaluate the antibacterial activity of materials after they set; however, in the clinic the sealers are placed in the root canal before setting(Faria-Junior, Tanomaru-Filho, Berbert, & Guerreiro-Tanomaru, 2013). As a result, to better simulate the clinical situation it is advisable to use both techniques.

5. Conclusion

Under the limitations of the present study it can be concluded that MTA-based sealer has better antibacterial properties, compared to resin-based sealers, against resistant endodontic bacterial species, which can be considered a strong point in favor of the clinical use of such materials.

6. Acknowledgment

The authors deny any conflict of interest.

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The development of financial intermediaries in North Africa region

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Abstract

The objective of this study is to investigate empirically the progress of financial development[1] of North Africa countries before and after financial system reforms. In order to fulfill this task, we represented the evolution of some development indicators, and then constructing a "global index of financial development" referring to the methodology of ***Demirguc-Kunt & Levine*** *(1996) and* ***Audrey Chouchane Verdier*** *(2004) by using database of the "world bank" and the "international monetary fund" for the period (1980-2012). Due to the lack of database about the other countries for all the period (1980-2012), our sample has been reduced to four countries (Algeria, Tunisia, Egypt and Morocco). Also, these countries hold some shared characteristics that allow us to make interesting comparisons. Our results show some heterogeneity in the progress of the "global index of financial development" for these countries. Morocco has recorded the best results after 2005.*

Keywords*:* NORTH AFRICA, Financial Development Indicators, global Index of financial development, Financial Liberalization;

1. Introduction

The adoption of financial liberalization policy has been largely considered as a necessary condition for an efficient development of financial systems. This policy enables us to overcome the obstacles caused by financial repression, guaranteeing an increase of interest rates for savings account *deposits* and increasing savings[2] by stimulating both investment and economic growth. Thus, for a better mobilization of financial resources, a developed financial system reduces transactions and information costs. In fact, a developed financial system identifies and finances the best investment projects in order to mobilize savings for investors and maximize the diversification of risks. Moreover, Macroeconomic Stability is a prerequisite for the success of financial liberalization policy by which we have to adopt convenient Macroeconomic policies in order to promote the competition in the financial system, developing transparent and legal institutional structure for activities and financial transactions (prudential regulation, property rights, financial and economic justice ...).

[1] Intermediaries financial development.

[2] Increased saving does not always correspond to increased investment. If savings are stashed in or under a mattress, or otherwise not deposited into a financial intermediary such as a bank, there is no chance for those savings to be recycled as investment by business.

Morocco, as a member of NORTH AFRICA region, had maintained several reforms of its financial and banking system from the 1990s, by following an irreversible process of liberalization and controlled openness of its financial system in order to set up pillars for a strong and durable economic growth. The banking sector was the highlight of these reforms, regarding its role in boosting growth and convergence process acceleration. Thus, apart from the privatization of public banks and restructuring of specialized banks, the Moroccan financial sector has achieved a profound change in its regulatory and institutional structure in order to match the international norms and standards. Regarding the main components of the Moroccan financial system (nearly 60% of the financial system assets), its banking sector introduces a similar degree of diversification to the developed countries that have higher levels of financial development such as Mexico or South Korea. This diversification is associated with depth and financial strength increasingly maintained and compared favorably with the regional average[3].

Since the Moroccan financial sector has currently emerged as one of the most powerful and organized sector of the southern Mediterranean countries, new challenges particularly related to the current and future commitments in the context of the liberalization of financial services have also emerged. These challenges acutely concern the question of adapting the sector to the demands of a globalized and competitive market that imposes as well the challenges of openness to the international financial markets.

Thus, in order to ensure a better funding of the Moroccan economy, the financial sector has experienced a progressive liberalization, which has taken place through two stages since the early 1990s:

- The first set of reforms, launched in the early 1990s, aimed essentially at the banking sector.
- The second stage of reforms initiated in the mid-1990s focused more on the capital market, with the pursuit of the liberalization measures of the banking sector.

Before the 1990s, almost 65% of Bank Resources were allocated in the form of mandatory employment with its interest rate that was below the market rate. For this reason, the appropriation of 35% of the left resources was increased to very high interest rates.

Since the early 1990s, the financial sector in Morocco has witnessed a liberalization movement marked by reforms (3D: Deregulation, decompartmentalization, disintermediation) supported by series of initiatives of the World Bank. These reforms focused on the Banking Sector (1991-1995), the capital market development and the extension of the financial sector liberalization (since 1996).

In 2003, a study undertaken by the IMF[4], which studied the efforts exposed in terms of the financial reforms since the beginning of the 1970s until 1996, ranks Morocco among the countries that have made considerable efforts, with a financial liberalization index of 11 out of 18. This reforms process started to show it results since 1993. However, despite all these strategies, Morocco still has to increase its efforts in other fields such as the institutional environment, the financial openness and the nonbanking financial system.

The *NORTH AFRICA* region consists of a diverse group of countries; some of them are among the poorest in the world and others among the richest (oil exporters). This region has achieved significant changes in terms of exchange and the situation of both its current account and its external financing needs. In spite of the recent developments, the global markets of raw materials have had a negative impact on the region economies. However, although these mutations have been produced in a period of deterioration of the external growth and international finance, the gross domestic product of the region remains unchanged in 2008.

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[3] MOUFTI Said, Système financier marocain : pour une convergence accélérée vers les standards de l'Union européenne », conférence économique africaine, 14 nov. 2008.

[4] International monetary fund

Concerning the financial development, retaining the main indicators of financial development, the results show that *NORTH AFRICA* countries have recorded a more developed financial system in the last decade. These countries have not been particularly exposed to the international financial crisis of 2008 because of their limited integration into the global financial institutions.

This article seeks to position Morocco among the countries of NORTH AFRICA region, regarding the financial development issue. First, we are going to determine the evolution of some development indicators according to the field's literature, then construct a *Global index of Financial Development* (GIFD) that will enable us to conduct clearer comparison between these countries.

The solution to this problematic issue necessitates particularly answering to the following questions:

1. After examining the indicators, could we say that NORTH AFRICA countries have a developed financial system?
2. What position does Morocco occupies in NORTH AFRICA region concerning the development of its financial system?

Two main assumptions were put forward in order to answer these questions:

- **H_1**: NORTH AFRICA countries still live its embryonic stage regarding the development of their financial systems.[2]
- **H_2**: Morocco owns one of the most developed financial systems in the region.

2. Literature Review

The economic growth can be defined as the continuous increase over time of the goods and services volume (quantity and/or quality) produced per capita in a certain economic space.

The ultimate purpose of any economy is to promote its progress. Thus, several empirical studies have confirmed the existence of a strong relation between financial development and the levels of income and economic growth of the countries. Otherwise, the direction of this causality between the two parameters has not been resolved and remains dependent on other variables such as indicators of financial development, estimating methods as well as the quality of the used Data. In other words, financial development can be an engine of economic growth as it can be a result of the latter. Despite this ambiguity, public authorities, realizing the benefits of financial openness, should ensure the creation of favorable conditions for the development of the financial system; eliminating the conditions of financial repression.

Theoretical studies, summarizing the ideas of the founders of the theory of financial liberalization, consider savings as a necessary condition for productive investment and economic growth. This relationship has been recognized in the literature for several decades by the predecessors Gurley and Shaw (1960) and Goldsmith (1969). Explicitly or implicitly, we find in the studies of these authors and others[5] the idea that an efficient financial system can lead to an economic growth. According to these authors, the major contribution of the financial system in the real economy lies in the fact that it ensures the functioning of an efficient and scalable payment system, which mobilizes savings and improves its allocation to the investment thanks to the real positive interest rates. Furthermore, the financial system with a necessary presence of macroeconomic stability makes the operation of the financial intermediation and the allocation of financial resources more efficient by keeping down the costs of intermediation and information.

Thus, the active financial intermediaries adapt financial assets to the potential needs of savers and investors, often divergent, while reducing the information asymmetry between lenders and borrowers and adjusting the offer and demand for funding to a higher level by increasing as well the amount of the invested savings.

[5] Fry (1988-1989), Thornton (1991-1994), king & Levine (1992-1993) and others.

Economies in the process of Development, such as Morocco, are generally classified as a "debt economies" where the largest share of external financing of companies is done through the financial intermediaries. The financial markets appear when companies reach levels of development in which firms can sell securities to financial intermediaries, but also directly to investors. The creation of these markets has the advantage of providing investors and savers with a richer battery of financial assets (it participate in the financial diversification). This quality enables them to have a better pooling of risks and limits somehow the monopoly of financial intermediaries which ; in the absence of competition, encourages companies to make non innovative projects with little risks, by taking large rents (Khan et Senhadji , 2003).

The fierce competition leads the banks to raise the interest rates in credit to retain or attract the deposits, which tend to reduce their margin. This is often considered as favorable to the development of savings and investment. Nevertheless, it is also possible that the reduction of margins will cut the value attached to the banking privilege (given the mandatory minimum ratio between capital and risk assets). This decrease may encourage banks to increase their performance by acquiring riskier assets, with a speculator behavior (Hellmann, Murdoch and Stiglitz, 2000). This is why; controlling interest rates on deposits can be very useful. Certainly, better regulation and banking supervision are necessary to prevent this behavior qualified on banks part, but their implementation is generally beyond the available expertise in developing countries (Andersen and Tarp, 2003)[6].

Gurley and Shaw (1960), McKinnon and Shaw (1973) have developed an analytical framework in which financial repression is the backdrop. According to these two authors, the government intervention in the functioning of financial markets discourages savings, leads to credit rationing and non-optimal resources allocation.

If the State fixes arbitrarily real interest rates (through the setting of nominal interest rates) below their market equilibrium values, it can reduce the economic growth as follows:

- This reduces the amount of funds available for investment (savings) through the decrease of bank deposits in favor of current consumption ;
- This affects the quality of investment by the modification of financial intermediaries behavior to the extent that banks are forced by the government to finance projects in low yields (priority sectors ...)
- Fixing investment below its optimum level ;

Indeed, liberalizing the financial sector and reviewing the level of real interest rates on deposits (an increase in nominal rates or a decline of inflation) will stimulate the accumulation of savings and therefore investment. This should also help increase the bank intermediation with reduced intermediation costs between lenders and borrowers through realizing economies of scales. However, further studies within the same logic came few years later to manifest this purpose, essentially the works of Galbis (1977), Kapur (1976-1986), Mathieson (1978-1979), Vogel and Buser (1976) Fry (1988), YJCho (1988), and N.Roubini X.Sala- i-Martin (1992), who had a primary mission to analyze the original contributions of MacKinnon (1973) and Shaw (1973). They conclude that if the financial liberalization promises the best, it will conduct the countries that have adopted this idea to serious problems. The financial crisis that began in Thailand in the summer of 1997 and the international financial crisis of 2008 are among the other limitations that attract the attention of researchers.

[6] S.guillaumont Jeanneney et K.R.Kpodar, « Développement financier, instabilité financière et croissance », CERDI, March 2004.

3. Methodology

3.1. Empirical Methodology

As a methodology of our study, we have selected four countries in NORTH AFRICA region (Algeria, Egypt, Morocco and Tunisia), mainly due to the lack of data concerning other countries. For that reason, the period of the study has lasted for 33 years from 1980 to 2012 divided into three periods; (1980-1990), (1991-2005) and (2006-2012). For consistencies sake, our data was taken from the database of the World Bank[7] and the International monetary fund[8]. The empirical study uses a battery of financial development indicators following the literature on the subject and as a basis for the progress representation of these variables. A *global index of financial development* will be built in order to facilitate the comparison between countries of the region.

3.2. Measurement Indicators of financial development

3.2.1. M_1/M_2 ratio

The money supply has several components that are classified according to the degree of liquidity. $[M_1]$, which represents the actual cash availability that contains scriptural money and trustee. It is indeed, all banks notes and coins in circulation are deposited without forgetting checks. The second aggregate, which may be designated by$[M_2]$ is the money supply at large definition. It is made in addition to the fiduciary and scriptural money contained in the first aggregate, savings bonds, term deposits and industrial savings as well as savings accounts.

The development of financial systems over time can be examined using the $[M_1/M_2\ ]$[9] ratio. It provides information about the attraction of savings by the financial sector. The more confidence in the banking system increases, the more financial savings products become available and the ratio tends to decrease, since savings pass from short period to long time savings[10].

3.2.2. M_2/PIB ratio

The liquidity ratio $[M_2/GDP]$[11] is the most widely used indicator in the literature (King and Levine, 1993a; World Bank, 1989 McKinnon (1973). This indicator takes into consideration the payment's means available in the economy. It tends to increase when the financial system develops and when the range of savings instruments expands as well as when liquidity is increasing in the economy, and decreasing when non-banking savings forms are used (informal savings). This variable reflects the volume of financial services available in the economy and explains financial deepening. Among the work that refers to this kind of ratio, we can refer to Leite study about sub-Saharan Africa (2001)[12]. However, it is necessary to pay attention to a disadvantage of this indicator. Indeed, a high level of this ratio is supposed to represent high liquidity of the system. But in some cases, this ratio may decrease as the financial system develops. This happens when the economic agents have other alternative long-term investment rather than short-term liquid investments.

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[7] (WDI : world development indicators 2013)
[8] (World Economic database Outlook. october.2014)
[9] Examination of the ratio over time can be a good indicator of the "speed" with which the financial sector is developing.
[10] SAMOUEL Beji, « Financial development for the South méditerranéen sea countries in a context of globalisation », thèse de l'université Paris 13, décembre 2009.
[11] In developing countries, usually an increase in this ratio could be explained by the monetization of transactions by the increase in the volume of bank deposits (the degree of financial intermediation) .
[12] Brahim GANA, Identification des principaux indicateurs de développement financier en Algérie par la méthode d'analyse en composantes Principales (ACP), mars 2013.

3.2.3. Domestic credit to private sector / GDP

The ratio of credit granted to the private sector on GDP[13]; $[CSP/GDP]$ is related to the quantity and the quality of the investment. It reflects the control of the crowding out effect of the public sector with the private sector. Its high level reflects, the effectiveness of the management of bank liquidity, especially in what concerns default risk[14].

3.3. The model and the indicators measurement

The construction of a global index of financial development for NORTH AFRICA countries refers to the method of calculation defined by Demirguk-kunt and Levine (1996) and A.Chouchane Verdier (2004). This index resumes the level of financial development of the countries although some economists (Levine, 1997; DE Gregorio & Guidotti, 1995) reported in their studies the difficulty of assessing it.

To measure the level of financial development of financial intermediaries, three indicators were considered:

1. $[M_2/GDP]$, noted M_2.
2. $[CSP^{15}/GDP]$, noted CSP.
3. $[DCPFS^{16}/GDP]$, noted DCPFS.

The construction of this index allows us initially to rank those countries in a descending order of their financial development and secondly to analyze the evolution of this index over time. Thus, periods of the study were not chosen at random; the first period (1980-1990) is the period before starting reforms, the second (1991-2005) is considered as the ambiguous period, where some countries had to improve their reforms and the last period (2006-2012) where we can clearly appreciate the fruits of reform processes of financial systems.

The calculation of the index was implemented in two stages. For each country -i- , we calculated 3 standardized indicators X_j^i* (i = 1,…..,4 et j = 1, ..., 3) corresponding to the M_2,CSP, and DCPFS variables .

$$X_j^i * = \left[\frac{X_{j-\bar{X}_j}^i}{\overline{X}_J}\right]$$

Where, $\overline{X}_j$ is the arithmetic mean of the indicator -*j*- on the 4 countries. The numerator; is the difference between country -*i*- and the average of countries in NORTH AFRICA region; is positive when the country has a higher indicator than the average of the region, negative otherwise. The Expected results allow us to figure out easily the situation of the country in question. Thus, once calculated the $X_j^i *$ for each country, the global index of financial development corresponds finally to the arithmetic average of the three indicators.

$$Y^i = \frac{1}{3}\sum_{j=1}^{3} X_j^i *$$

[13] Gross domestic Product
[14] Brahim GANA, Identification des principaux indicateurs de développement financier en Algérie par la méthode d'analyse en composantes principales (ACP), mars 2013. Risque qu'une perte financière soit causée par l'incapacité d'un emprunteur d'honorer ses engagements de paiement des intérêts ou de remboursement de la créance.
[15] Credit to private sector.
[16] Domestic credit provided by financial sector.

4. Discussion

4.1. The progress of some indicators of financial development

4.1.1 The evolution of the ratio M_1/M_2

Following the evolution of the $[M_1/M_2]$ ratio for the four countries in NORTH AFRICA region in the Figure n°1, we notice a remarkable decrease in this ratio between 1980 and 2013. Furthermore, several observations can be drawn for some countries. Thus, until 2006, Morocco is the country that has had the highest ratio, which explains the prevalence of the available monetary mass$[M_1]$, explaining also the extent of the attractiveness of savings by the financial sector. This ratio is expected to decline if an important trust is established for the banking sector, where products of savings becomes largely available, moving from a short period of savings to a long time savings. Moreover, Algeria has taken the first place, since 2006; with a $[M_1/M_2]$ ratio exceeding 65 % followed by Morocco 60% then 42%, 30% for Tunisia and Egypt respectively. However, the examination of this ratio alone is not sufficient to explain the level of financial development of a country. We will complete our analysis using other variables.

4.1.2 The evolution of the ratio M_2/GDP

The ratio $[M_2/GDP]$ as mentioned above is an indicator that explains both the volume of financial services available to the economy and the financial deepening. The latter tends to increase when the financial system is in the process of development and when the range of savings instruments widens. However, it decreases when some forms of savings, which are not placed in banks, increase.

According to the Figure n°2, Morocco ranks first in terms of the share of the monetary mass $[M_2]$ out of the gross domestic product. Its ratio has increased from 40% in 1980 to even 110% in 2012. This result should have some explanations; the progress curve of this indicator witnesses a positive growth throughout the period with stronger growth since 2005. However, continuous improvement of the ratio $[M_2/GDP]$ explains the increase of bank deposits (financial intermediation) and as a result probably the increase of the credit supply.

Egypt ranks second with a ratio of around 80 % in 2012, while it was around 60% in the early 1980s. This improvement is certainly important, but we notice a nonlinear evolution of this indicator, having experienced more substantial results in 1987 and 2003 with 95% of gross domestic product. For Algeria and Tunisia, they have recorded a consistent positive growth of this indicator since the 1990s, but this development is still very slow; the ratio increased from 45% to only 60% in 2012.

4.1.3 Evolution of the ratio CSP/GDP [17]

This ratio provides information on the quantity and quality of private investment in the country. A first reading of the Figure n°3 shows that Morocco and Tunisia are the countries that have the highest ratio of credit granted to the private sector /GDP; it reached 70 % in 2013. Furthermore, the evolution of this indicator during period of our study was significantly heterogeneous for both countries. Tunisia initially recorded a ratio of 38% in the early 1980s to reach 70 % in 2013 as shown above. Morocco, in contrast, witnessed a spectacular progress with a slow ratio in 1980, which moved from 15% in 1980 to 70% in 2013. The important questions also arise in the case of Algeria with 70% in 1986, which decreased to almost 15% in 2013, in the same way, Egypt achieved a remarkable growth between 1980 and 2000 (a ratio of 55%), then suffered fall since that date until 2013 to reach 28%.

Indeed, we see consequently that Tunisia and Morocco; going back to the growth of their ratios over time, increased successfully the quality and quantity of private investments due to the increase in the credit

[17] Credit to private sector reported to gross domestic product

supply given by the financial/banking sector. This relatively high level of this ratio in 2013 particularly (70%) leads us to notice the good management of the bank liquidity, namely in regard to the assessment of default risk[18].

4.2. The global index of financial development (GIFD)

The Indexes representing the financial development of the countries have been calculated for 4 periods: (1980-1990), (1991-2005), (2006-2012) and (1980-2012) as the overall period.

After calculations on the period (1980-2012), three categories[19] of countries were found:
- One country with a low level of financial development, Algeria, with an index of -0.2553
- One country with an acceptable financial development, Morocco, with an index of -0.0084
- Two countries, which are financially developed Tunisia and Egypt with 0.0907 and 0.1730 respectively.

Table 1. The evolution of GIFD for NORTH AFRICA countries.

	General period		**First period**		**2nd period**		**3rd period**	
Country	1980-2012	Rank	1980-1990	Rank	1991-2005	Rank	2006-2012	Rank
Algeria	-0,255	4	0,247	1	-0,455	4	-0,665	4
Egypt	0,173	1	0,130	2	0,267	2	0,067	3
Morocco	-0,008	3	-0,386	4	0,046	3	0,467	1
Tunisia	0,090	2	0,008	3	0,141	1	0,130	2

Following the expected results in the above table, we can draw several conclusions about the evolution of financial development of the four countries. First, Algeria achieved throughout this period almost a very low index of financial development, except in the period 1980-1990, where it ranked first with an index of 0, 24. Besides, this indicator in Egypt has been declining continuously throughout the period to reach 0.06 by the end of the period after being ranked first in the period 1991-2005 with an index of 0,26. However, Tunisia left the first rank to Morocco during the period 2006-2012; during which Morocco recorded its best result (0.46) after being ranked as the fourth country during the first period with (-0.38). These results justify the effort made by the country to improve its financial system in the context of the financial liberalization policy.

[18] Risk that a financial loss due to the failure of a borrower to meet its obligations to pay interest or repayment of the debt : http://www.iotafinance.com

[19] The average of financial development is around zero , low if it is below - 0.013 and high above 0,013 , which is a distribution calculated by dividing by six , the sum of absolute differences of the lowest financial development index and the highest one.

Table 2. The evolution of GFDI between the two extreme periods

Amelioration of GIFD	Rate	Deterioration of GIFD	Rate
Morocco	0,8539	Algeria	0,4179
Tunisia	0,1218	Egypt	0,0627

The progress of the financial development index over time determines two categories of countries. The first category includes countries that have improved their financial development indicators; namely Morocco and Tunisia and the second category for the countries that have experienced a delay in this issue. Morocco is considered as the country that has significantly improved its financial development index with an increase of more than 0.85 points.

5. Conclusion

The review of the index of financial development leads us to draw good conclusions for all the countries of this study. Going back to the questions stated in the problematic, we can confirm the hypothesis, which advocates the weak financial development of NORTH AFRICA countries. Algeria and Egypt caused a significant delay of the development of financial intermediaries during the period 1980-2013; 0.41 and 0.06 respectively. Tunisia recorded a low growth of (0.12); whereas Morocco is the only country that succeeded in achieving good results between 1980 and 2013; moving from an index of (-0 38) to (0.46) in 2013 to rank first after 2005. This result confirms the authenticity of the second hypothesis, stipulating the right place of Morocco among those countries regarding the level of the development of its financial system.

Considering Morocco as one of the most powerful member among NORTH AFRICA countries, its financial sector has achieved continuous improvements in terms of the improvement in its financial development indicators. Indeed, the conditions of the bank financing, financing costs and debts management... have been largely improved. Thus, it turned out clearly through our results that the progress made by Morocco in the modernization and development of its financial system, in order to improve the financing of productive sectors, are highly visible in relation to NORTH AFRICA countries, especially for Egypt and Algeria. However, major challenges have to be considered in terms of deepening its financial system. It can be summarized in improving the accessibility of Small Medium-sized companies to financing, transparency and modernization of the information system. Besides, it improves the liquidity of financial markets, the integration of the informal sector and diversification of financing instruments as well as the promotion of the competition to decrease the costs of global financing.

In fact, despite the efforts of the Mediterranean countries to develop their financial sector by integrating in the financial liberalization stage, these countries still far from the financial development level achieved by the developed countries.

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INCREASING THE EFFICIENCY OF UNDER ROAD CULVERTS IN PROTECTING THE DESERT ROADS AGAINST TORRENTS & FLASH WATER

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Abstract: *Owing to the huge damage caused by flash water and torrents in the desert roads, the attempts to prevent such damage have received a great attention. Culverts are the popular engineering tool usually used for converting the accumulated runoff water from one side of the desert roads to the other side. This engineering tool prevents overtopping which stops the safe traffic stream over the roads. Since the culvert entrance geometry is one of the prime factors affecting its accurate performance. The present study is a trial for increasing the discharging efficiency of such culverts to give more safety for the desert roads. Investigating the influence of using inclined headwall at the culvert entrance on discharge efficiency, its inclination angle in the same direction of the flow and in the opposite direction will be tested as well. A needed survey for references related to the current study topic, covers a suitable time period were included in a tabulated form, with the needed technical comments. The theoretical approach also was introduced. A comparative study was done for the results obtained by most popular researchers and the calculated discharging efficiency reached by each of them, and given in a tabulated form.*

Key words: *Culverts, Discharge coefficient, Headwall, Desert road culverts.*

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1. Introduction

Assiut governorate is one of the most developed governorates in Upper Egypt. In the last two decades, many great engineering infrastructure projects were carried out for serving several Industrial areas constructed in the desert extension to the East and West of the River Nile in all Upper Egypt governorates. Such new industrial communities and new cities need great logistical activities, transportation, and perfect desert highway networks which represent the heart of such needed logistical activities. Many desert highways were constructed in the Eastern and Western deserts to join all the Upper Egypt governorates, and their new industrial communities. Since the Eastern Egyptian desert is located in an arid region (13mm average annual rainfall), the region does experience occasionally intense rainfall events (often 60 mm/hour) over fairly short periods. The rainfall events are, as in the most arid areas, the result of severe local convective thunderstorms created by unstable weather conditions and the aerographic effect of these regions (Zeller 1990 [1], Greenbaum 1998 [2]). These storms generate flash floods that run rapidly along the network of dry wades drain the mountains and cause severe damage to people property and specially highways. Along the last twenty years, more than once flash water and torrents attacked the Eastern main desert highways (Zeinab and, Sallam 2004 [3]) in El-Minia, and Assiut governorates. This flash water causes a huge damage to road body and stops the traffic stream among many of the Upper Egypt governorates affecting negatively the commercial and daily human activities.

The present study focuses on more efficient protection for such desert roads against the expected attack of the flash flooding or torrents by improving and increasing the performance efficiency of the under desert roads culverts. Since culverts are the most popular constructional tool used for converting any accumulated flash water from one road side to the other without any water overtopping for the road. The geometry of the culvert entrance is of a great importance in improving, and increasing its performance efficiency so, our work here is for testing the influence of equipping an inclined headwalls in the entrance of such culverts.

Effect of the equipped headwall angles to the direction of the flow was tested as well. The chosen approach was carefully done after studying the previous researches carried out related to our topic and highlighted some parameters still need more investigations for achieving the main needed goal required for introducing the most efficient culverts in discharging flash flooding through roads without any damage.
From studying the previous available researches concerning the under desert roads culverts performance, it was noticed that many of the affecting parameters concerning increasing such culverts discharging efficiency were investigated. At the same time no study was carried out to know the influence of using the headwalls in the entrance, and their inclination to the direction of the flow .That is why the topic of our study was chosen.
Six angles of headwall inclination to the direction of the flow can be tested with eight discharges for each angle of headwall inclination. The obtained results were recorded, discussed through tables, and charts from which main conclusions were drawn down.

2. Culverts

A culvert is a structure under the roadway conveys the surface water through a roadway embankment or away from the highway for drainage [4]. In spite of, culverts are minor structures but they have a great importance in protecting desert roads against flash floods and torrents. For economy and hydraulic efficiency, engineers should design culverts to operate with submerged inlet during the flood flows. Determination of culvert performance is not a simple problem because of the effect of different factors such as geometry of the inlet and exit, culvert alignment, barrel shape, materials, culvert slope and length. However, once the operation type is established the analysis may proceed according to the well defined principles. Therefore the discharge through culverts is controlled by one of three means [5].

The first mean is the geometry of the inlet while the culvert is running partially full on mild slopes, or running full in steep slopes. At this case the culvert is running under inlet control only.

The second mean is the combined effect of the entrance, length, slope, shape, and roughness of the culvert barrel while the condition of running may be full or partially full.

The third mean is the elevation of the tail water at the outlet. When the water depth is higher than the culvert spring it will be running full. Inlet control is affected by the inlet geometry and the existence of the headwall and its inclination. Outlet control is affected by all the geometrical and hydraulic parameters of the culvert such as the inlet configurations, barrel shape and slope, roughness and water elevation in U.S and D.S.
Generally, culverts can be classified according to more than one criteria such as construction materials, barrel cross section, alignment, position and purpose of construction.
Materials most commonly used in construction of culverts are reinforced concrete, corrugated metals, timber, cast iron, verified clay and sometimes stone masonry. Using a specific material is depending on the design factors and the economical considerations. The concrete sections can be cast in place or pre-cast unites.
The cross section of a culvert may be circular, oval, elliptical, arched, box rectangular or square. The rectangular section for culverts is used when it is desired to reduce the height of the culvert to keep the roadway level as it is. For small discharges single barrel can be used. Otherwise excessive flood requires more than one opening and it is called multiple culverts.
Culvert alignment should be the same of the natural stream that crosses the roadway. So the culvert may be skew or perpendicular to the centerline of the roadway. Proper design requires a good alignment to reduce construction costs. A good designer should design the culvert with a grade keeps suitable velocity because less velocities cause sediment in the culvert barrel and high velocities cause scour. Flow type through the culvert barrel shouldn't be changed within the length of the culvert so changes in slope within the length of the culvert should be avoided as possible.
Hydrological studies for highway culverts are essential to estimate discharge amount which must be handled safely and economically. There are many methods of estimating the designed discharge of culverts. For example the rational method, direct observation method, judge method, .etc. may be used.

The amount of the flood water (runoff) which considered as a product in the hydrologic cycle is affected by two major groups of factors: Climatic factors such as rainfall and evaporation. Rainfall density, duration, frequency and distribution time have the major effect. On the other hand, physiographic factors depending on the catchment's area of the rainfall. These factors are: soil type and its water holding capacity, surface infiltration conditions, geological conditions, land use or cover, ground water table, and topographic conditions. Once these factors are known the design discharge could be estimated by any method of calculating the peak discharge of road culverts [18].

3. Previous studies

Many experimental studies and field observations were carried out for illustrating culvert performance. Among of them, those of Chow 1959 [6], Henderson 1966 [7], Norman et al. 1985 [8], Moawad 1995 [9] and Chaudhry 1993 [10]**.** They pointed out that, several factors affect on the flow through culverts whether they running full or partially full. These factors are x-sectional shape and dimensions, length, roughness, inlet and outlet geometry, edge configurations, slope, U.S. and D.S. water depths. Culvert may flow with inlet control or outlet control depending on such factors. Henderson 1966 [7] concluded that culvert in mild slopes does not run full unless the ratio between U.S. water depth (H) and the pipe diameter (D) is more than 1.2 in case of circular x-section. Chaudhry1993 [10] indicated that this ratio is much more than 1.2 and reaches 1.5 because of the sharpness of the edge and the contraction flow at the inlet.

3.1. Inlet control

Laster 2003 [11] stated that, inlet flow control condition occurs when the culvert barrel can convoy more than the inlet will accept. Inlet control condition affected with inlet geometry and configuration, U.S. water depth, barrel shape and slope. FHWA (Federal Highway Administration) had published in the HDS (Hydraulic Design Series) No. 5 [8] that culverts flowing under inlet control condition have one of the following cases:

First case is when the barrel is not full and the U.S. water depth is less than the barrel spring. As shown in Fig. (1-a). Culvert in this case acts like a weir and the relation between discharge and U.S. water height can be written as:

$$Q = C_d B H^{1.5} \tag{1}$$

Second case is when the barrel is not full but the U.S. water height is higher than the barrel spring. As shown in Fig.(1-b). Culvert in this case acts like an orifice and relation between discharge and U.S. water height can be written as:

$$Q = C_d A \sqrt{2gh} \tag{2}$$

Third case which shown in Fig. (1-c), from which it is clear that, on steep slopes culvert may runs full and the relation between discharge and head loss can be written as [12]:

$$H_l = \frac{fLQ^2}{2gDA^2} + H_{ex} + H_{in} \tag{3}$$

3.2. Outlet control

Outlet control flow condition occurs when the culvert barrel is not capable to convoy as much as flows which the inlet opening can accept (Laster, 2003 [11]). The control section is located at the exit. Geometric and hydraulic characteristics affect the flow and play role in the performance of the culvert. Culvert barrel is always running full as shown in Fig. (1-d), and the outlet is submerged. The relation between discharge and head loss can be written as Darcy Weisbach equation No. 3. [12].

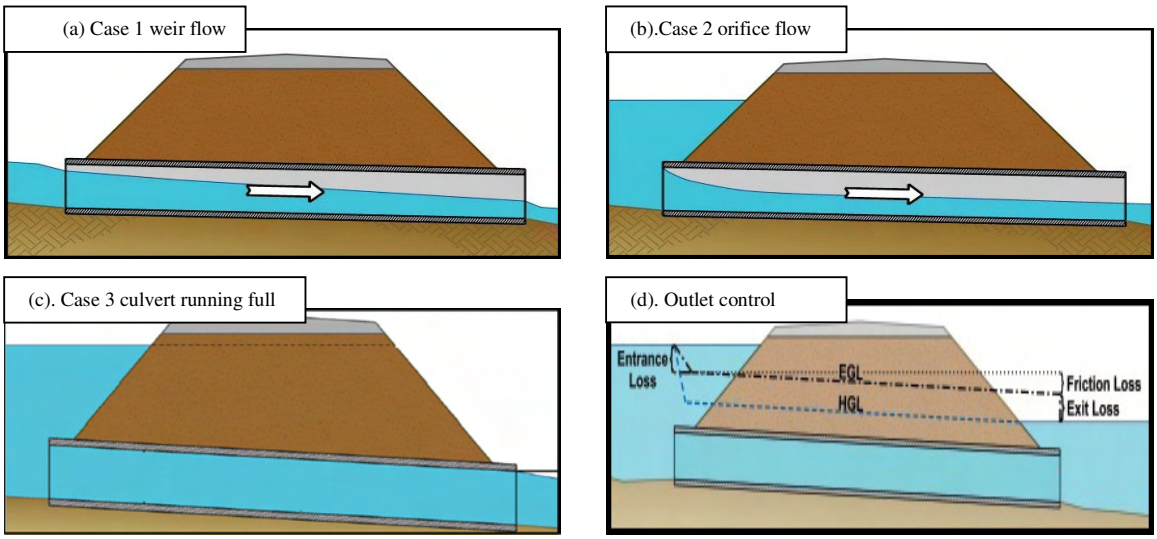


Fig. 1 cases of control flow

3.3. Culvert headwall

Headwall is a retaining wall normally constructed at both ends (U.S. or D.S.) of a culvert barrels. Headwall functions are to Control erosion and scour resulting from excessive velocities and turbulence, Stabilize the side slopes filling at the culvert entrance, anchor the culvert body (one barrel or more) to prevent movement, reduce seepage through road embankments, enhance the hydraulic efficiency of culvert [8]. A culvert fulfills both the structural and hydraulic requirements for the stream crossing and may constructed from a variety of materials but headwalls usually constructed from reinforced concrete, plain concrete or masonry. They may be cast in place or pre-cast units depending on site and economical considerations. In all ways headwall must be constructed perpendicular to the centerline of the barrel with a good fixation to it is required.

For best hydraulic performance, a rounded or beveled edge between the headwall and the barrel should be done [16]. If high headwater depths are likely, a short apron is often desirable to prevent bottom scour at the toe of the wall.

3.4. Culvert efficiency improvements

Since the economical considerations are the prime factor in constructing such essential structures, the same barrel cross section shall be used with some other barrel shapes to gain the maximum discharging efficiency for the same x-sectional barrel area through some geometrical modification. Regarding to this fact, the entrance geometry and configurations should be modified. The culvert performance efficiency can be represented by the value of the discharge coefficient when the culvert operates with inlet control. It also can be represented by the coefficient of entrance head loss when the culvert operates with outlet control [13]. A larger coefficient of discharge or smaller head loss gives a higher efficiency. Many attempts were made to improve the hydraulic efficiency of culverts by modifying the entrance configurations.

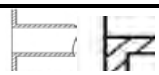
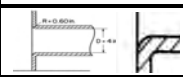
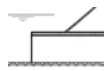
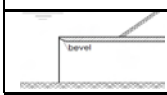
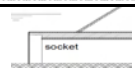
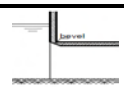
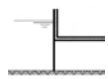
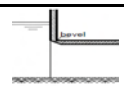
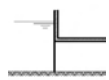
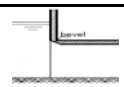
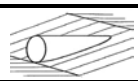
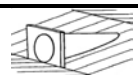
After reviewing the available previous studies and discussing their main results, a comparative study was carried out to differentiate between the main obtained results by each study for highlighting the most efficient method that used to improve the performance of such culverts. Table (1) and (2) were constructed

for tabulating all the used data and measured parameters. In addition to the recommended technical points concluded from each study. At the same time, the constructed tables include a special column for the calculated percentage of increased efficiency of the culvert performance.

From such constructed tables for both inlet control and outlet control conditions, it is clear that no one of such studies used the headwall with different inclination angles to the stream flow as a tool for enhancing the inlet geometrical configurations for improving the working efficiency. Also no one tested the influence of the headwall inclination to the stream flow in the same direction of the flow and in the opposite direction.

In table (1) the performance was represented by the coefficient of discharge. The efficiency of the culvert was calculated according to the increase of the discharge coefficient. The studies examined different lengths and different cross sections for culvert barrels.

Table 1: Comparative study of some of previous works (Inlet control).

Reference	x-sec. & length (Inch)	Definition sketch Before	Definition sketch after	Calculated increase of efficiency %	Notes
Lorenz, 1953 **[13]**	D=4 L=420			-	Square edge
				10	Rounded edge R=0.6
French, 1964 **[14]**	D=5.5 L=363			-	Projected square
				17.3	Square +Vertical Headwall *
				55	beveled + Vertical Headwall*
				-	Projected beveled
				2.5	beveled + Vertical Headwall*
				59.8	Socket +projected
				74.8	Socket + Vertical Headwall + wingwall*
French 1969 **[15]**	8×4, 12×6			-	Square + Vertical Headwall *
				34.2	Bevel edge + Vertical headwall*
	4×4			-	Square + Vertical Headwall *
				28.7	Bevel edge + Vertical headwall*
	6×12			-	Square + Vertical Headwall *
				29.7	Bevel edge + Vertical headwall*
Smith 1995 **[16]**	12.1cm L=1.85m			-	Projected
				16.7	Vertical Headwall *

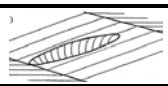
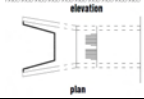
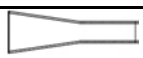
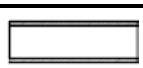
t taper inlet. ** using vertical headwall.*

From the above comparative table (1), the following main technical points can be obtained:-

1. Using the headwall without any inclination to the stream of flow at the upstream of the culverts improves the hydraulic performance, and maintains the same discharge with low water height at the upstream side of the culvert. Which was explored by French1964 **[14]**, 1969 **[15]**, and Smith 1995 **[16]**.
2. For the circular pipe culverts, the best inlet shape is the taper inlet with angle of slope 15.5^{o} (Slope 4:1). This taper gives the maximum discharge coefficient, C_d=0.93 for the inlet control (French 1964 **[14]**).
3. The worst shape of the inlet for the circular culverts is the projected sharp edged without headwall. Besides, the worst shape for box culverts is the conventional sharp edged without any modifications.
4. Using the beveled or the rounded edge barrels improves the hydraulic performance of culverts.

For outlet control some attempts are summarized in the table (2). In this table the performance was represented by the head loss (H_l). The efficiency was represented according to the decrease of the head loss (H_l). The studies examined different lengths and different cross sections for culvert barrel and gave a head loss equation for each type of entrance modification. The U.S submergence ratio (H/D) at which the culvert running full was introduced.

Table 2: Comparative study of some previous works. (Outlet control)

Reference	x-sec. & Length cm	Definition sketch	H/D	Decrease in head loss%	Notes
Khalil&zein 1995[17]	15×10 L=100		>1.3	-	Conventional inlet
			=1.1	22	Side taper 3:1
			=1.1	29	Side taper&deck3:1
Hesham.k.M 1998[18]	D=15 L=120		>1.13	-	Vertical inlet
			=1.06	12.5	Slope face 2:1
	14*7 L=120		>1.13	-	Vertical inlet
			=1.06	5.7	Slope face 1:1
	10×10 L=120		>1.1	-	Vertical inlet
			=1.03	8.3	Slope face 1:1
Elbahar 1998 [19]	5×5 L=100		>1.23-1.4	-	Box inlet(conventional)^R
			=1.05-1.26	32.4	Side taper 5:1^R
			=1.05-1.26	21.6	Slope deck 3:1^R
			=1.05-1.26	21.4	Slope taper 3:1^R
Khalid.A.A 2004[20]	D=14.4 L=216		>1.27-1.54	-	Conventional inlet
			=1.33-1.165	34.5	Flared 4:1
			=1.08-1.21	30.3	Elliptical inlet

R rounded edge inlet R=.5cm

From the table (2), the following main technical points can be obtained:-

1. The performance of culverts is affected by the inlet shape and configurations.
2. For the circular pipes culverts, the best inlet shape is the taper inlet Slope 4:1 (angle equal to 15.5^o). This taper gives the minimum head loss for the outlet control (Khaled A. A. 2004 [20]).
3. For the box culverts, the best inlet shape is the inlet with side taper 5:1 in the horizontal plane with rounded sides (R=0.5 cm). So, it gives the minimum head loss which means the best performance (Elbahar 1998 [19]).
4. The worst shape of the inlet for the circular culverts is the projected sharp edged without headwall. Besides, the worst shape for box culverts is the conventional sharp edged without any modifications.

From the above comparative tables (1 & 2), It is clear that the inclination of the headwall at the inlet hasn't been studied yet. That is why we decided to study the effect of its inclination on the discharge efficiency of the culvert in this work.

4. Theoretical approach

Flow in culverts could be controlled by inlet or outlet depending on where the control section is. Inlet control depends on the U.S. water depth, entrance shape, and edge conditions. Outlet control depends on all factors as U.S. and D.S. water depths, culvert entrance and shape, length, slope, and roughness. For studying the headwall inclination on the performance of a culvert U.S. the inlet must be submerged.

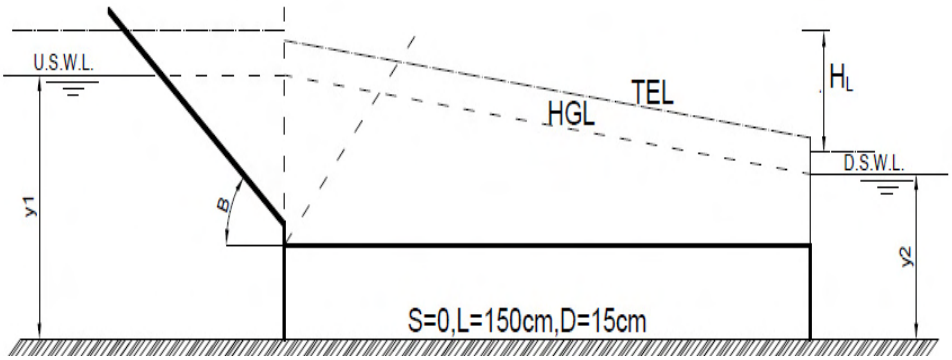


Fig.2 Definition sketch for experimental model flow.

Referring to Fig (5) the following functional form of variables used in dimensional analysis are selected to represent all parameters affecting the problem. The general functional relationship for these variables can be given in the form

$$C_d = \phi(\rho, \mu, g, y_1, y_2, \beta, H_l) \tag{4}$$

Using the dimensional analysis principle based on the aid of the "Buckingham π theorem" considering ρ, μ, g as the repeated variables, it could be proved that

$$C_d = \phi(\frac{y_2}{y_1}, F_e, R_e, \frac{H_l}{y_1}, \beta) \tag{5}$$

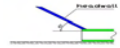
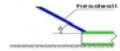
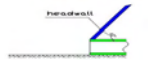
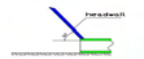
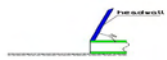
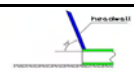
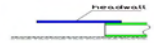
Since the effect of R_e is neglected as the viscosity has a negligible effect on the hydraulic.
Re-arranging the terms gives the equation the following shape.

$$C_d = \phi(\frac{y_2}{y_1}, F_e, \frac{H_l}{y_1}, \beta) \tag{6}$$

5. Experimental work program

A set of wooden inlet headwalls were manufactured in the work shop of the faculty of Eng., Assiut University. They were coated to prevent water effect. Different angles of inclinations of headwalls to the direction of the stream, in the same direction of the flow and in the opposite direction, were prepared to be tested for determining the discharge coefficient for each headwall inclination angle (0, 30, 45, 60, 75 and 90) to recommend the most efficient inclination of the inlet headwall which permits the passage of maximum discharge in minimum time as described in table 3. Experiments were carried out in a channel has a trapezoidal shape of 1:1 side Slopes, 13 m long, 84 cm bottom width, and 54 cm height in the irrigation and hydraulic laboratory of civil engineering department, Assuit University. The discharge ranges from 5 to 40 l/s. The experimental model of culvert was represented as a circular pipe of 15 cm diameter, and 150 cm long impeded in the above mentioned channel.

Table3. Studied headwalls angles of inclination in the direction of the stream and in the opposite direction.

In the direction of the flow				In the opposite direction of the flow			
No of tested model	Name	Inclination angle B	Shape	No of tested model	Name	Inclination angle B	Shape
1	A	30		6	F	30	
2	B	45		7	J	45	
3	C	60		8	K	60	
4	D	75		9	L	75	
5	E	90		10	M	0	
11	N	-		Conventional			

6. Conclusion

From the above presented technical surveying for the previous studies carried out to investigate methods of increasing the efficiency of under roads culverts in protecting such desert roads against flash floods, and torrents, the following main points can be drawn dawn:

1. The carried out studies covered all the parameters may affect the efficiency of the under desert roads culverts hydraulically, and geometrically. But no one investigation had been carried out concerning the use of headwalls with different angles of inclination to the stream flow.
2. Choosing studying the effect of using inlet headwalls in culverts with different angles of inclination to the stream flow,(in the same direction, and in the opposite one), for improving culverts performance and efficiency was to complete the shortage in the reviewed literature.
3. the comparative study carried out for the most popular investigations concerning improving the under desert roads performance and efficiency showed that :

- For the circular culverts, the **best** inlet shape is the taper inlet with slope 4:1while [14],
- For the box culverts, the **best** inlet shape is the inlet side taper with slope 5:1 in the plan, with rounded edges [19].

At the same time the comparative study showed that:

- For the circular culverts, the **worst** shape of the inlet is the projected sharp edged without any headwalls. While [13],[14],[15],[16],
- For the box culverts the conventional sharp edged inlet without any geometrical modifications is the **worst** shape [17],[18],[19].

Notation

A	Barrel area	Fr	Froude number.
B	Barrel	S	Barrel slope
β	Headwall inclination angle	H_{ex}	Exit loss
C_d	Discharge coefficient	H_{in}	Inlet loss
D	Culvert height	H_l	Head loss
f	Friction factor	h	Water height over the orifice
g	Acceleration of gravity	Q	Discharge
L	Culvert length	Y_1	Upstream water depth
R	Hydraulic radius	Y_2	Downstream water depth
R_e	Reynolds's number		

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Teaching Introductory Physics with a Twist - Concept Questions and Team Work

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Abstract:

In a small liberal arts college, like Susquehanna University students generally come to the Introductory Physics class with all backgrounds, from novices to experts. For the IntroductoryPhysics, concept questions, mostly comprising of definitions and important but misunderstood concepts from the chapters in the book were prepared. These concept questions were given to the students as part of the lecture and most were interactive and students voted on answers in class.

One problem with lecture courses is that students sometimes feel unengaged and just attending lecture, specifically spoken lecture delivered by an instructor can be a passive experience. The strategy for team work is simple and recognized widely as a good way to engage the students. This well-known strategy was tweaked to include "`team quizzes"'. In a graded team quiz, all students make sure that their team members contribute, since the team is only as good as its weakest link. This strategy has delivered mixed results, from panic to triumph to ah-ha moments for students. This paper reports on the effectiveness of these strategies on student learning, by comparing the gain result of the Force Concept Inventory (FCI) test when compared to the student gains in lectures that did not use these strategies.

I. INTRODUCTION

Most students have varying approaches to and motivations for learning. Hence they respond differently to different class room environments and instructional practices. The model of single one-size-fits-all approach to teaching cannot simultaneously meet the needs of every student in the classroom. However, this approach has dominated Physics education for centuries. In this model, students absorb the content of lectures and regurgitate said content on exams; passing with flying colors, without necessarily demonstrating or obtaining any success in the learning of physics. This method however, violates virtually every principle of effective instruction established by experts in educational psychology[1,2,3,4].

In order to start, a basic understanding of today's student is necessary. Students today are profoundly different from the students of even a decade ago. Recent technological advances have had a major impact on student personalities, interests, and learning styles.

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Historically, the "singleton approach" has always been employed in the classroom, however its inadequacy is increasingly tangible due to the rapidly changing student. To put that change in perspective, today's average college graduate has spent only 5000 hours devoted to reading books but over 10,000 hours with electronic gadgets of one form or the other, including but not limited to games, internet, cell phones etc. It is worth mentioning that the 10,000 hours do not include the 20,000 hours that they might have spent watching TV[5]. Then it falls on us as instructors to develop materials and courses that will develop student interest.

According to G. Lawrence people in general can be broadly classified by the Myers-Briggs Type Indicator® (MBTI) based upon their preferences pertaining to four scales derived from Jung's Theory of Psychological Types[6].

This information is summarized in Table 1.

Table 1: The Myers-Briggs Type Indicator (MBTI)

Type 1	**Extraverts:** These people are triers, they will try things. **Introverts:** These people are thinkers, they will thoroughly analyze before performing an action.
Type 2	**Sensors:**These are practical, detail-oriented, focused on facts and procedures. **Sensing-Intuitors:** They are imaginative, concept-oriented, focus on meanings and possibilities.
Type 3	**Thinkers:**skeptical, tend to make decisions based on logic and rules. **Feelers:** appreciative, tend to make decisions based on personal and humanistic considerations.
Type 4	**Judgers:**They set and follow agendas, seek closure even with incomplete data. **Perceivers:** They adapt to changing circumstances, and postpone reaching closure to obtain more data

Applying the above said facts about people to specifically students, and probing into a model developed by Felder and Silverman[7,8], a student's learning style may be defined by how the student answers the following four questions:

1. What type of information does the student preferentially perceive?
2. What type of sensory information is most effectively perceived?
3. How does the student prefer to process information?
4. How does the student characteristically progress toward understanding?

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The student's mindset can be determined by the manner in-which information is received and processed. A summary of classifiers and types is offered in Table 2.

Although it is possible, it would be unreasonable to propose that instructors decompose the psychology of each student and make drastic yearly modifications to lesson plans to individually accommodate the needs of the current group of students. Such an approach would be too tedious and complex for an instructor to maintain if he/she has obligations other than teaching one or two small to medium sized classes.

However, there has to be a middle ground that is more effective than the singleton approach yet not ridiculously strenuous on the instructor. Both instructors and administrators are aware of the need for such a system; that is not over-encumbering on the professor, yet robust enough to appeal effectively to the range of student learning styles and ability levels that exist in a normal classroom environment. Although this issue has received administrative attention and been the subject of much research there is still a need for more research and curriculum development.

Table 2: Understanding the Student's Mind Set by How They Learn

1. Information Preference		
	Sensory Learners	They learn by experiencing - sights, sounds, they are also called hands-on learners. They tend to be concrete, practical, methodical, and oriented toward facts.
	Intuitive Learners	They learn by memorization, and are mostly innovative problem solvers. They are more comfortable with abstractions, theories, and mathematical models.
2. Sensory Information Perception		
	Visual Learners	They learn by pictures, diagrams, flow charts, demonstrations
	Verbal Learners	written and spoken explanationssuite verbal learners the best
3. Information processing		
	Active Learners	They earn through physical engagement activity or discussions and do not learn much in situations that require passive learning
	Reflective Learners	They do not learn much in situations thatdo not provide opportunity to think about the information being presented.
4. Progression towards understanding		
	Sequentially	Tend to think in a linear manner, in a logical progression of incremental steps. They are able to function with only partialunderstanding of taught material
	Globally	They want to understand everything andhave trouble applying materialuntil they know everything. They should be given the freedom to devise own methods of solving problems and beexposed to advanced concepts ahead of time.

i. TEAM WORK AS AN EFFECTIVE STRATAGY

Team work as a strategy has been developed over the last couple of decades to enhance student learning and promote interactive classrooms. Over time much research has been done to prove the effectiveness of working in teams. Teamwork helps all students at nearly all levelsof education, even though the vast majority of students are not immediately cognizant of its positive effects.

Discussion amongst groups of students must occur in a language that all group members are comfortable with. This forces students to discuss physics in a language that is understandable to their peers and this process is fundamental to conceptual understanding. It forces the student to learn the meaning of the language of physics rather than memorize a series of meaningless orthographic symbols.

Students that are fluent in the "language" and are strong in the technical jargon, benefit from being required to perform and express physics in the common tongue. This ability expresses true mastery over the subject as it demonstrates understanding that extends beyond memorization of content.

Group work also generates more class participation than a teacher-delivered lecture. Students often feel more comfortable asking their peers for help. Additionally there is a subset of undergraduates who listen to their peers, perhaps in part due to the similar ability level, particularly in regards to the teacher-student language difference. Teamwork also helps improve the teaching skills of the students and allows for the development of a lot of the upper level physics concepts.

II. WORK DONE AT SUSQUEHANNA UNIVERSITY

At Susquehanna University we have utilized concept questions and team quizzes that with the intent of accommodating all learning styles without the need for hyper-customization on the part of the professor. The tools that have been developed for this intent and their effectiveness will be the subject of the remainder of this paper.

It is a first in a series of studies designed to help identify the impact of these practices in a class room environment. Data presented here has been obtained for the Introductory Physics classes taught at Susquehanna University over a course of three years. This data has been used to form hypotheses and design experiments possibly for further study.

i. CONCEPT QUESTIONS IMPLEMENTATION

For the Introductory Physics class strategic concept questions taken from often misunderstood but important concepts were utilized. These questions were offered as a part of the lecture and did not require any work out of class but made a huge impact in terms of student's understanding of physics. The student's grades were not impacted in any way by the implementation of these concept questions but the class participation was essential.

A popular method used to implement concept questions is the use of clickers. In this case clickers were not utilized mainly because this exercise was not intended as a part of the students grade and also because we wanted to make students accountable for their own learning. The strategy used was named "vote-and-argue strategy". Students at the beginning of the semester were provided with a piece of paper that had numbers one

through four written on them. They voted via this sheet for the answers and the entire class got to see their answers, often the class members were divided in their answers and they would be allowed to argue their points for a few minutes. Then they voted again and finally were told the correct answer.Please refer to Figure 6 for a sample of the administered concept question. Keep in mind that this question was asked before introducing the concept of torque.

ii. TEAM WORK AND TEAM QUIZZES

Students in the Introductory Physics class at Susquehanna University are a mix of Biology, Earth and Environmental Science, Chemistry, Bio-Chemistry, Physics and Mathematics majors. The students are divided into two groups one for Biology Ecology and Earth and Environmental Science students (called Algebra section) are mostly comprised of juniors. The other group comprises of Chemistry, Bio-Chemistry, Physics and Mathematics majors (called Calculus section) which are mostly sophomores. Most incoming students lack the technical language of physics, and tend to memorize the words without the understanding that should be associated with the study of material.

At the beginning of each semester the class is divided into teams of three to four students each. The student teams collaborate and work together on homework's and problem solving, in-class as well as out-of-class. Once every two weeks or so, they take a graded "team quiz", which comprises of in-class quizzes or take-home quizzes that they have to usually hand back after a couple of days. In both cases students work together and hand back one exam to be graded. In a graded quiz, it is in the interest of all students to make sure that their team members contribute, since the team is only as good as its weakest link.Please refer to Table 7 for a sample of the administered take-home team quiz.

III. RESULTS AND OUTCOMES

i. CONCEPT QUESTIONS

The concept questions were strategically taken from most-often misunderstood concepts in physics. They were self-contained in class and did not require any work out-side of class hence it made it easier for students to get motivated. It actually made a huge impact in terms of student's familiarity with the materials that were covered in class and help address misunderstood concepts.

ii. TEAM WORK STRATAGY

The "team quiz" strategy worked even better than anticipated. Not only do the students learn in an encouraging and productive environment but they also made sure each of the team memberwas held to a higher standard. The questions were very helpful to start class discussions and in promoting student understanding. Fewer lectures from the instructor and more discussion between students was very useful in promoting student understanding. It helped clarify and enhance understanding physics concepts by discussions with their peers.

IV. EVALUATION OF LEARNING GAINS

To evaluate the effectiveness of these ideas based on the student learning gains when compared to the gains in traditional lecture classes not utilizing these ideas are discussed here. We administered Force Concept Inventory (FCI) Tests (pre-test, in the first week of the semester and post-test, administered in the last week of classes) and used "normalized gain" represented by equation 1 to evaluate student learning progress. The findings from the test are summarized in Tables 3 and 4.

$$\text{Normalized Gain} = \frac{\text{Post test} - \text{Pre test}}{\text{Full test} - \text{Pre test}} \times 100\% \quad (1)$$

Table 3: Normalized Gain Vs Year

	Students Enrolled	Pre-test	Post-test	Normalized Gain (%)	Gain[a] (%)
Year 1	A = 22[b]	10.2 ± 4.6	13.4 ± 4.4	16.2 %	15 %
	C = 15[c]	8.2 ± 3.6	15.0 ± 3.8	31.2 %	
Year 2	A = 29	12.2 ± 7.3	14.5 ± 5.0	12.9 %	1%
	C = 11	13.3 ± 6.6	15.6 ± 4.7	13.8 %	
Year 3	A = 35	6.9 ± 6.3	10.7 ± 4.3[d]	16.5 %	9%
	C = 19	9.2 ± 8.7	14.5 ± 6.6[e]	25.5 %	

[a] gain here is referred to as the student gain in Technique class Vs. the Lecture class

[b] Regular Lecture = Algebra Class

[c] Implementing Techniques = Calculus Class

[d] number tested =24

[e] number tested = 14

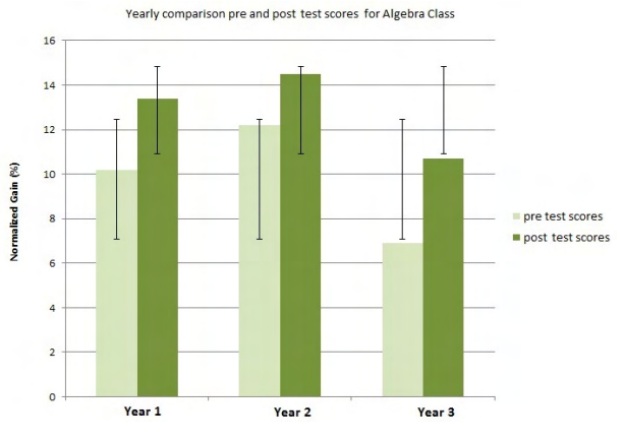

Figure 1: Normalized Gain Percentage for the Years tested - Lecture Class

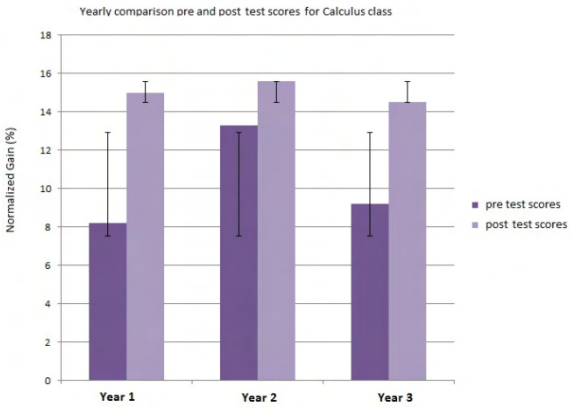

Figure 2: Normalized Gain Percentage for the Years tested - Technique Class

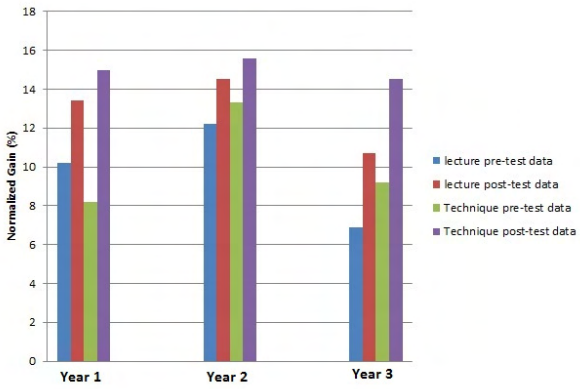

Figure 3: Normalized Gain Percentage for all the Years Tested

Table 4: Gain Boys Vs. girls for the Technique (Calculus) Class

	Students Enrolled	Pre-test	Post-test	Gain[a] (%)
Year 1	Males = 7	7.0 ± 3.2	16.4 ± 3.6	40.9 %
	Girls = 8	9.3 ± 3.8	13.8 ± 3.7	21.7 %
Year 2	Males = 7	16.0 ± 4.4	17.0 ± 5.2	7.1 %
	Girls = 4	12.5 ± 2.6	13.3 ± 2.9	4.6 %
Year 3	Males = 14	16.1 ± 6.8	18.7 ± 6.3[a]	18.7 %
	Girls = 8	8.4 ± 1.4	10.1 ± 2.2[b]	8.3 %

[a] number test administered = 7

[b]number test administered = 7

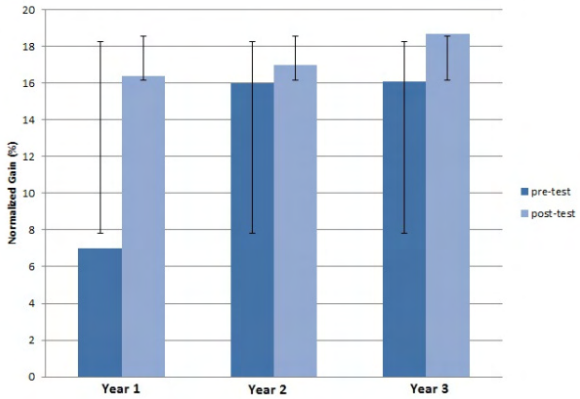

Figure 4: Gain Comparison for males in Technique Class, Pre-test score is represented by dark blue and Post test result by light blue.

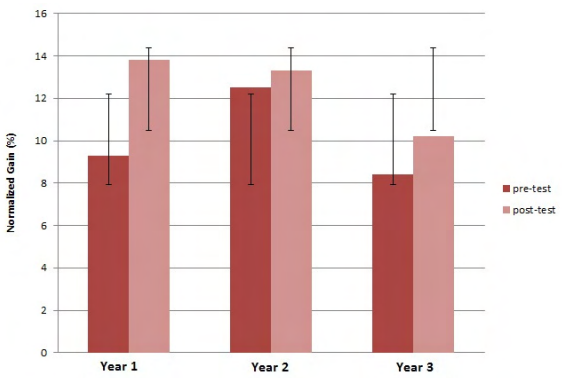

Figure 5: Gain Comparison for girls in Technique Class, Pre-test score is represented by dark red and Post test result by light red.

V. NEXT STEPS

For the purpose future study and evaluation of the findings, a student survey for the Technique (calculus) class is under development which will be administered next Fall. You can find a sample of the survey in Table 5.

VI. SUMMARY AND CONCLUSION

In conclusion, we find for our sample size that there was a marked difference observed in the gains for the simple lecture class vs. the class that was implementing the techniques. The lecture class had an overall gain of 15.2 ± 6.5, whereas the Technique class had a 23.5 ± 6.3 overall gain.

We also report that we observed a difference between the net gains achieved by the students on the basis of their gender. The overall gain for all years by the boys was 22.2 ± 3.7 %, whereas the girls accomplished a net gain of 11.5 ± 2.0.

VII. ACKNOLEDGMENTS

I would like to thank everyone that contributed to this paper and Professor. Fred Grosse for teaching the Algebra lecture class and making this study possible.

Wow, You already Know Torque!

A man weighs twice as much as his daughter and they would like to play on a see-saw. His daughter gets on the see-saw first and sits two meters from the pivot. How far from the pivot should the man sit to make the see-saw balance?

A) 0.5 m
B) 1.0 m
C) 1.5 m
D) 2.0 m
E) A different see-saw

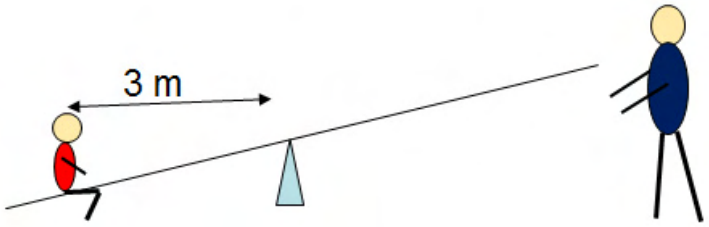

Figure 6: A Sample Concept Question

Table 5: CONCEPT QUESTIONS AND TEAM QUIZ SURVEY QUESTIONS

1. Are you a,
a. Freshman b. Sophomore c. Junior d. Senior

2. What is your major?

3. Are you a
a. Male b. Female

4. Did you work in teamwork in this class?
a. Yes b. No

5. How many members were there in your team?
a. 2 b. 3 c. 4 d. 5

6. Were you allowed to choose you own team or was the team assigned to you?
a. Assigned b. Chose our own

7. Did you feel like there were one or more people in your team that did not pull their own weight?
a. Yes b. No

8. Did you have the option of firing a person that was not contributing to your team?
a. Yes b. No

9. If so, did you have to fire any one?
a. Yes b. No

10. Did you yourself get fired from any team? What consequences did you have to face?
a. No b. Yes, please explain

11. On a scale from 1 to 5, 5 being the best, how satisfied were you with the teamwork quiz strategy? What would you do differently to improve the team work technique?

Assigned: August 30, 2013
DUE DATE: September 4, 2013
Introductory PhysicsTake home team Quiz #2

Team / Member Names:_____
_____

Instructions: To get ***any credit,*** show **all your steps/calculations**. No points will be awarded for just writing the answers, even if they are correct.

Are following equations dimensionally correct? Justify and explain your answers.

1. $xt = x_o + v_o t + (1/2)\, a\, t^2$

   Where,
   x→ the displacement at time t
   x_o→ the displacement at time t = 0
   v_o→ the velocity at time t = 0
   a→ the constant acceleration
   t→ time

2. $P = \sqrt{\rho g x}$

   Where
   P → pressure
   □→ density
   g→gravitational acceleration
   x→ height

3. $log\ N_2/N_1 = -\ [\ V g d(□_□ - □_1)]\ /\ kT$

   where
   N_2 and N_1→ are number of particles,
   V → volume,
   g→ gravitational acceleration,
   d→ distance,
   $□_□$and$□_1$→ densities,
   k → Boltzmann's constant with SI units = Joules per kelvin,
   T → absolute temperature.

2. Using dimensional analysis determine the numerical value of the Planck length, denoted by l_p, where Planck length is the size of the observable universe at the Planck time. Given that the Planck length depends on the following three fundamental constants: gravitational constant, $G = 6.67\times10^{-11}$ $m^3/kg.s^2$, the speed of light in a vacuum, $c = 3\times10^8$ m/s, and the quantum Planck constant, $h=6.63\times10^{-34}$ J·s (=$kg.m^2/s$).

Please ignore the dimensionless constant ($2□^{-1/2}$ for this calculation, which cannot be determined using dimensional analysis.

BUSINESS EDUCATION STUDENTS' UTILIZATION OF E-LEARNING IN ANAMBRA STATE TERTIARY INSTITUTIONS

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ABSTRACT

The study investigated the utilization of e-learning among business education students in Anambra State tertiary institutions. Two research questions were posed and two hypotheses formulated. A total of 1603 business education students in four tertiary institutions in Anambra State made up the population of the study, out of which 320 students were used as sample. A researcher-developed instrument was used for data collection. Mean rating and z-test were used for data analysis. The results showed that students often searched for educational materials online and checked results online; they fairly often read e-books and e-journals, teleconferenced with classmates during group work, send feedbacks to lecturers via emails and undertake courses on the internet. It was recommended, among others, that learning management systems should be introduced in the tertiary institutions and business education lecturers should make their books in the e-book format so as to encourage students' utilization.

Key words: *e-learning, utilization, computer competence, business education*

1. Introduction

The 21st Century has witnessed the advancement of learning technologies especially that of electronic learning. In developed countries, learning is made easier as a result of easy accessibility to computers, internet service and other electronic devices. Students are, therefore, enthusiastic about the usage of these devices in the learning process. There seems to be open access to information on a wide variety of subjects.

Okereke (2005) reports that in the developed countries, various electronic devices and facilities have been used to aid education. He posits that electronic mail, real time text conferencing, and online tutorials have been used in the teaching and learning process for several years. Some e-learning platforms used in the developed countries, as listed by Ipaye (2011), include websites, wikis, blogs, Second Life, e-mail, twitters, Course Management systems, video/audio podcasts, facebook, threaded discussion lists, video/audio text chat, videoconferences software etc.

However, e-learning appears to be poorly utilized in Nigerian Tertiary Institutions. It appears that business education students in many institutions still do not have e-mail addresses; cannot operate a computer and have little knowledge of e-learning platforms. As posited by Olusegun et. al. (2006), e-learning utilization is influenced by the students' computer literacy and many business education students do not have the needed competency in computer operations that forms the basis for e-learning integration.

Business Education is a program geared towards the acquisition of knowledge and skills needed in the work place. One vital need in the present business environment is the staff's ability to use computer programs for different purposes. The usage of e-learning by business education students in tertiary institutions will lay the foundation for computer and software utilization in the business environment. It seems to the researchers that the extent to which Business Education students in tertiary institutions utilize e-learning has not been established, hence this study. This study is focused on determining the level of utilization of e-learning by Business Education Students in Anambra State Tertiary Institutions.

1.1 Statement of the Problem

There appears to be under utilization of electronic devices for educational purposes by business education students. This under utilization is as a result of inability of students to use the computer. Manir (2011) pointed out that the lack of computer culture among students will impede the integration of new technologies in the educational process. This has prompted this study.

1.2 Purpose of the Study

The main purpose of this study is to determine the extent of business education students' utilization of e-learning in Anambra State Tertiary Institutions. Specifically, the study aims at:

1. Determining how often business education students in tertiary institutions in Anambra State utilize e-learning.
2. Determining how competent business education students in tertiary institutions in Anambra State are in computer usage.

1.3 Research Questions

1. How often do business education students in Anambra State tertiary institutions utilize e-learning facilities in their learning process?
2. How competent do business education students in Anambra State tertiary institutions consider themselves in the use of computers?

1.4 Hypothesis

H_{01} There is no significant difference in the mean ratings of business education students in Anambra State tertiary institutions in how often they utilize e-learning as a result of gender.

H_{02} There is no significant difference in the mean ratings of business education students in Anambra State tertiary institutions in their computer competence level as a result of the type of institution.

2. METHOD

The population of this study comprised of 1603 business education students in the four tertiary institutions in Anambra State offering the Business Education Program. The Proportionate random sampling technique was used to draw 320 students. The proportion was based first on the population size of each institution and then on the gender. Questionnaire, constructed by the researchers from literature, was the instrument used for data collection. The first section contained 10 e-learning applications to which the respondents were to indicate how often they utilized them. The responses were structured on a four point scale of *Very Often, Often, Fairly often,* and *Rarely.* The Second section was adapted from Wayne State University (2006) and it was aimed at determining how competent the respondents were in computer usage. The responses were structured on a four point scale *Very Competent, Competent, Fairly Competent* and *Not Competent*.

The questionnaire was validated by four business educators and one expert in Information and Communication Technology. The instrument was tested for reliability using the split-half method. The coefficients of 0.62 and 0.97 were obtained for the two sections of the questionnaire using the Spearman Brown Prophecy formula. Three hundred and twenty copies of the questionnaire were administered by the researcher with the aid of 2 research assistants. Out of the 320 copies administered, 301 were retrieved and used for data analysis. Mean ratings and z-test were used to analysis the data collected. The null hypothesis will be rejected where the calculated value of the z is greater than or equal to the table value of z, and retained where the calculated value of z is less than the table value of z.

2.1 Research Question 1

How often do business education students in Anambra State tertiary institutions utilize e-learning facilities in their learning process?

To answer Research Question 1, the mean of the data were computed from the frequency distribution of the responses. The result of the computation is shown in Table 1. The data in Table 1 indicate how often business education students in Anambra State tertiary institution utilize e-learning for educational purposes. The results indicate that four out of the ten items were ranked as being used often while the remaining were ranked as being used fairly often. The item that ranked 1st was *listening to educative programs on the radio*, having a mean score of 3.36. This was followed by *processing assignments with the computer* with a mean score of 3.28. *Checking results online* ranked 3rd with a mean score of 3.19 while 4th in the ranking is searching *for educational materials online* with a mean score of 3.09. The e-learning operations that were indicated as being used fairly often include: *undertaking online examinations* (mean score of 2.47), *reading e-books and e-journals* (mean score of 2.40), *teleconferencing with classmates during a group work* (mean score of 2.28) and *chatting online with classmates and teachers* (mean score of 2.27). The two lowest ranked items were *undertaking a course on the internet with interactive features* and sending *feedback to lecturers via e-mail* whose mean scores are 2.09 and 1.86 respectively. In all, the grand mean of 2.63 indicates that students often utilized e-learning in the educational process.

2.2 Research Question 2

How competent do business education students in Anambra State tertiary institutions consider themselves in the use of computers?

To answer Research Question 2, the mean of the data were computed from the frequency distribution of the responses. The result of the computation is shown in Table 2. The data in Table 2 indicates how business education students consider themselves competent in computer usage. Out of the 25 computer operations, the respondents indicated that they were fairly competent in two operations: *modifying the orientation of the worksheet*, and *adding and deleting slides using different layouts*. These two items had means of 2.41 and 2.39 respectively. The data indicates that the students considered themselves competent in the other 23 basic computer operations. Students considered themselves competent in all the online operations (items 28-37) and this indicated that they could easily adapt to any e-learning activity, online or offline. The grand mean of 2.81 indicates that the respondents considered themselves competent in the use of computers for both offline and online computer operations.

2.3 Hypothesis

H_{o1} There is no significant difference in the mean ratings of business education students in Anambra State tertiary institutions in how often they utilize e-learning as a result of gender.

This null hypothesis is tested at 0.05 alpha level using z-test. The results are presented in Table 3. The z-calculated value (0.614) is less than the critical z-value (1.97) at 299 degree of freedom and 0.05 level of significance. The results indicate that male business education students in Anambra state tertiary institutions with a mean score of 2.58, and female business education students with a mean score of 2.65 do not differ significantly on how often they utilize e-learning. The null hypothesis is therefore retained that there is no significant difference in the mean ratings of business education students in Anambra State tertiary institutions in how often they utilize e-learning as a result of gender.

H_{02} There is no significant difference in the mean ratings of Business education students in Anambra State tertiary institutions in their computer competence level as a result of the type of institution.

This null hypothesis is tested at 0.05 level of significance using z-test. The results are presented in Table 4.

Data in Table 4 indicate that business education students in universities in Anambra State had a mean score of 2.58 in their computer competence level while those in the colleges of education had a mean score of 2.83. The z-calculated of 1.7 is less than the z-critical value of 1.97 at 299 degree of freedom and 0.05 level of significance. Since the z-calculated is less than the z-critical, the null hypothesis is retained. This implies, therefore, that there is no significant difference between the mean ratings of business education students in Anambra State tertiary institutions on their computer competence level as a result of type of institution.

3.0 Discussion of Findings

Findings of the study in Research Question 1, which was analyzed and presented in Table 1, revealed that business education students often utilize e-learning in the educational process. This finding updates the findings of Ajadi et.al.(2008) who, at the time of their research, argued that there is gross underutilization of e-learning in Nigerian tertiary institutions. Students now utilize some e-learning facilities often while some others are utilized fairly often. The results show that students listened to educational programs often and this is in line with Tinio (2003) who pointed out the importance and ease of access of the radio for educational purposes.

More so, the findings also show that students often checked their results online and get academic information from the internet. Students also process their assignments using the computer and this supports findings of Manir (2009) that there is tremendous growth of computer equipment and internet utilization by staff and students of Nigerian tertiary institutions. This shows that to some extent, e-learning is being often utilized by business education students in tertiary institutions which contradicts the views of Abubakar (2010).

However, students fairly often utilized some e-learning applications. These include: undertaking online examinations, reading e-books and e-journals, teleconferencing with classmates during a group work and chatting online with classmates and teachers. These e-learning applications appear not to be commonly utilized in tertiary institutions in Anambra State because of the attending challenges accompanying its usage. As pointed out by Tinio (2003), the problems of e-learning utilization range from slow internet connection to poor electricity power supply. It is therefore clear that the utilization of e-learning in Nigerian tertiary institutions is still in its infancy stage as argued by Eke (2011).

Findings of the study in Research Question 2, which was analyzed and presented in Table 2, revealed that the business education students in Anambra State tertiary institutions considered themselves competent in the usage of computers. This is in contrast with the views of Okiki (2011) who pointed out that there is shortage of skilled manpower among lecturers and computer technology illiteracy among students. The results show that the respondents had the knowledge and competence in basic computer operations and as such would not find the integration of e-learning as a difficult thing. As pointed out by Olusegun, et.al. (2006), the utilization of e-learning is affected by the level of computer literacy of the students. Students who are not competent in the general use of computers will not be able to utilize them for educational purposes. The results show that students would be able to adapt to e-learning processes introduced to them since they had the basic computer competence needed.

Findings of the study presented in Table 3, which is for the first hypothesis (H_{01}), reveals that there is no significant difference in the mean ratings of business education students in Anambra State tertiary institutions

in how often they utilize e-learning as a result of gender. This means that male business education students in Anambra State tertiary institutions do not differ from the female students in how often they utilize e-learning facilities. Gender, therefore, is not a factor in the effective integration of e-learning in the educational process. This contradicts the views of Murphy and Greenwood (1998) who reported that age and gender effects could be factors in determining the extent of the low student ICT uptake. The result of this study is also in contrast with the views of Agboola (2006) who suggested that male students experience less anxiety about ICT and make more frequent use of it. VanBraak (2001) posited that female students are assumed to show lower confidence or knowledge ability than males about using computers. However, the result of this current study shows that male and female business education students do not differ in how often they utilize e-learning in Anambra State tertiary institutions.

Result in Table 4, which is for the second Hypothesis (H_{02}), reveals that there is no significant difference in the mean ratings of business education students in Anambra State tertiary institutions in their computer competence level as a result of the type of institution they attend. Computer literacy and competence is not conditioned on the type of institution a student attends. The results show that business education students in the universities do not significantly differ from those in the colleges of education on how competent they consider themselves in the use of computers. This result contradicts the findings of Olatunji (2011) who noted that the computer literacy level differed among teachers in various tertiary institutions in Nigeria. It was noted that some institutions offer more computer literacy programmes than others and as such these institutions ought to have more students who are competent in computer usage than other institutions. This current study showed that business education students in universities and in the colleges of education in Anambra State do not significantly differ in their computer competence level.

3.1 Conclusion

Based on the findings of the study, it is concluded that business education students in Anambra State often utilize e-learning and they are competent in the usage of basic computer operations.

3.2 Recommendations

Based on the findings of the study, the following recommendations were made:

1. The management of tertiary institutions should introduce platforms for e-learning usage. Such platforms, like learning management systems, open courseware etc, will create the opportunity for the administration, documentation, examination, feedback giving and reporting of classroom and online events.

2. Business education lecturers should apply different forms of e-learning methods in their teaching as students are competent in the use of synchronous and asynchronous e-learning modules.

3. There should be collaboration with other institutions, especially foreign institutions, from where lectures, seminars and other activities could be relayed via video conferencing and webinars.

4. Business education lecturers should produce their books in the e-book format so as to encourage the students in the reading of e-books and e-journals.

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Table 1: Respondents' Mean Rating of Utilization of E-learning Facilities

S/N	Business education students' mean rating of utilization of e-learning facilities	Level of Utilization				Mean	Remark
		Very often	Often	Fairly often	Rarely		
1.	Reading e-books and e-journals	51	93	82	75	2.40	Fairly Often
2.	Searching for educational materials online	128	99	48	26	3.09	Often
3.	Processing assignments with the computer	164	80	34	23	3.28	Often
4.	Teleconferencing with classmates during a group work	49	77	83	92	2.28	Fairly Often
5.	Sending feedbacks to lecturers via e-mail	24	60	66	151	1.86	Fairly Often
6.	Undertaking a course on the internet with interactive features	49	57	68	127	2.09	Fairly Often
7.	Listening to educative programs on the radio	175	76	32	18	3.36	Often
8.	Undertaking online examinations	76	75	64	86	2.47	Fairly Often
9.	Chatting online with classmates and teachers	103	80	55	63	2.27	Fairly Often
10.	Checking results online	172	59	25	45	3.19	Often
	Grand Mean					**2.63**	**Often**

Table 2: Respondents' Mean Rating on their Computer Competence

N = 301

S/N	Business education students' rating on their computer competence	Level of Competence				Mean	Remark
		VC	C	FC	NC		
11	Resizing, moving, closing and scrolling windows	145	65	59	32	3.07	Competent
12	Creating, deleting and renaming files and folders	142	91	40	28	3.15	Competent
13	Formatting a disk	105	83	62	51	2.80	Competent
14	Installing a software	74	92	70	65	2.58	Competent
15	Opening and closing word document	150	67	44	40	3.09	Competent
16	Highlighting, italicizing, underlining and bolding text	137	79	48	37	3.05	Competent
17	Setting tabs, line spacing, margins and page layout	126	88	54	33	3.02	Competent
18	Inserting pictures and objects from other files	119	80	66	36	2.94	Competent
19	Merging cells	82	82	71	66	2.60	Competent
20	Inserting and deleting cells, rows and columns	95	85	64	57	2.72	Competent
21	Creating formulas	79	78	60	84	2.50	Competent
22	Modifying the orientation of the worksheet	56	89	78	78	2.41	Fairly Competent
23	Creating and modifying charts	78	70	78	75	2.50	Competent
24	Adding and deleting slides using different layouts	72	69	64	96	2.39	Fairly Competent
25	Changing slide background	90	85	51	75	2.63	Competent
26	Entering and modifying text	97	90	52	62	2.74	Competent
27	Setting up the presentation for manual delivery	109	75	49	68	2.75	Competent
28	Opening and closing a browser	138	81	37	45	3.04	Competent
29	Refreshing a webpage	122	93	43	43	2.98	Competent
30	Composing and sending an e-mail	133	80	38	50	2.98	Competent
31	Attaching documents	107	76	58	60	2.76	Competent
32	Using a search engine	114	59	49	79	2.69	Competent
33	Finding a specific information on a web site	148	75	36	42	3.09	Competent
34	Downloading information from the web	132	81	47	41	3.01	Competent
35	Uploading information to the web.	125	71	41	64	2.85	Competent
	Grand Mean					**2.81**	**Competent**

Table 3: The z-test result of the difference between the mean ratings of business education students on how often they utilize e-learning as a result of gender.

Gender	N	$\bar{X}$	z-cal	α	Df	z-crit	Remark
Male	**55**	**2.58**					
Female	**246**	**2.65**	**0.614**	**0.05**	**299**	**1.97**	**Retained**

Table 4: The z-test result of the difference between the mean ratings of business education students in their computer competence level as a result of type of institution (University or college of education).

Type of Institution	N	$\bar{X}$	S	z-cal	α	df	z-crit	Remark
Universities	66	2.58	1.029					
Colleges of Education	235	2.83	1.128	1.7	0.05	299	1.97	Retained

POST PROJECT REVIEW OF LUMBER USED FOR CONSTRUCTION OF BUILDING PROJECTS IN OSUN STATE, NIGERIA

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ABSTRACT
Post project review of lumber used for construction of building projects was studied in Osun State Nigeria. This was with a view to assessing some of the technical changes that occur after the project delivery. Also, to determining what went right, what went wrong and what to do differently in future? The study covered six local government areas in the state. The research instrument used was questionnaire. It elicited information on the issues such as achievement of the project goals and objectives outlined in the project baseline plan, lumber defects that affected the quality of projects delivered and problems associated with the lumber defects detected. The data collected were analysed using descriptive statistics. The results indicated among others that the clients were satisfied with the deliverables provided by the project team during closing (3.47), disintegration of the ceiling materials from the nogging due to dry rot (2.58), sagging of the roof due to lumber shrinkage (2.53), removal and replacement of both windows and doors frames (3.55), time (3.47) and money (3.40) spent on replacement of lumber materials were above average. The study recommended among others that the Forestry Research Institute of Nigeria should let the Nigerians feel its impact on the use of seasoned and treated lumber through carpenters and joiners. This will assist the future clients in avoidance of wastage of funds.
Key words: post project review, building projects, lumber seasoning, technical changes

INTRODUCTION
There are several materials used in the construction of building projects. Among these materials include concrete, steel, metal, aluminum, lumber (timber) and glass of various grades. The use or application of some of these materials depends on the amount a client has, local conditions and practices of the environment where the building project is located. Construction projects full of uncertainties, including weather, labour skills, site conditions, and management quality (chitkara, 2009). A project can be considered to be a set of activities with a defined start point and a defined goal and uses a defined set of resources (slack, chambers and Johnson, 2010). All the resources should be put together and managed well to achieve the goals and objectives of the project. Project management can be explained as the application of knowledge, skills, tools and techniques of project activities to meet requirements (schwalbe, 2008).
For a project to meet requirements such a project should be within the budget, be delivered on time, within the scope and of good quality.

In Nigeria, one of the local resources being use as construction material, especially for roofs, windows and doors frames are lumber. After a tree has been felled, it would be cut into sawlogs with the aid of chainsaw machine. The logs would be transported by truck, rail or water to the sawmill. In the sawmill, the sawlogs would be converted into the required standard marketable sizes. After conversion, the next stage is seasoning, followed by the application of preservatives before use.
Post project review describes the expected outcomes of a project as it was originally planned and compares these outcomes against the actual outcomes (piscopo, 2013). It is a formal review of the project which

examines the lessons which may be learnt and used to the benefit of future projects (lane,2000 in kones and Goffin, 2007). In reality, the actual outcome is the project deliverable. This should not only meet the clients needs and expectations but also all other stakeholders' goals. In order for this to happen, the deliverable should be in line with the goals and objectives of the project.

The main purpose of the post project review is to review the completed project and find lessons learnt on what went right, what went wrong and what to do differently next time (buehring, 2012). A good time to carry out the post project review is when project team members remember the most project management phases. This should be shortly after the project has been delivered, when most of the identified problems have been noticed this time, observations are still fresh in team members' minds (Mind Tools, 2014)

However, the purpose of this study is to assess some of the technical changes that didn't emerge when deliverables were delivered for use. Therefore, between six (6) and eighteen (18) months were used as observation period before carrying out the full post project review of private buildings in the study area. The study was directed primarily toward the product rather than the process.

MATERIALS AND METHOD

After considering the problems and purpose of this study the survey research technique design was chosen. This provides answers to questions relating to the post project review of the building projects in the state.

The study was carried out in Osun State, Nigeria, comprising 30 Local government areas. The whole of the area is located within the region known as lowland humid tropical rainforest and is blessed with abundant agricultural products. It is characterized by wet and dry seasons.

The scope of coverage of this study was limited to parts of the building where lumber was applied in the construction of the building projects in the state. Such parts of the building among others include doors and windows frames, door leaves and roof members (wall plates, rafters, purlins, struts, king posts and so on). The buildings should have been completed, delivered and occupied between six and eighteen months.

For the purpose of this study, simple random sampling method was used from the two local government areas from each of the three senatorial districts in Osun State. Primary data was obtained using structured and unstructured questionnaires, interviews and personal visitation/observation. to see what actually happened to the buildings.

Seventy (70) copies of questionnaire were administered to the clients / occupants who had been occupying the buildings between six and eighteen months, who had knowledge of the present conditions of the buildings. The reliability and validity of the questionnaire were based on the use of rating scale to elicit information on the post project review of the defects that affected the lumber used for construction of projects, and a total of fifty-five (55) copies of questionnaire were returned and found useful which amounts to a return rate of 78.57%.

(Table1)

Interviews were conducted to complement the questionnaires administered to the respondents. Also, personal visits were carried out to physically observe the present conditions of the buildings. The questionnaire was subjected to content validity. The data collected were analysed with the use of simple descriptive statistics. Clients / occupants perspective in achieving the goals and objectives outlined in the project baseline plan, lumber defects that affected the quality of the projects delivered and problems associated with the lumber defects were measured on 5 point rating scale with 1- very low, 2- low, 3-moderate, 4-high and 5-very high.

RESULTS AND DISCUSSION

Table 2 presents the personal characteristics of the respondents such as age and occupation. The data from the table shows that respondents above 51 years of age rank highest with 76.36%, followed by 46 to 50 years of age with 18.18% while the remaining 5.5% are between 30 and 45 years of age. As indicated, majority of the respondents are of age to own their own buildings. Therefore, this provides a good basis for the review of the project.

Further observation of the table revealed that retirees ranked highest with 38.2%, followed by civil servants 34.5%, businessmen with 18.2% while artisans had 5.5% and farmers with 3.6%.

Most of the respondents are retirees; it may be difficult for them to get money for the replacement of the lumber members affected. During the study, all the retirees covered (38.2%) in the state are yet to be paid their retirement benefits. Most of them had retired three to five years ago.

Table 3 shows the worth of the project delivered, 85.5% of the projects studied was above N15.0m ($ 81,521.7), while 14.5% was between N10.0m ($54,347.83) and N15.0M ($ 81,521.7).

Presently, building materials are expensive, either locally produced or imported from other countries. To own a building in Nigeria is expensive.

Table 4 shows the perceived factors in achieving the goals and objectives outlined in the project baseline plan. The mean values of the respondents vary from 3.47 to 2.95, thus, all the respondents have different perception of the significance of the factors in achieving the goals and objectives outlined in the project baseline plan. As revealed by the table, the factors are: satisfied with the deliverables provided by the project team (3.47), the materials used were suitable for function and purpose (3.40), and project achieved the quality standard defined in the quality management plan (3.05), were rated moderately while benefits/goals achieved (2.95) was rated above average. Whether a project is private or public owned, it is certain that such a project would be executed, monitored, controlled and closed when all the materials are provided. The purpose of project execution and control is to develop the product or service that the project has commissioned to delivered (Digiman and Coumo, 2009).

Table 5 presents the time and period when the lumber problems started. The table revealed that all the respondents (100.0%) indicated that the problems started after project delivery. The lumber problems started between the sixth and twelfth month as indicated by 69.0% of the respondents, while 31.0% indicated that it started between the twelfth and eighteenth month after occupying the building.

Table 6 presents the perceived lumber defects that affected the quality of the projects delivered between the sixth and eighteenth month after occupying the buildings. The mean values of the respondents range between 2.58 and 2.36, thus, all the respondents have similar perception of the significance of defects that affected the quality of the projects delivered. As revealed by the table, the lumber defects that affected the quality of the projects delivered are: disintegration of the ceiling materials from the noging due to dry rot (2.58), sagging of the root members due to shrinkage (2.53), separation of the door leaves from door frames (2.47), and twisting of doors and windows frames (2.36). Though the defects were rated low but none should not have happened at all, the project should be lumber defects free by the time of closing the projects, all the projects achieved the goals and objectives outlined in the project baseline plan but after occupying the buildings, about six months later lumber problems emanated. These problems among others include: shrinkage, twist, warp, bow, cup and dry rot. These defects were caused due to the use of under sized, unseasoned and unpreserved lumber. Presently, in Osun State majority of the carpenters used undersized, unseasoned and unpreserved lumber for construction purposes. They do not bother whether the lumber is for temporary or permanent work. After second or third day of the conversion of logs of wood in the forest especially by the chainsaw machine operators, lumber users (carpenters and Joiners) used the lumber for construction without seasoning and

preservation (Ojo, et al, 2012). Lumber that is not seasoned before use will not absorb wood preservatives; also it will be very difficult to work on (Milnell, 2012). In addition, seasoned lumber conditions are less favourable for decay, mould stains and some insect attack, also further shrinkage, checking and distortion (warping) are reduced to a minimum (Walton, 1994). Wood preservation protecting wood, wood products or timbers from deterioration, decomposition or damage due to pest attacks through application of chemical substance (GSM, 2014).

Table 7 presents perceived problems associated with the lumber defects detected. The mean values of the respondents' ranges between 3.55 and 3.27, thus, all the respondents have similar perception of the significance of the problems associated with the lumber defects detected. As revealed by the table, the problems are removal and replacement of both windows and doors frames (3.55), time spent on replacement of the lumber members (3.47), money spent on replacement of lumber members (3.40), and removal of both the roof covering materials and lumber roof members due to lumber defects attack (3.27) were rated moderately.

The time and money spent on the replacement of lumber materials was too much. This was observed during the field work of the study. The roof of a duplex building which had been completed, occupied by the client for almost nine months was affected. The roof had to be replaced (plates 1, 2, & 3). The removal and replacement were carried out during the study. According to the owner, the exercise cost him about N 1. 75m ($ 9510.8).

CONCLUSION AND RECOMMENDATION

In this study, what went right and what went wrong have been discussed extensively. Recommendation will take care of what is to be done in future when executing similar projects. The use of lumber in building projects is compulsory. Lumber is used for both temporary and permanent work. In a situation where metal is used for the doors and windows and steel for the roof, it may be expensive for an individual to bear. Lumber is available, cheap and easy to work on if treated. Also, it will last long for a period of time. Forestry Research Institute of Nigeria (FRIN) should let the Nigerians feel its impact on the use of treated lumber through carpenters, joiners and so on. Farmers are feeling the impact of International Institute of Tropical Agriculture (IITA) through regular training of farmers by the extension officers in supplying and planting of food crops. The use of unseasoned and untreated lumber should be discouraged. This is very important because the volume of lumber being produced by the unregistered chainsaw machine operators in the forest is higher than that of registered timbers sawmill firms.

Table 1: Local Government Areas

Local Government Areas	Building projects covered	
	Distributed	Retrieved
Osun Central		
Osogbo	12	9
Olorunda	12	10
Osun East		
Ife Central	12	8
Ilesha West	12	9
Osun West		
Ede North	11	9
Iwo	11	10
TOTAL	**70**	**55**

Table 2: Personal Characteristics of the Respondents.

Variables	Frequency	Percentage (%)
Age		
30-45	3	5.5
46-50	10	18.18
Above 51	42	76.36
Total	**55**	**100.0**
Occupation		
Artisan	03	5.5
Business	10	18.2
Civil Service	19	34.5
Farming	02	3.6
Retired	21	38.2
Total	**55**	**100.0**

TABLE 3: Worth of the Projects

Worth	Frequency	Percentage (%)
N10.0m – N15.0m ($54,347.83)	8	14.5
Above N 15.0m ($ 81,521.7)	47	85.5
Total	**55**	**100.0**

Table 4: Achievement of the Project Goals and Objectives Outlined in the Baseline Project Plan

Goals and Objectives	Mean	Std. Deviation
Satisfied with the deliverable provided by the Project Team during Closing	3.47	0.899
The materials used were suitable for function and purpose	3.40	0.894
Project achieved the Quality Standard defined in the quality management plan	3.05	1.145
Benefits/goals achieved	2.95	1.283

Table 5: When Lumber Problems Emanated

When	Frequency	Percentage (%)
Time		
Before Project delivery		
After Project delivery	55	100.0
Total	**55**	**100.0**
Period		
6-12 months	38	69.0
12-18 months	17	31.0
Total	**55**	**100.0**

Table 6: Perceived Lumber Defects that Affected Quality of Project Delivery

Defects	Mean	Std. Deviation
Disintegration of the ceiling materials from the noggin due to dry rot.	3.47	0.899
Sagging of the roof members due to shrinkage.	3.40	0.894
Separation of panel from panel door leaves.	2.49	1.260
Separation of door leaves from frames.	2.47	1.289
Twisting of doors and windows frames.	2.95	1.283

Table 7: Problems Associated with the Lumber Defects Detected

Problems	Mean	Std. Deviation
Removal and replacement of both windows and doors frames	3.55	0.978
Time spent on replacement of lumber members	3.47	1.152
Money spent on replacement of lumber members	3.40	1.082
Removal of both the roof covering materials and lumber roof members Due to lumber defects attack	3.27	0.952

Environmental Risk Assessment of Petroleum Industry in Nigeria

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Abstract

Relying on some primary and secondary data obtained from the oil rich Niger Delta region of Nigeria, this paper assesses the environmental risks associated with the exploration of oil and gas in the region. The paper examines the present and past states of petroleum exploration activities and policies with a view to identify their impacts on the environment.

Findings show that the activities of the oil companies operation in the region have tremendous impacts on the health of ecosystems and biodiversity of the region. In addition, the paper observes that some techniques presently employed by the oil companies presuppose that degradation of the environment is inevitable. However, data analysis reveals that there are some avoidable aspects of industrial processes impacting negatively on the environment, which have been allowed to thrive due to a lack of appropriate environmental regulation and compliance.

Implicit from the findings, the paper makes some recommendations for the protection of the Niger Delta environment, prevention of loss of crude oil as well as lives and livelihoods in the region.

Key Words: Environment, risk assessment, petroleum industry, Nigeria

1.0 INTRODUCTION

1.1 Background to the paper

Petroleum exploration and exploitation has been on-going for several decades in the Niger Delta region in Nigeria. It has had disastrous impacts on the environment in the region and has adversely affected people inhabiting that region. The Niger Delta consists of diverse ecosystems of mangrove swamps, fresh water swamps, rain forest and is the largest wetland in Africa and among the ten most important wetland and marine ecosystems in the world, but due to petroleum pollution, the area is now characterized by contaminated streams and rivers, forest destruction and biodiversity loss, in general the area is an ecological wasteland. This affects the livelihood of the indigenous people who depend on the ecosystem services for survival leading to increased poverty and displacement of people. The oil industry located within this region has contributed immensely to the growth and development of the country which is a fact that cannot be disputed but unsustainable oil exploration activities has rendered the Niger. Delta region, one of the five most severely petroleum damaged ecosystems in the world. Studies have shown that the quantity of oil spilled over 50 years was a least 9-13 million barrels, which is equivalent to 50 Exxon Valdez spills (Adegoke, 2013). .

For any material or substance to qualify to be called a resource, such item must be physically and technically accessible to man with attendant uses. This implies that naturally endowed resources, be it renewable and non-renewable are destined to be used by man. The Niger Delta basin, though just about 2% of the total area of Nigeria, is endowed with abundant natural resources. These include oil and natural gas, sand and gravel and rich biological diversity among others. Granted, the Niger Delta as fragile as it is, has become the hub of extractive and related industries. The activities of these companies have tremendous impact on the health of ecosystems and biodiversity of the area (Niger Delta). Some techniques presently employed by the companies presuppose that degradation of the environment is inevitable. However, there are aspects of the industrial processes causing pollution and loss of biodiversity, which are avoidable, but, allowed to thrive due to environmental negligence, disrespect for biodiversity and lack of political will (laws and implementation).

Industry is a user of fossil fuels, certainly through its use of electricity, and probably through heating and production. Carbon dioxide, a powerful greenhouse gas, is thus added to the atmosphere, causing the enhanced greenhouse effect. Up till now there have very few restrictions on the amount of pollution industry is allowed to emit, so emission of harmful gases into the environment like CO, CO2 and other effluents have resulted in acid rain, among other things. This paper, therefore, discusses the effects of petroleum companies on the environment. To achieve this somewhat "in exhaustive" objective, emphasis shall be placed on prominent extractive areas such as exploration and exploitation of crude oil, natural gas and sand dredging activities. To do justice to the diverse audience, background information on key areas or concept is provided..

1.2 Statement of Problem

Oil plays a vast and vital role in our society as it is organized today. Oil represents much more than just one of the main sources of energy used by mankind. Besides being an important energy source, petroleum products serve as feedstock for several consumer goods, thus playing a growing and relevant role in people's lives.

On the other hand, the oil industry holds a major potential hazard for the environment, and may impact it at different levels like: air, water, soil, and consequently all living things. The most wild spread and dangerous consequence of oil and gas industry activities is pollution. Pollution is associated with virtually all activities throughout all stages of oil and gas production, from exploratory activities to refining. Other environmental impacts caused by the oil industry include intensification of the greenhouse effects, acid rain, poorer water quality, ground water contamination, etc. Oil and gas industry also contribute to biodiversity loss.

1.3 Aim and Objectives

The major aim of this paper is to assess the effects of oil industry on the Nigerian environment. The objectives of this study include:

- To examine how much harm the emission from industry causes to the environment;
- To assess the effects of the emission to mankind;
- To study how the emission from industry can be reduced, since it cannot be stopped completely;
- To investigate what the individuals and government are doing about the reduction of emission from the oil industry.

1.4 Study Area and Scope

In order to achieve the aim of the study and to be able to examine the impact of oil industry on the environment the paper focuses mostly on the Niger Delta belt because the region hold 90% of the Nigerian oil, and also shell company (petroleum industry in Nigeria) because of limited resources and time factor. Shell Company has different branches in Nigeria, and the scope of the study focused on the branch at the Federal Capital Territory (Abuja).

Shell Oil Company is the United States-based subsidiary of Royal Dutch Shell, a multinational oil company of Anglo–Dutch origins, which is amongst the largest oil companies in the world. Shell Company has different branches in Nigeria like in: Port Harcourt, Abuja, Lagos, and Warri. Shell produces oil and gas and operates Nigeria's largest liquefied natural gas (LNG) plant.

1.5 Summary

This section gives a clear and brief introduction to the paper. And it is intended that the reader will keep the information from this section in mind because it is a framework within which the detailed contents of the subsequent sections will be understood.

2.0 LITERATURE REVIEW

2.1 Definition of Terms

Here are definitions of terms that will appear in this paper, which includes: **Fossil fuels:** a natural fuel such as coal or gas, formed in the geological past from the remains of living organisms. **Greenhouse gas:** a gas that contributes to the greenhouse effect by absorbing infrared radiation. Carbon dioxide and chlorofluorocarbons are examples of greenhouse gases. **Greenhouse effect:** the trapping of the sun's warmth in a planet's lower atmosphere, due to the greater transparency of the atmosphere to visible radiation from the sun than to infrared radiation emitted from the planet's surface. **Emission:** the production and discharge of something, especially gas or radiation. **Feedstock:** raw material to supply or fuel a machine or industrial process. **Hazard:** a danger or risk. Biodiversity: the variety of plant and animal life in the world or in a particular habitat, a high level of which is usually considered to be important and desirable. **Raw materials:** the basic material from which a product is made. **Power plant:** another term for power station. **Chemical reaction:** a process that involves rearrangement of the molecular or ionic structure of a substance, as distinct from a change in physical form or a nuclear reaction. **EU:** European Union.

2.2 Discovery of the Nigerian Petroleum

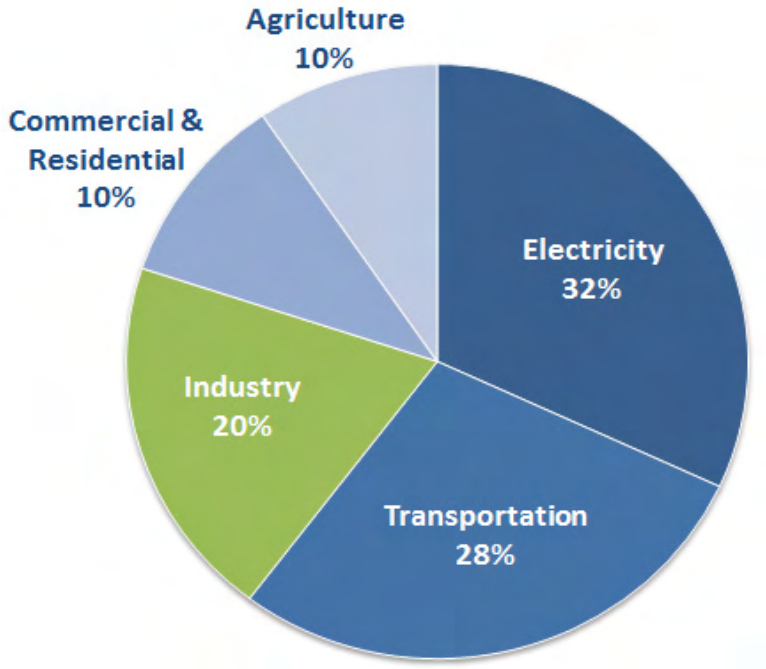
Oil was discovered in Nigeria in 1956 at Oloibiri in the Niger Delta after half a century of exploration. The discovery was made by Shell-BP, at the time the sole concessionaire. Nigeria joined the ranks of oil producers in 1958 when its first oil field came on stream producing 5,100 bpd. After 1960, exploration rights in onshore and offshore areas adjoining the Niger Delta were extended to other foreign companies. In 1965 the EA field was discovered by Shellin shallow water southeast of Warri. Oil and gas which is currently being exploited from the Niger Delta region, is Nigeria's greatest assets. Suffice to say that, oil and gas industry is capital and technology intensive and not labor intensive. So a lot more is expected from the federal government of Nigeria and the multinational companies who are the major beneficiaries of this resources.

2.3 THE NEED FOR EMISSION REDUCTION IN MAJOR CITIES

The production of goods and raw materials we make use of everyday, is gotten from the industry, and during industrial production the greenhouse gases emitted are spilt into two categories: the direct emissions and the indirect emissions. The direct emissions are produced by burning fuels for power and heat, through chemical reactions, and from leaks from industrial processes or equipment. Most of the direct emissions are generated from the consumption of fossil fuels for energy. While the indirect emissions are produced by burning fossil fuels at a power plant to generate electricity, which is then used by an industrial facility to power industrial buildings and machinery.

The chart below shows that the industry is responsible for about 20% of the emission. And when both direct and indirect emissions that are associated with electricity use are included, it makes industry the second largest contributor of greenhouse gases to the environment. This means, emissions need to be

reduced since it cannot be stopped completely because we rely on industry for most of our needs. Adverse environmental effects are caused as a result of air pollutants, such as photochemical smog, acid rain, deforestation, and so on. Emissions of the greenhouse gases from combustion of fossil fuels are associated with the global warming of Earth's climate



.Source: UN, 2003.

2.4 Effects of Petroleum on Biodiversity

Oil and gas constitute over 90% of Nigerian foreign exchange earnings. And the Niger Delta is the seat bench of oil and gas production in Nigeria. Virtually all aspects of oil and gas exploration and exploitation have deleterious effects on the ecosystem and local biodiversity. Oil exploration by seismic companies involves surveying, clearing of seismic lines and massive dynamiting for geological excavation (Seismic testing). The explosion of dynamite in aquatic environment produces narcotic effect and mortality of fish and other faunal organisms. Destabilization of sedimentary materials associated with dynamite shooting cause's increment in turbidity, blockage of filter feeding apparatuses in benthic fauna, reduction of photosynthetic activity due to reduced light penetration etc. Burying of oil and gas pipelines in the Niger Delta fragments rich biodiversity ecosystems like rainforest, and mangroves. Apart from the reduction in habitat area, clearing of pipeline track delineates natural populations, which might in turn distort bleeding.

Oil spillages routinely occur in the Niger Delta. Sources of oil spill on the environment are variable, including, pipeline leakage and rupturing, accidental discharges (tank accident) discharges from refineries, urban centres etc. There are also biogenic sources of hydrocarbons. Between 1976 and 1997, there have been 5334 reported cases of crude oil spillages releasing about 2.8 million barrels of oil into the land, swamp, estuaries and coastal waters of Nigeria (Getter, 1998). Most of these oil spill incidents reported in Nigeria occur in the mangrove swamp forest of the Niger Delta. Mangrove, of course, is one of the most productive ecosystems in the world with rich community of fauna and flora. It is pertinent to note that majority of oil spills occurring in the Niger Delta are considered minor and are not reported. Some of the pronounced oil spillages recorded in the petroleum industry of the Niger Delta include, Bomu – II blowout, 1970; Forcados terminal spillage, 1980; Funiwa – 5 oil well blowout, 1980; Oyakana pipeline spillage, 1980; Okoma pipeline spillage, 1985; Oshika pipeline, 1993 and the recently Goi Trans Niger pipeline oil spill, 2004. The overall effects of petroleum on ecosystem health and biota are very many. Oil interferes

with the functioning of various organs systems of plants and animals. It creates environmental conditions unfavourable for life. For example, oil on the water surface forms a layer which prevents oxygen from dissolving in water. Crude oil contains toxic components, which caused out right mortality of plants and animals as well as other sub lethal impacts. Generally, toxicity is dependent on the nature and type of crude oil, the level of oil contamination, type of environment and the selective degree of sensitivity of the individual organism.

2.5 Gas Flaring

Gas flaring associated with oil production in the Niger Delta is very unfriendly to natural ecosystems and biodiversity. Gas flares contain over 250 toxins. Environmental Rights Action (ERA), Nigeria and The climate justice programme, UK, (2005) usefully documented the environmental and economic implications of gas flaring in Nigeria. Perhaps more important is the finding in a study of the impact of gas flaring on the environment which revealed that there was about 100% loss in yield in all crops cultivated about 200 metres away from the Izombe station, 45% loss of those about 600 metres away and about 10% loss in yield for crops about one kilometre away from the flare (Oyinlola, 1995). Leakages and fire incidents are also associated with gas production and transportation. Not long ago, the Nigerian Liquefied Natural Gas (NLNG) pipeline traversing Kala-Akama, Okrika mangrove swamps leaked and caught fire which burned uncontrollably for 3 days. Local plants and animals inhabiting the affected area were killed. It must be stressed that incidents such as this one outlined above can result in elimination of whole population of endangered species with restricted distribution.

2.6 Socio-Economic Effects

2.6.1 Nutritional styles and Food Shortages

Fallout of oil pollution in the Niger Delta region is the destruction of the traditional local economic support system of fishing and farming. The combination of the effects of oil spill and acid rain resulting from gas flaring has been soil degradation which affects crop yield and harvest. Fish are driven away from in-shore or shallow waters into deep-sea as a result of flaring. The ultimate result of this is the poor crop yield as the soil has been rendered infertile and poor fish catch, as most fish has been driven into deep waters and the local people do not have the fishing gadgets to go into deep-sea fishing. The whole impact of this is food shortage and which has affected the ability of most families to feed themselves. As a result of the above, Ogoni that was once the food basket of the Niger Delta, is now fully dependent on imported food such as the popular ice fish, which has now replaced the traditional fish in menu table. Thus, oil pollution has impacted on the right to food of the region.

African Commission (1996) state that:

amongst others that the government's treatment of the oil rich Delta has violated all three minimum duties of the right to food by allowing private oil companies to destroy food sources thereby falling short of what is expected, under the provisions of the African Charter and international human rights standards, and hence, is in violation of the right to food of the region (Decision 155/96, para 66 involving The Social and Economic Rights Action Center and the Center for Economic and Social Rights versus the Federal Republic of Nigeria).

2.6.2 Destruction of Traditional Means of Livelihood

Another implication of oil pollution is that having destroyed biodiversity, it has also rendered the agricultural sector, which is the largest employer of labour in the study area, unprofitable. Hence, most of the youth and women have become jobless since their local economic support system of fishing and farming is no longer sustainable. An example is the case of the mangrove abundant community of Bodo where the livelihood of the local people have been sustained by living in the midst of a once healthy and productive mangrove forest by fishing and farming. They also gathered mangrove wood for building and

for local energy and fuel. However, due to being subjected to incessant oil spill incidences, oil have coated the breathing roots of this plant killing off parts of the mangrove forest and animals and marine life that depend on it. This mangrove forest which serves as habitats for fish and mollusks as well as a source of raw materials for communities in the region have been lost to the ravages of oil pollution. The land, the sea and the environment can no longer support the subsistence life that this local Ogoni community, which they have been dependent upon for thousands of years.

2.6.3 Migration and Rise of Environmental Refugees

Socio-culturally, the region people live in closely knit communities and are more endogenous. The local people were not used to mass outflows/movement from their territory as their subsistent economy provided them with their basic needs. To an average indigene of the Niger Delta, movement from the area, which was considered a place of abundance into alien lands, means subservience, poverty in the new area, and loss of pride and self-esteem. This indeed, was the situation before economic consideration led to the development intervention of oil exploration and exploitation by Shell Petroleum Development Company (SPDC), which resulted in a complete change in the socio-economic landscape of the region. Oil pollution has resulted in the destruction of the Delta environment. This in turn has led to the unsustainability of land for the traditional economic livelihood patterns that once thrived in the area. As a result, there are many local women and youth emigrating out of the area into cities especially to Port Harcourt where they have become environmental refugees[i] and because of their poor economic status, have had to take up accommodation in shanties, slums and waterfronts with its attendant risks especially in terms of rights protection. In recent times, these slums have been facing demolitions by government.

2.6.4 The Impact of Cultural Values and Spirituality

Oil spills and Gas flares knows no boundaries so there are adverse impacts on cultural values and social harmony. One of the most telling impacts of oil pollution on the region is that it has led to the death and possible extinction of medicinal plants and herbs that are rooted in our traditional medicine and spirituality and have deep spiritual significance to the community. This degradation is brought about by the fact that most of these herbs and plants are found in sacred grooves, shrines and forests, which have fallen under direct destruction in the course of oil exploitation and the toxicity of oil pollution. An interesting point to note in this regard is that under Nigerian law, a licensee of an oil mining lease is precluded from exercising its mining lease where, inter alia, the land is a sacred forest but this is routinely flouted with impunity by the rampaging oil companies.

2.7 Oil Spillages

An estimated 9 million- 13 million (1.5 million tons) of oil has been spilled in to the Niger Delta ecosystem over the past 50 years; 50 times the estimated volume spilled in Exxon Valdez oil spill in Alaska 1989 (FME, NCF, WWF UK, CEESP-IUCN 2006).The first oil spill in Nigeria was at Araromi in the present Ondo state in 1908 (Tolulope, 2004). In July 1979 the Forcados tank 6 Terminal in Delta state incidence spilled 570,000 barrels of oil into the Forcados estuary polluting the aquatic environment and surrounding swamp forest (Ukoli, 2005; Tolulope, 2004). The Funiwa No.5 Well in Funiwa Field blew out an estimate 421,000 barrels of oil into the ocean from January 17th to January 30th 1980 when the oil flow ceased (Ukoli, 2005; Gabriel, 2004; Tolulope, 2004), 836 acres of mangrove forest within six miles off the shore was destroyed. The Oyakama oil Spillage of 10th may 1980 with a spill of approximately 30,000bbl (Ukoli, 2005).

In August 1983 Oshika village in River state witnessed a spill of 5,000 barrels of oil from Ebocha Brass (Ogada-Brass 24) pipeline which flooded the lake and swamp forest, the area had previously experienced an oil spill of smaller quantity; 500 barrels in September 1979 with mortality in crabs, fish and shrimp. Eight months after the occurrence of the spill there was high mortality in embryonic shrimp and reduced reproduction due to oil in the lake sediments (Gabriel, 2004). The Ogada-Brass pipeline oil spillage near

Etiama Nembe in February 1995 spilled approximately 24,000 barrels of oil which spread over freshwater swamp forest and into the brackish water mangrove swamp.The Shell Petroleum Development Company (SPDC) since 1989 recorded an average of 221 spills per year in its operational area involving 7,350 barrels annually (SPDC Nigeria Brief,May 1995:3). From 1976-1996 a total of 4647 oil spill incidences spilling approximately 2,369,470 barrels of oil into the environment of which 1,820,410.5 (77%) were not recovered. Most of these oil spill incidences in the Niger Delta occur on land, swamp and the offshore environment (Nwilo and Badejo 2005). NNPC estimates 2,300 cubic meters of oil has spilled in 300 separate incidences annually between 1976-1996 (Twumasi and Merem, 2006). Table I below show some of the oil polluted sites in the Niger Delta region.

2.8 Current Efforts on Emission Reduction and the Associated Challenges

In recent times, there have been various on-going projects and organisation trying to reduce the rate of emission. For instance, in the United States of America, the Obama administration has engaged in different steps to reduce the harmful emissions into the environment such as: the international climate negotiations, the clean energy ministerial, climate and clean air coalition, Montreal protocol, and APEC summit. In California, the governments have done things like: legislative restrictions on coastal oil drilling, which have kept valuable oil reserves undeveloped; creation of a far-reaching air regulatory system prior to the Federal Clean Air Act and establishment of state-wide appliance and building efficiency standards. In Nigeria, the Federal Ministry of environment initiated a program called the "clean energy initiative" as part of African strategy on voluntary emission reduction, and program implementing clean development mechanism (CDM).

There are a number of programs going on to help reduce the emission of greenhouse gases in different part of the world today, but they face various challenges like: corporation from the industry by working hand-in-hand to reduce emission, following the regulations of emission, and paying funds if they exceed the amount of emission allowed. And also there are future challenges that include: The future development and implementation of the on-going projects, there are some on-going projects that exit because the people in power are concerned about the environment and when they are not there the projects dies, future coordination of environmental diplomacy, and ensuring unity in the face of recurring centrifugal forces.

2.9 Benefits of Emission Control to the Environment and Human Settlements

Greenhouse gases such as carbon dioxide trap heat, helping warm the globe. The surge in carbon dioxide levels due to human activity since the Industrial Revolution is now causing an overall warming of the planet that is having impacts around the globe. And the burning of fuel generates not only carbon dioxide, but also air pollutants that are harmful to human health. Past studies have analysed how reductions in greenhouse gas emissions would improve air quality, and new study suggests that reducing the flow of the greenhouse gases that spur global warming could prevent up to 3 million premature deaths annually by the year 2100. However the control of emission will have large effect on the environment and climate change because climate change is an important problem that needs strong action, and study suggests serious benefits to reducing greenhouse gases in addition to helping slow down climate change.

2.10 Legislation (Local, National and International)

Industrial activities play an important role in the economic well-being of both developing and developed countries. But these activities have significant impacts on the environment. Emissions from industrial installations have been subject to EU-wide legislation for some time and currently the following main pieces of legislation apply in this field: The IPPC Directive concerning integrated pollution prevention and control, which sets out the main principles for the permitting and control of installations based on an integrated approach and the application of best available techniques (BAT)

which are the most effective techniques to achieve a high level of environmental protection, taking into account the costs and benefits.

Several sectorial directives, which lay down specific minimum requirements, including emission limit values for certain industrial activities (large combustion plants, waste incineration, activities using organic solvents and titanium dioxide production).
The Regulation on the European Pollutant Release and Transfer Register (E-PRTR), which makes accessible to the public detailed information on the emissions and the off-site transfers of pollutants and waste from approx. 24 000 industrial facilities.

In Nigeria, the Federal Government has developed environmental regulations like the: National Environmental Standards and Regulations Enforcement Agency Act 2007 (NESREA), The Environmental Impact Assessment Act (EIA Act), The National Oil Spill Detection and Response Agency Act 2005 (NOSDRA Act), and Harmful Wastes (Special Criminal Provisions) Act of 1988 (Harmful Wastes Act).

2.11 Summary of Review

This literature review basically discusses how the emission rate can be reduced and the legislation governing emission. If the rate of emission can be reduced and controlled, the issue of climate change, acid rain, pollution of the environment and other effects of emission will not be an issue. A lot of work is being done to reduce the emission rate that comes from the industry during production but they face different challenges that always set them back. The reduction of emission cannot be achieved without the corporation of industry owners because the rules and regulations that protect the environment are not being adhered to.

3.0 METHODOLOGY

3.1 Research Strategy

This involved obtaining data from past and present studies, government and non- government bodies and existing literature (Agho, 2007). The paper relied on secondary data; data was obtained from The Nigerian National Petroleum Cooperation, World Bank Reports, and National Bureau of Statistics, United Nations Environmental Protection Programme, Amnesty International, International Monetary Fund, Published and Unpublished materials, Books, Newspapers, Conference and Seminar Papers, Journals and the internet.) Background on the Niger delta region, and the data obtained was analyzed using descriptive method to obtain logical deductions and sequential presentation of facts.

3.2 Primary and Secondary Data

For this paper, secondary data was largely used. The secondary data research started with a search for articles, text books, and other sources that explained in details the effect of petroleum industry in the environment and other related topics. And then they were read for understanding and a start was made with the literature review. To find more sources, the bibliographies of the texts that were already used were screened, and as a result much more relevant information was found.
Some primary data were also used and a visit to the study area was useful during the study.

3.3 Brief Description of Data Analysis

From the secondary research conducted, it is obvious that if the rate at which the industry produces harmful toxics in the environment is not reduced; the environment and the people living in it will be exposed to dangerous risk. The next section presents and interprets the results from the primary and secondary data.

4.0 ANALYSIS AND RESULT

This paper recognises the belief that the Nigerian petroleum sub-sector has had several transformations since the discovery of crude oil in 1956, and the oil boom of the 1970s. These transformations were as a result of lapses in the management of the petroleum industry. Against this background, the paper was aimed at examining the present and past states of the petroleum industry with a view to identifying the various petroleum policies and their implications for effective development of the Nigerian economy. The paper recognised the belief that petroleum is an important source of energy for the households and industries. The interest was on the social, political, and economic, and most importantly the environmental issues that have become the order of the day in recent times, despite the numerous petroleum policies of the federal government. Analysis from available information shows that Nigeria has had few petroleum policies in the past; first is the production-related policies aimed at increasing the oil reserve base and production of petroleum products, and second is the consumption-related policies aimed at effective distribution of petroleum products in the country.

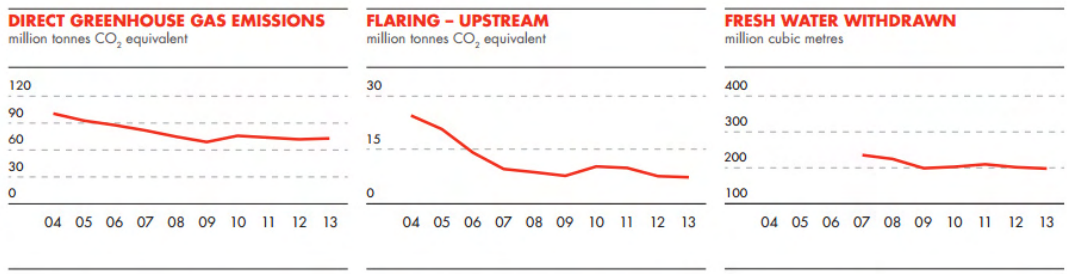
Analysis of the table below (environmental data from shell sustainable report 2013) shows that, greenhouse gas emissions comprise carbon dioxide, methane, nitrous oxide, hydroflurocarbons, perfluorocarbons and sulphur hexafluoride. The data were calculated using locally regulated methods where they exist. Where there is no locally regulated method, the data are calculated using the 2009 API Compendium, which is the recognised industry standard under the GHG Protocol Corporate Accounting and Reporting Standard. There are inherent limitations to the accuracy of such data. Oil and gas industry guidelines (IPIECA/API/OGP) indicate that a number of sources of uncertainty can contribute to the overall uncertainty of a corporate emissions inventory.

	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004
Greenhouse gas emissions (GHGs)										
Direct total GHGs (million tonnes CO_2 equivalent) [A]	73	72	74	76	69	75	82	88	93	101
Carbon dioxide (CO_2) (million tonnes)	71	69	71	72	66	72	79	85	89	96
Methane (CH_4) (thousand tonnes)	120	93	133	128	127	126	119	124	173	192
Nitrous oxide (N_2O) (thousand tonnes)	1	1	1	2	2	2	2	2	2	2
Hydrofluorocarbons (HFCs) (tonnes)	17	23	22	23	25	23	28	24	20	13
Energy indirect total GHGs (million tonnes CO_2 equivalent)	10	9	10	9	9	n/c	n/c	n/c	n/c	n/c
Flaring										
Flaring (Upstream) (million tonnes CO_2 equivalent)	7.4	7.7	10.0	10.4	7.8	8.8	9.7	14.3	20.8	24.6
Flaring (Upstream) (million tonnes hydrocarbon flared)	2.1	2.3	3.4	3.6	2.6	2.8	3.4	4.8	7.0	8.1
Nigeria [B]	1.1	1.5	2.0	2.4	1.9	2.3	2.5	3.7	5.8	6.6
Rest of world [C]	1.0	0.8	1.4	1.2	0.7	0.5	0.9	1.1	1.2	1.5
Energy intensity										
Upstream excl. oil sands and GTL (gigajoules per tonne production) [D]	0.86	0.78	0.75	0.74	0.76	0.74	0.78	0.78	0.71	0.69
Oil sands (gigajoules per tonne production) [E]	6.5	6.6	6.4	6.8	6.6	6.4	5.7	5.3	5.2	5.8
Refineries: Refinery Energy Index [F]	95.6	98.4	100.8	101.8	102.2	98.9	98.6	98.4	98.0	96.7
Chemical plants: Chemicals Energy Index	89.8	91.7	90.8	89.3	92.0	93.0	92.6	92.5	95.8	93.3
Acid gases and VOCs										
Sulphur oxides (SO_x) (thousand tonnes SO_2)	99	113	136	139	141	175	212	233	226	247
Nitrogen oxides (NO_x) (thousand tonnes NO_2)	156	147	146	159	142	150	145	154	157	172
Volatile organic compounds (VOCs) (thousand tonnes)	89	89	129	147	126	130	148	185	199	213
Ozone-depleting emissions										
CFCs/halons/trichloroethane (tonnes)	0.0	0.0	0.0	0.0	0.4	1.4	0.6	0.3	0.8	2.3
Hydrochlorofluorocarbons (HCFCs) (tonnes) [G]	8	8	12	21	24	26	27	35	35	42
Spills and discharges [H], [I]										
Sabotage spills – volume (thousand tonnes) [J]	2.2	3.3	1.6	3.0	14.0	6.5	3.4	1.9	1.5	1.1
Sabotage spills – number [J]	157	137	118	112	95	115	197	123	111	101
Operational spills – volume (thousand tonnes) [K]	0.9	2.1	6.0	2.9	1.4	8.8	3.5	3.9	3.4	3.4
Nigeria	0.4	0.2	5.3	0.7	0.3	7.1	1.6	1.4	0.1	0.0
Rest of world	0.5	1.9	0.7	2.2	1.1	1.7	1.9	2.5	3.3	3.4
Operational spills – number [L]	174	207	211	195	275	275	392	465	560	711
Nigeria [M]	31	37	64	32	37	42	52	41	63	48
Rest of world	143	170	147	163	238	233	340	424	497	663
Hurricane spills – volume (thousand tonnes)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9	1.0
Oil in effluents to surface environment (thousand tonnes)	1.0	1.0	1.3	1.6	1.5	1.7	1.6	1.8	2.3	2.1
Water										
Fresh water withdrawn (million cubic metres)	198	203	209	202	198	224	235	n/c	n/c	n/c
Waste disposal										
Hazardous (thousand tonnes)	770	820	740	1,048	962	688	907	716	631	714
Non-hazardous (thousand tonnes)	2,065	2,295	1,850	1,079	1,139	996	1,899	1,154	632	421
Total waste (thousand tonnes) [N]	2,835	3,115	2,590	2,127	2,101	1,684	2,806	1,870	1,263	1,135

[A] Greenhouse gas emissions comprise carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride. The data are calculated using locally regulated methods where

Source: Shell, 2013.

The graph below from the shell environmental sustainability data 2013 shows that, the direct greenhouse gas (GHG) emissions from facilities they operate were 73 million tonnes on a CO2-equivalent basis in 2013, which is slightly higher than 72 million tonnes of CO2 equivalent in 2012. The flaring of natural gas in the upstream business decreased in 2013 to 7.4 million tonnes of CO2 equivalent, from 7.7 million tonnes of CO2 equivalent in 2012.



In summary, the effects of petroleum industries to the environment of the Niger Delta belt and in general are very many. This ranges from subtle sub lethal impairment to outright mortality of plants and animals. Undoubtedly, development and environmental degradation and pollution are like twin brothers, but the extractive companies must adopt technologies and "best" practices that will forestall or lessen impacts on biological diversity for our collective well-being. Government and regulatory bodies have potent role to play in maintaining biodiversity of the fragile Niger Delta. This should include enacting pragmatic laws that will protect biodiversity, enhance strict monitoring of industrial activities and enforcement of the laws protecting biodiversity. Enforcement becomes very crucial in the conservation process, because, it is sad to mention that "sound conceived" laws on environmental protection and conservation exist in Nigeria but implementation is nothing to write about.

5.0 CONCLUSION AND RECOMMENDATIONS

Although, the activities that come with the oil exploration and exploitation causes alterations to the environment, which significantly have negative effects; some of the effects that come with petroleum development can be reduced or prevented basically by taking some steps in terms of prevention. Monitoring is also essential, but is lacking in the Niger Delta region. Monitoring the location of the oil companies; the terrain, the accessibility, revenue, man power availability for the monitoring agency, qualified personnel are not available. This restricts the ability and efficiency of monitoring by the government.

Environmentalist and people generally blame the oil companies but the Federal Government provides the laws, legislations and license, which the oil companies must adhere too. The Federal Government has to take steps, which they have started with NESREA, NOSDRA, NDDC, UNEP, UN SPDC and NGOs. Improvement have begun in terms of achieving sustainable development in the Niger Delta, the government should continue to allocate more revenue Into the Niger Delta for steps toward finding a permanent and lasting solution.

The analysis of available information shows that Nigeria has had two major petroleum policies in the past: first is the production-related policies aimed at increasing the oil reserve base and production of petroleum products. The second is the consumption-related policies aimed at effective distribution of petroleum products in the country. The analysis however, could not identify direct economic benefits of the Nigerian petroleum policies, but was able to identify three major implications: first is expansion of the number of economic actors in the petroleum industry, as there were significant increases in participants of the downstream oil exploration activities; secondly, there were rapid development of the Nigerian transport system; third is the expansion of economic activities through increases in the gross domestic product, foreign direct investment, and employment generation. On the negative side, the consumption-related policies appear to have done more harm than good. The fuel subsidy, for instance, had generated economic

problems ranging from scarcity of petroleum products to loss of man-hours due to labour unrest and related problems. There were also other observed economic costs. There were confusions among social activists, economists, and politicians on the actual beneficiaries of fuel subsidy in Nigeria. Annual government expenditures on fuel subsidies have been enormous.

5.1 Recommendations

a. All draconian laws concerning oil, gas and land-use that exclude indigenous peoples from participation in the control and use of their resources be abrogated or amended. The 1978 land use Act and the 1969 Petroleum Act (in Nigeria) should be repealed immediately as recommended by the Committee on the Elimination of Racial Discrimination (CERD). The government should take urgent steps to restore the right of communities to some measure of control over their resources.
b. A multi-stakeholder approach to oil exploration and exploitation should be put in place involving the triad of government, oil companies and host communities. The multi-stakeholder mechanism should address issues of biodiversity conservation and regeneration.
c. Oil and gas matters which are currently put on the exclusive legislative list should be removed and put on concurrent list to enhance partnership and collaborative decision making involving the oil companies, government and host communities. This will provide more choices for the people.
d. The government of Nigeria should muster the political will to exact stricter respect for environmental laws and regulations by oil companies and a penalty plan established that require oil companies whose activities cause excessive pollution or are ill–equipped, to forfeit their licenses.
e. Oil companies should be made to pay greater respect to the implementation of judicial pronouncements on their activities. A case in point is the recent judgment by a Federal High Court in Nigeria that all oil companies in Nigeria should stop gas flaring.
f. A disaggregated approach to policy formulation and implementation in the petroleum sub-sector. This would suggest involvement of all stakeholders in both the introduction and implementation of petroleum policies.
g. A total deregulation of the petroleum sub-sector. This would minimize free-market distortions and encourage competitive tendencies.
h. Emphasis on alternative sources of energy, such as gas, solar, and hydraulic sources. The proposed liquefaction of the Nigerian natural gas is a way forward. If effectively implemented, the liquefied natural gas (LNG) project has many economic advantages. LNG has minimal transportation cost. It is, most importantly, a potential source of foreign-exchange reserve.

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Subdegrees of the Primitive Permutation Representations of the Symmetric Group S_5

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Abstract

In this paper, we determine the subdegrees of primitive permutation representations of the symmetric group S_5 using table of marks. Computations will mainly be done using Group, Algorithms and Programming (GAP) system.

Keywords: Rank, Subdegrees, Symmetric group, Group action

1. Introduction

The rank and subdegrees are very significant characteristics of a group action. In certain cases, knowledge of these properties is sufficient for resolution of the following problems:

i) identification of rank 3 graphs (Habaut [3]);
ii) proof of the existence and non-existence of distance-transitive graphs (Ivanov [5]);
iii) computation of the decomposition of the permutation character of the group into irreducibles by means of the character table ([Faradzev *et al.* [2]).

There are two different approaches to computation of subdegrees of a transitive permutation group. The first approach relies on the famous Cauchy-Frobenius Lemma (See Burnside [1]). This is one of the classical enumeration techniques and is applicable to groups of finite order only.

The second approach relies on solution of systems of linear equations arising from the computation of marks of a finite group. For any two subgroups A and B of a group G, the mark of A in the representation of G on the cosets of B is the number $m(A, B, G)$ of the cosets of B that are fixed by every permutation of A (Ivanov *et al.* [4]). This method can be applied not only in concrete groups, but also in infinite series of groups provided detailed structural information about the group under investigation is known.

2. Notations and Preliminaries

Notation 2.1

Throughout this paper, G will represent the symmetric group S_5 while $m(F)$ will denote the mark of the subgroup F in the coset representation $G(/H)$.

Definition 2.1

The action of a group G on a set X is said to be transitive if for each pair of points $x, y \in X$, there exists $g \in G$ such that $gx = y$; in other words the action has only one orbit.

Definition 2.2
Suppose that G acts transitively on a finite set X. Then a subset Y of X is said to be a block for the action if, for each $g \in G$, either $gY = Y$ or $gY \cap Y = \phi$. In particular, ϕ, X and all 1-element subsets of X are obviously blocks: these are called the trivial blocks. The action is said to be primitive if the only blocks are the trivial blocks; otherwise the action is imprimitive.

Theorem 2.1 (Wielandt [6])
Let $x \in X$, $|X| > 1$. A transitive group G on X is primitive if and only if G_x is a maximal subgroup of G.

Definition 2.3
Let G be transitive on a set X and let G_x be the stabilizer in G of a point $x \in X$. The orbits $\Delta_0 = \{x\}, \Delta_1, \Delta_2, \ldots, \Delta_{r-1}$ of G_x on X are known as suborbits of G. The rank of G in this case is r. The sizes $n_i = |\Delta_i| \; (i = 0,1,2,\ldots,r-1)$ often called the lengths of suborbits, are known as the subdegrees of G. It is worthwhile noting that if G acts on X transitively, then its action is equivalent to the action on the cosets of $H = G_x$, while that of H on $\Delta_i \; (i = 0,1,2,\ldots,r-1)$ is equivalent to its action on the cosets of some subgroup F of H.

Definition 2.4
Let $\{H_1, H_2, \ldots, H_t\}$ be a set of representatives of all distinct conjugacy classes of subgroups of $H = G_x$ in G, ordered such that $|H_1| \le |H_2| \le \ldots \le |H_t| = |H|$. Form a matrix $M = (m_{ij})$, where $m_{ij} = m(H_j, H_i, H)$. We call M the table of marks of H.

Theorem 2.2 (Ivanov *et al.* [4])
Let Q_i denote the number of suborbits Δ_j on which the action of H is equivalent to its action on the cosets of $H_i \; (i = 1,2,\ldots,t)$, then by computing all Q_i we get the subdegrees of G on X. Furthermore the numbers Q_i satisfy the system of linear equations

$$\sum_{i=j}^{t} Q_i m(H_j, H_i, H) = m(H_j, H, G) \;,$$

for each $j = 1,2,\ldots,t$.

3. Determination of Conjugacy Classes of Maximal Subgroups of $G = S_5$ and Construction of Table of Marks using GAP

```
gap> SymmetricGroup(5);
Sym( [ 1 .. 5 ] )
gap> ConjugacyClassesMaximalSubgroups (g);
[ AlternatingGroup( [ 1 .. 5 ] )^G, Group( [ (1,2,3), (1,2), (4,5) ] )^G, Group( [ (1,2,3,4),
(1,2) ] )^G,
  Group( [ (2,3,4,5), (2,4)(3,5), (1,2,3,5,4) ] )^G ]
gap> h:=AlternatingGroup(5);
Alt( [ 1 .. 5 ] )
gap> Order (h);
60
gap> ConjugacyClassesSubgroups (h);
[ Group( () )^G, Group( [ (2,3)(4,5) ] )^G, Group( [ (3,4,5) ] )^G, Group( [ (2,3)(4,5),
(2,4)(3,5) ] )^G,
  Group( [ (1,2,3,4,5) ] )^G, Group( [ (3,4,5), (1,2)(4,5) ] )^G, Group( [ (1,2,3,4,5), (2,5)(3,4)
] )^G,
  Group( [ (2,3)(4,5), (2,4)(3,5), (3,4,5) ] )^G, AlternatingGroup( [ 1 .. 5 ] )^G ]
```

```
gap> Table1:=TableOfMarks (h);
TableOfMarks( Alt( [ 1 .. 5 ] ) )
gap> Display (Table1);
1:  60
2:  30 2
3:  20 . 2
4:  15 3 . 3
5:  12 . . . 2
6:  10 2 1 . . 1
7:   6 2 . . 1 . 1
8:   5 1 2 1 . . . 1
9:   1 1 1 1 1 1 1 1 1

gap> OrdersTom(Table1);
[ 1, 2, 3, 4, 5, 6, 10, 12, 60 ]
gap> LengthsTom(Table1);
[ 1, 15, 10, 5, 6, 10, 6, 5, 1 ]
gap> i:= Group ((1,2,3,4), (1,2));
Group([ (1,2,3,4), (1,2) ])
gap> Order (i);
24
gap> ConjugacyClassesSubgroups (i);
[ Group( () )^G, Group( [ (1,3)(2,4) ] )^G, Group( [ (3,4) ] )^G, Group( [ (2,4,3) ] )^G,
  Group( [ (1,4)(2,3), (1,3)(2,4) ] )^G, Group( [ (3,4), (1,2)(3,4) ] )^G, Group( [ (1,3,2,4),
(1,2)(3,4) ] )^G,
  Group( [ (3,4), (2,4,3) ] )^G, Group( [ (1,4)(2,3), (1,3)(2,4), (3,4) ] )^G,
  Group( [ (1,4)(2,3), (1,3)(2,4), (2,4,3) ] )^G, Group( [ (1,4)(2,3), (1,3)(2,4), (2,4,3), (3,4)
] )^G ]
gap> Table2:=TableOfMarks (i);
TableOfMarks( Sym( [ 1 .. 4 ] ) )
gap> Display (Table2);
 1:  24
 2:  12 4
 3:  12 . 2
 4:   8 . . 2
 5:   6 6 . . 6
 6:   6 2 2 . . 2
 7:   6 2 . . . . 2
 8:   4 . 2 1 . . . 1
 9:   3 3 1 . 3 1 1 . 1
10:   2 2 . 2 2 . . . . 2
11:   1 1 1 1 1 1 1 1 1 1 1

gap> OrdersTom(Table2);
[ 1, 2, 2, 3, 4, 4, 4, 6, 8, 12, 24 ]
gap> LengthsTom(Table2);
[ 1, 3, 6, 4, 1, 3, 3, 4, 3, 1, 1 ]
gap> j:= Group ((2,3,4,5), (2,4)(3,5), (1,2,3,5,4));
Group([ (2,3,4,5), (2,4)(3,5), (1,2,3,5,4) ])
gap> Order (j);
20
gap> ConjugacyClassesSubgroups (j);
[ Group( () )^G, Group( [ (2,4)(3,5) ] )^G, Group( [ (2,3,4,5), (2,4)(3,5) ] )^G, Group( [
(1,2,3,5,4) ] )^G,
  Group( [ (1,2,3,5,4), (2,4)(3,5) ] )^G, Group( [ (1,2,3,5,4), (2,4)(3,5), (2,3,4,5) ] )^G ]
gap> Table3:=TableOfMarks (j);
TableOfMarks( Group([ (2,3,4,5), (2,4)(3,5), (1,2,3,5,4) ]) )
gap> Display (Table3);
1:  20
2:  10 2
3:   5 1 1
4:   4 . . 4
5:   2 2 . 2 2
6:   1 1 1 1 1 1
gap> OrdersTom(Table3);
[ 1, 2, 4, 5, 10, 20 ]
gap> LengthsTom(Table3);
[ 1, 5, 5, 1, 1, 1 ]
Group([ (1,2,3), (1,2), (4,5) ])
gap> k:= Group ((1,2,3), (1,2), (4,5));
Group([ (1,2,3), (1,2), (4,5) ])
gap> Order (k);
12
```

```
gap> ConjugacyClassesSubgroups (k);
[ Group( () )^G, Group( [ (4,5) ] )^G, Group( [ (2,3) ] )^G, Group( [ (2,3)(4,5) ] )^G, Group( [
(1,2,3) ] )^G,
  Group( [ (4,5), (2,3) ] )^G, Group( [ (1,2,3), (4,5) ] )^G, Group( [ (1,2,3), (2,3) ] )^G,
  Group( [ (1,2,3), (2,3)(4,5) ] )^G, Group( [ (1,2,3), (4,5), (2,3) ] )^G ]
gap> Table4:= TableOfMarks (k);
TableOfMarks( Group([ (1,2,3), (1,2), (4,5) ]) )
gap> Display (Table4);
 1:  12
 2:   6 6
 3:   6 . 2
 4:   6 . . 2
 5:   4 . . . 4
 6:   3 3 1 1 . 1
 7:   2 2 . . 2 . 2
 8:   2 . 2 . 2 . . 2
 9:   2 . . 2 2 . . . 2
10:   1 1 1 1 1 1 1 1 1 1

gap> OrdersTom(Table4);
[ 1, 2, 2, 2, 3, 4, 6, 6, 6, 12 ]
gap> LengthsTom(Table4);
[ 1, 1, 3, 3, 1, 3, 1, 1, 1, 1 ]
```

4. Determination of Subdegrees of Primitive Permutation Representations of *G*

By Theorem 2.1, it suffices to consider the action of G on the cosets of its maximal subgroups. From computations done in Section 3 using GAP, we see that a maximal subgroup of G is either of order 60 isomorphic to A_5, or of order 24 isomorphic to S_4, or of order 20 isomorphic to $<(abcd),(aedcb)>$ or of order 12 isomorphic to $S_3 \times C_2$.

a) Subdegrees of *G* acting on the cosets of $H = A_5$

From the results generated in Section 3, H has nine conjugacy classes of subgroups. These are;

i). Identity.
ii). 15 conjugate subgroups of order 2, C_2.
iii). 10 conjugate cyclic subgroups of order 3, C_3.
iv). 5 conjugate subgroups of order 4 isomorphic to C_2 x C_2.
v). 6 conjugate cyclic subgroups of order 5, C_5.
vi). 10 conjugate subgroups of order 6 isomorphic to D_3.
vii). 6 conjugate subgroups of order 10 isomorphic to D_5.
viii). 5 conjugate subgroups of order 12 isomorphic to A_4.
ix). A_5.

The table of marks of H is as shown in Table 1 in Section 3. Furthermore for $F \leq H$, the marks of F in the coset representation $G(/H)$ are given by the components of the vector $(m(F_1),\ m(F_2),...,m(F_9)) = (2,\ 2,\ 2,\ 2,\ 2,\ 2,\ 2,\ 2,\ 2)$. If $Q = (Q_1, Q_2, \ldots, Q_9)$, then by Theorem 2.2 and using Table 1 we obtain,

$$
\begin{aligned}
60Q_1+30Q_2+20Q_3+15Q_4+12Q_5+10Q_6+6Q_7+5Q_8+Q_9 &= 2\\
2Q_2+3Q_4+2Q_6+2Q_7+Q_8+Q_9 &= 2\\
2Q_3+Q_6+2Q_8+Q_9 &= 2\\
3Q_4+Q_8+Q_9 &= 2\\
2Q_5+Q_7+Q_9 &= 2\\
Q_6+Q_9 &= 2\\
Q_7+Q_9 &= 2\\
Q_8+Q_9 &= 2\\
Q_9 &= 2
\end{aligned}
$$

$\Rightarrow Q=(0,0,0,0,0,0,0,0,2)$.

Hence the subdegrees of *G* are as displayed in Table 5.

Table 5: Subdegrees of *G*

Suborbit length	1
No. of suborbits	2

b) Subdegrees of *G* acting on the cosets of $H = S_4$

From the results generated in Section 3, *H* has eleven conjugacy classes of subgroups. These are;

i). Identity.
ii). 3 conjugate subgroups of order 2 generated by permutations of the form (*ab*) (*cd*).
iii). 6 conjugate subgroups of order 2 generated by permutations of the form (*ab*.
iv). 4 conjugate cyclic subgroups of order 3, C_3.
v). A normal subgroup of order 4 isomorphic to C_2 x C_2 generated by permutations of the form (*ab*) (*cd*).
vi). 3 conjugate subgroups of order 4 isomorphic to C_2 x C_2 generated by permutations of the form (*ab*) and (*ab*) (*cd*).
vii). 3 conjugate cyclic subgroups of order 4, C_4.
viii). 4 conjugate subgroups of order 6 isomorphic to D_3.
ix). 3 conjugate subgroups of order 8 isomorphic to D_4.
x). A_4.
xi). S_4.

The table of marks of *H* is as shown in Table 2 in Section 3. Moreover for $F \leq H$, the marks of *F* in the coset representation *G*(/*H*) are given by the components of the vector $(m(F_1),\ m(F_2),...,m(F_{11})) = (5,\ 1,\ 3,\ 2,\ 1,\ 1,\ 1,\ 2,\ 1,\ 1,1)$. If $Q=(Q_1,Q_2,\ldots,Q_{11})$, then by Theorem 2.2 and using Tables 2 we obtain,

$$
\begin{aligned}
24Q_1+12Q_2+12Q_3+8Q_4+6Q_5+6Q_6+6Q_7+4Q_8+3Q_9+2Q_{10}+Q_{11}&=5\\
4Q_2+6Q_5+2Q_6+2Q_7+3Q_9+2Q_9+Q_{11}&=1\\
2Q_3+2Q_6+2Q_8+Q_9+Q_{11}&=3\\
2Q_4+Q_8+2Q_{10}+Q_{11}&=2\\
6Q_5+3Q_9+2Q_{10}+Q_{11}&=1\\
2Q_6+Q_9+Q_{11}&=1\\
2Q_7+Q_9+Q_{11}&=1\\
Q_8+Q_{11}&=2\\
Q_9+Q_{11}&=1\\
2Q_{10}+Q_{11}&=1\\
Q_{11}&=1
\end{aligned}
$$

Hence $Q=(0,0,0,0,0,0,0,1,0,0,1)$.

Therefore the subdegrees of *G* are as displayed in Table 6.

Table 6: Subdegrees of *G*

Suborbit length	4	1
No. of suborbits	1	1

c) Subdegrees of *G* acting on the cosets of *H* =<(*abcd*), (*aedcb*)>

From the results obtained in Section 3, *H* has six conjugacy classes of subgroups. These are;

i) Identity.
ii) 5 Conjugate cyclic subgroups of order 2.
iii) 5 Conjugate cyclic subgroups of order 4.
iv) A normal cyclic subgroup of order 5.
v) A normal subgroup of order 10 isomorphic to D_5.
vi) *H* =<(*abcd*), (*aedcb*)>

The table of marks of *H* is as shown in Table 3 in Section 3. Furthermore for $F \le H$, the marks of *F* in the coset representation *G*(/*H*) are given by the components of the vector $(m(F_1),\ m(F_2),...,m(F_6))=(6,\ 2,\ 2,\ 1,\ 1,\ 1)$. Let $Q=(Q_1,Q_2,\ldots,Q_6)$, then by Theorem 2.2 and using Tables 3 we obtain,

$$
\begin{aligned}
20Q_1+10Q_2+5Q_3+4Q_4+2Q_5+Q_6&=6\\
2Q_2+Q_3+2Q_5+Q_6&=2\\
Q_3+Q_6&=2\\
4Q_4+2Q_5+Q_6&=1\\
2Q_5+Q_6&=1\\
Q_6&=1
\end{aligned}
$$

$\Rightarrow Q=(0,0,1,0,0,1)$.

Hence the subdegrees of G are as shown in Table 7 below.

Table 7: Subdegrees of G

Suborbit length	5	1
No. of suborbits	1	1

d) Subdegrees of G acting on the cosets of $H = S_3 \times C_2$

From the results generated in Section 3, H has 10 conjugacy classes of subgroups. These are;

1. Identity
2. A normal cyclic subgroup of order 2.
3. 3 conjugate cyclic subgroups of order 2 generated by permutations of the form (ab).
4. 3 conjugate cyclic subgroups of order 2 generated by permutations of the form (ab) (cd).
5. A normal cyclic subgroup of order 3.
6. 3 conjugate subgroups of order 4 isomorphic to $C_2 \times C_2$.
7. A normal cyclic subgroup of order 6.
8. A normal subgroup of order 6 isomorphic to D_3 generated by permutations of the form (ab) and (abc).
9. A normal subgroup of order 6 isomorphic to D_3 generated by permutations of the form (ab) (cd) and (abc).
10. $S_3 \times C_2$

The table of marks of H is as shown in Table 4 in Section 3. Moreover for $F \leq H$, the marks of F in the coset representation $G(/H)$ are given by the components of the vector $(m(F_1), m(F_2), \ldots, m(F_{10})) = (10, 4, 4, 2, 1, 2, 1, 1, 1, 1)$.

Let $Q = (Q_1, Q_2, \ldots, Q_{10})$, then by Theorem 2.2 and using Tables 4 we obtain,

$$
\begin{aligned}
12Q_1 + 6Q_2 + 6Q_3 + 6Q_4 + 4Q_5 + 3Q_6 + 2Q_7 + 2Q_8 + 2Q_9 + Q_{10} &= 10 \\
6Q_2 + 3Q_6 + 2Q_7 + Q_{10} &= 4 \\
2Q_3 + Q_6 + 2Q_8 + Q_{10} &= 4 \\
2Q_4 + Q_6 + 2Q_9 + Q_{10} &= 2 \\
4Q_5 + 2Q_7 + 2Q_8 + 2Q_9 + Q_{10} &= 1 \\
Q_6 + Q_{10} &= 2 \\
2Q_7 + Q_{10} &= 1 \\
2Q_8 + Q_{10} &= 1 \\
2Q_9 + Q_{10} &= 1 \\
Q_{10} &= 1
\end{aligned}
$$

$\Rightarrow Q = (0,0,1,0,0,1,0,0,0,1)$.

Thus we have Table 8 showing subdegrees of G.

Table 8: Subdegrees of G

Suborbit length	6	3	1
No. of suborbits	1	1	1

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