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Editorial

Dear authors, reviewers, and readers

It has been a month since I was given the privilege to serve as the Chief Editor of the International Journal for Innovation Education and Research (IJIER). It is a great pleasure for me to shoulder this duty and to welcome you to ***THE VOL-6, ISSUE-6 of IJIER*** which is scheduled to be published on **30th June 2018.**

International Journal for Innovation Education and Research (IJIER) is an open access, peer-reviewed and refereed multidisciplinary journal which is published by the International Educative Research Foundation and Publisher (IERFP). IJIER aims to promote academic interchange and attempts to sustain a closer cooperation among academics, researchers, policy makers and practitioners from a wide range of disciplines, which contribute to state of the art in science, education, and humanities. It provides a forum for the exchange of information in the fields mentioned above by welcoming original research papers, survey papers, and work-in-progress reports on promising developments, case studies, and best practice papers. The journal will continue to publish high-quality papers and will also ensure that the published papers achieve broad international credibility.

The Chief Editor, appointed by the Associate Editors and the Editorial Board, is in charge for every task for publication and other editorial issues related to the Journal. All submitted manuscripts are first screensed by the editorial board. Those papers judged by the editors to be of insufficient general interest or otherwise inappropriate are rejected promptly without external review. Those papers that seem most likely to meet our editorial criteria are sent to experts for formal review, typically to one reviewer, but sometimes more if special advice is needed. The chief editor and the editors then make a decision based on the reviewers' advice.

We wish to encourage more contributions from the scientific community to ensure a continued success of the journal. We also welcome comments and suggestions that could improve the quality of the journal.

I would like to express my gratitude to all members of the editorial board for their courageous attempt, to authors and readers who have supported the journal and to those who are going to be with us on our journey to the journal to the higher level.

Thanks,

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"Amoateng Gut Check" approach to forecasting exchange rate using standard parity relationships

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[a]-The author is grateful to Professor Ben Amoako-Adu, Professor of Finance and Economical Insurance Professor at Wilfred Laurel University, Waterloo Canada for many useful comments. The author is responsible for any remaining errors.

Abstract

This pedagogical paper demonstrates how "the Gut check approach" uses a made-simple technique for international corporate finance and economics students to forecast exchange rates using parity relationships. The "Gut-check approach" uses two simple steps. First, check out if the spot exchange rate is either direct or indirect. Second, review the parity relationships (purchasing power parity or interest rate parity) for the two currencies in question to find out which currency appreciate or depreciates. To this end, the paper provides historical review of the standard technique by many textbook authors. The "Amoateng Gut-check technique" yields similar but more precise foreign exchange rate forecasting results than the standard approach. Moreover, it provides international corporate finance and economics students who may not recognize foreign and home countries an easy way of exchange rate forecast.

1. Introduction

Forecasting in general is a tricky proposition and it has become an occupational hazard for students, investors, importers and exporters, and financial executives of multinational corporations. The potential for periodic, and unpredictable, government intervention makes currency forecasting much more difficult (Shapiro and Sarin, 2009). People's expectations and news events also play important factors in exchange rate determination. As a result, exchange rates tend to exhibit dynamic and volatile short-term behavior responding to people's expectations and news events (Eun and Resnick, 2009). In my two and half decades of teaching international finance, I have observed many bright students let alone average students struggling to forecast the forward exchange rates using parity relationship models. The crust of this problem lies in detecting either which foreign inflation rate over/under domestic inflation rate (purchasing power parity) or which foreign interest rate over/under domestic interest rate (interest rate parity). Misalignment of these foreign inflation rates and domestic inflation rates on one hand and foreign interest rates and

domestics interest rates can lead to wrong currency forecast. This difficulty has not killed the drive for students and financial economists to find easier ways to forecast exchange rates using purchasing power parity and interest rate parity relationships. The "Amoateng Gut-check" has been designed as one of the newest approaches to currency forecasts using the standard parity relationships. It reviews quickly whether the spot exchange rate has been quoted as direct or indirect as the first line gut check. The second line of gut check is to review each of the parity relationships for two countries under question. For example, the review on purchasing power parity shows that a country with relatively high inflation will have its currency depreciating (paying more for another currency) the opposite is true. Similarly, the review on the interest rate parity indicates that a country with relatively high interest rates will have its currency depreciating (paying more for another currency).

2. Review and Discussion of Literature

Many equilibrium-pricing relationships in economics finance come from imposing the law of one price (that is if two things are equal to each other then they must be selling for the same price). In profitable arbitrage opportunities, the market cannot be in equilibrium. Most fundamental analyses in economics start from arbitrage equilibrium, such as interest rate parity (IRP) and purchasing power parity (PPP) (Eun and Resnick, 2009).[1] The IRP is a manifestation of the law of one price applied to international money market instruments. The IRP relationship among currency traders dates back to the late 19th century. However, it was during the 1920s that the relationship became widely known to the public from the writings of John M. Keynes and other economists (Keynes, 1924). IRP also applies the law of one price to financial assets, especially to risk-free assets denominated in different currencies. Thus, risk-free investment should offer the same return (after converting currencies) everywhere. Spot and forward rates correlate to each other and to interest rates in different currencies through arbitrage opportunities. Thus, the movement of funds between two currencies to take advantage of interest rate differentials is a major determinant of the spread between forward and spot rates (Shapiro and Sarin, 2009). For instance, when the dollar is at a forward discount the implication is that the dollar expects to depreciate against the British pound. If so, the U.S interest rate expects to rise higher than the U.K interest rate to compensate for the expected depreciation of the dollar. Otherwise, no investor would hold dollar-denominated securities. On the other hand, when the dollar is at a forward premium the implication is that the dollar expects to appreciate against the British pound. If so, the U.S. interest rate expects to fall lower than the U.K. interest rate to compensate for the expected appreciation of the dollar. Again, otherwise no investor would hold dollar-denominated securities. Therefore, the forward exchange rate will deviate from the spot rate as long as the interest rates of the two countries are not the same. When the IRP holds, an investor will be indifferent between investing in the U.S. and investing in the U.K. with forward hedging. However, if IRP is violated an investor will prefer one to another (Eun and Resnick, 2009 pp. 136).

Purchasing power parity implies that currencies with high rates of inflation should depreciate relative to currencies with lower rates of inflation. Thus, PPP argues that exchange rate movements should just cancel out changes in the foreign price level relative to the domestic price level. The simplest form of purchasing power parity is the law of one price. Thus, with the absence of trade barriers, transaction cost, transportation

cost, identical goods trading in different markets should sell at the same price. For instance, if the price of an item in domestic currency is P_{dom} and the price of the identical item in foreign currency is $P_{for.}$ If the spot exchange rate quoted in foreign currency per domestic is $S_{for/dom}$, then the law of one price holds if the following is true. $P_{for}/P_{dom} = S_{for/dom}$ The law of one price is applicable to any pair of countries (Graham et al, 2010). Since the absolute PPP ignores the effects on free trade of transportation costs, tariffs, quotas and other restrictions, and product differentiation, relative PPP is practical to exchange rate forecasting. Relative PPP states that countries with high inflation see their currencies depreciate over time, whereas the opposite happens for countries with lower inflation.[2] If price differences across markets are sufficiently large and persistent, arbitageurs find it profitable to trade. Hence, purchasing power parity does a good job of explaining long-run movements in currencies but not day-to-day (or even year-to-year) fluctuations.

3. Exchange rate Forecasting with Parity models (IRP and PPP) and "Gut Check Approach"

Spot and forward rates closely link to each other and to interest rates in different currencies through the medium of arbitrage. For instance, the movement of funds between two currencies to take advantage of interest rate differentials is a major determinant of the spread between forward and spot rates.[3] Thus, the forward discount or premium closely relate to the interest differential between the two currencies (Shapiro and Sarin, 2009).

IRP is expressed in mathematical terms as follow:

$$E(S_{t=n}) = S_0 \times [(1 + r_{foreign})/(1 + r_{domestic})]^n \rightarrow (1)$$

Where $E(S_{t=n})$ = the forward exchange rate forecast, S_0 =current spot exchange rate, n = number of forecast period (in days, weeks, months and years), $r_{foreign}$ = foreign interest rate, and $r_{domestic,}$ = domestic interest rate. The equation (1) is the standard approach of forecasting foreign exchange rate using interest rate differentials across countries. The implication is that if domestic investors send money abroad then they realize an exchange loss (when they convert back to domestic currency) because the foreign currency buys less domestic currency than it did at the spot rate. Domestic investors this, so they require an incentive in the form of a higher foreign interest rate before they will send money abroad. To maintain equilibrium, the right-hand side must also be greater than 1.0, implying that when a nation's currency trades at a forward premium (discount), risk-free interest rates in that country should be lower (higher) than they are abroad (Graham et al, 2009).

PPP states that if the law of one price holds at all times, then differences in expected inflation between two countries are associated with expected changes in currency values. Mathematically, it expresses, as follows:

$E(S_{t=n}) = S_0 \times [(1 + h_{foreign})/(1 + h_{domestic})]^n \rightarrow (2)$

Where $E(S_{t=n})$ = the forward exchange rate forecast, S_0 =current spot exchange rate, n = number of forecast period (in days, weeks, months and years), $h_{foreign}$ = foreign expected inflation rate, and $h_{domestic,}$ = domestic expected inflation rate. It is to be noted that, the left-hand of equation (2) exceeds 1.0 if traders expect the domestic currency to appreciate but is less than 1.0 if traders expect the foreign currency to appreciate. Similarly, the right-hand side of the equation (2) exceeds 1.0 when expected inflation is higher abroad than it is at home, and the ratio falls below 1.0 when the opposite is true. Equation (2) produces the already familiar prediction that if inflation is higher in one country than another, then the currency of the country with higher inflation will depreciate. In addition, it offers the helpful information that traders who want to forecast currency movements should invest resources in forecasting inflation rates (Graham et al, 2009). Research evidence shows that over the long term there is a strong correlation between currency values and inflation rates. Therefore, countries with high inflation observe their currencies depreciate over time, whereas the opposite happens for countries with lower inflation.

4. Practical Applications of Exchange rate Forecasting with Parity models (IRP and PPP) and "Gut Check Approach"

(i) Question on purchasing power parity (PPP) using "Amoateng Gut-Check".

The inflation rate in Japan over next 3 years will run 1.10% per year, while the U.S. inflation rate will be 2.10%. If the yen/dollar rate is 110. 75 what is the expected exchange rate in 3 years?

Example 1: Apply the relative PPP that says a country with higher inflation will experience depreciating currency and the country with lower inflation will experience appreciating currency. If h_d (inflation)↑→ Δe0↑, consequently, h_f (foreign inflation) ↓(low). The opposite is true.

Applying Amoateng's Gut Check to the above problem→ (a) E_0 or S_0 is indirect quotation (¥ 110.75 = U.S. $1.00). Also, (b) shows that Japan's inflation rate is relatively lower than the United States inflation rate. Thus, 1.10% (Japan) < 2.10% (United States) indicates that the Japanese Yen will appreciate over the U.S dollar. Therefore, the only set up according to the "Gut check" is to make Japan give less for the same amount of U.S dollar (appreciation) is as follows:

$¥110{,}75\downarrow \times [(1.0110/1.021)]^3$

¥110.75 x 0.970904 **= ¥107.53**

(ii) Question on interest rate Parity using "Amoateng Gut-Check":

If the exchange rate of the U.S dollar and Euro rate (U.S. 1.2818) in December 30, 2016, and the interest rates in the U.S. and Europe are 0.60%, and 0.7164%, respectively, what is the expected exchange rate in 5 years from 2016?

Example 2:

Solution Using the Amoateng Gut Check: (a) the spot rate is quoted in direct or American, and (b) US. T-bill rate < Europe's LIBOR rate, reflecting on the IRP, the U.S dollar will project a forward premium and the Euro will project a forward discount. Thus, the US dollar will appreciate over the Euro, so the U.S will give less amount of dollars for the same amount of Euro. Therefore, the $1.2818 will drop so we will expect $[(1.04)/(1.05)]^5 < 1=0.9810$

(U.S 1.2818↓)→$1.2818 x $[(1.0060)/(1.007164)]^5$

→$1.2818 x 0.994234739 =**U.S$1.2744**

Concluding Remarks:

The importance and the value of exchange rate forecast in our global economy cannot be underestimated. Multinational corporations (MNCs) apply it for the following strategic reasons:

(i) Hedging decision- to hedge future payables and receivables in foreign currencies to reduce currency losses (risk); (ii). Short-term financing decision- because currency and interest rate volatility (risk) may produce default or repayment problems; (iii). Short-term investment decision- MNC's deposits can be established in several currencies. The ideal currency for deposits would (a) exhibit a high interest rate; and (b) strengthen in value over the investment horizon. Currency crisis will dampen investment opportunities; (iv). Capital Budgeting decision- accurate forecasts of currency values will improve the estimates of the cash flows, and therefore enhance the MNC' s decision-making abilities; (v). Long-term financing decision- to estimate the cost of issuing bonds denominated in a foreign currency, forecasts of exchange rates are required, and (vi). Earnings assessment- forecast of exchange rates play an important role in the overall forecast of an MNC's consolidated earnings (both home reporting and subsidiaries.

This pedagogical paper demonstrates how "the Gut check approach" uses made-simple technique for international corporate finance and economics students to forecast exchange rates using parity relationships. The "Gut-check approach" employs two simple steps. First, check out if the spot exchange rate is either direct or indirect. Second, review the parity relationships (purchasing power parity or interest rate parity) for the two currencies in question to find out which currency appreciate or depreciates. To this end, the paper provides historical review of the standard technique by many textbook authors. The "Amoateng Gut-check technique" yields similar but more precise foreign exchange rate forecasting results than the standard approach. Moreover, it provides international corporate finance and economics students who may not recognize foreign and home countries an easy way of exchange rate forecast.

Endnotes

[1]IRP is an arbitrage condition that must hold when international financial markets are in equilibrium. It is an arbitrage equilibrium condition holding that the interest rate differential between two countries should be equal to the forward exchange premium or discount. Violation of IRP gives rise to profitable arbitrage opportunities. The PPP is a theory stating that the exchange rate between currencies of two countries should be equal to the ratio of the countries' price levels of a commodity basket.

[2]This is not a flute chance. If one did not observe this correlation in the data, then it would be a signal of gross violations of the law of one price and a sign that arbitrage was not working to bring prices back into line (Graham, et al, 2010).

[3]The implication is that if the forward premium is equal to the interest rate differential as explained above, covered interest arbitrage will not be feasible (Madura, 2010).

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Policies and Programs for Cervical Cancer Prevention and Control in Public Health Services: An Integrative Review

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Abstract

Aim: analyzing and assessing the scientific evidences about Health Services Administration through the practice of cervical cancer prevention programs and policies. Methodology: integrative literature review carried out in September/October 2017. Electronic search for publications in databases such as PubMed, Portal Periódicos CAPES, BVS, EBSCO and SciELO. Results and Discussion: eighteen articles approaching the topic were selected and their analyses resulted in the following thematic axes: Organization of cervical cancer prevention and control policies/programs, Follow-up and monitoring of actions taken and Quality Management of Cytopathological exams for diagnostic and treatment. There were differences between programs in the country, either in their recommendations or in their effectiveness. Final considerations: investments must be done in order to qualify technical procedures and involved health professionals, as well as to support health education in the target population.

Keywords: Health Services Administration; Uterine Cervical Neoplasms; National Health Programs

1. Introduction

Uterine Cervical Neoplasm is the fourth most common type of cancer in women (approximately 530 thousand cases and 265 thousand deaths/year worldwide) and the third in number of cases in Brazil (5,797 deaths recorded in 2015; 16,370 new cases estimated to be recorded in 2018) [1].

Uterine Cervical Neoplasm presents slow evolution; therefore, it can be prevented. Professionals working at different healthcare levels (primary, secondary and tertiary) are responsible for the early prevention and detection of the disease. They work with relatively simple equipment and exams such as Pap smear or cytopathology ones, which are used in disease screening, as well as with prophylactic measures such as the recommendation for the HPV vaccine [2,3,4,5].

Nowadays, many of the established assistance policies, programs and protocols focused on Uterine Cervical Neoplasm (UCN) prevention aim at providing integrated and qualified attention to women's

health by embracing their demands and needs, as well as by assuring their access to healthcare services for screening protocols, early diagnosis and proper treatment [2,6].

In Brazil, documents such as the Brazilian Guidelines for Cervical Cancer Screening and the Basic Attention Guide – Cervical and breast cancer control [2,6] -, are the most common references used by health professionals. These documents are edited by experts and published by the Ministry of Health. Countries in Europe and North America have many guidelines to control and prevent cervical cancer; however, they are not linked to a responsible governmental bureau; each country or state makes the choice for a reference of interest [7,5].

Despite these policies, the fragilities, gaps and barriers to reach proper prevention coverage for this cancer type in women remain real. Indices and estimates from recent years still report high mortality rates among women. In addition, 266,000 death cases were recorded worldwide in 2012, estimates expect 547,000 deaths in 2016. The mortality rate in developing countries reached 230,158 cases and more developed regions recorded 35,514 cases; however, such number remains relevant [8].

Accordingly, in order to have effective UCN prevention and control actions and strategies, it is essential to organize public healthcare services focused on them. The management of such services must be part of this organization in order to reinforce the performance of these programs and to reach the maximum efficiency, efficacy and effectiveness possible (solve the identified issues) [9].

Thus, we understand that healthcare management is responsible for organizing the services, supervising the proposed actions and for assuring the participation of important established programs, among others, in order to provide integral and qualified health attention assistance to the target population.

Therefore, the aim of the present study was to qualify women healthcare assistance and to point out management considerations, as well as strategies capable of reinforcing the prevention actions taken against the disease and of assuring their effectiveness.

2. Aims

The aim of the present study was to assess and analyze national and international scientific evidences about Health Services Administration in the practice of Uterine Cervical Neoplasm prevention and control policies and programs.

3. Methodology

The study is an integrative literature review. It was carried out in September and October 2017 by two researchers. The choice made for the integrative review method is justified by the need of getting considerable clarifications and references about the effectiveness of UCN prevention policies and programs in public healthcare services through management procedures based on the assessment of studies available in databases. Thus, the following guiding question was formulated: How are cervical cancer prevention and control policies and programs made effective by the management practices in public healthcare services?

The integrative literature review was a method developed for Evidence-Based Practice (EBP). It is a judicious method based on systematically summarizing recorded results about a topic or matter, in an

ordered and broaden way. The records are judiciously assessed by a professional (of proven clinical skill) and, subsequently, incorporated to assistance practices [10].

The methodological stages featuring the integrative-review operation were herein followed. These stages encompassed: 1st) identifying the topic and selecting the research question; 2nd) setting the inclusion and exclusion criteria; 3rd) Identifying the pre-selected and selected studies; 4th) Categorizing the selected studies; 5th) Analyzing and interpreting data; and 6th) presenting the review on the knowledge [11,12].

3.1 Inclusion and exclusion criteria

Complete articles, in English and Portuguese, about the proposed topic, published between 2004 and 2007, available in electronic medium, were included in the review.

The choice made for the referred period (2004-2007) is justified by the elaboration of the National Policy of Integral Attention to Women's Health (PNAISM) in Brazil, in 2004. It is one of the precursor and more complete programs to prevent and control cervical and breast cancer. It was launched after the National Program for Integral Assistance to Women's Health (1984) and the National Program for Cervical Cancer Combat (1998) and became an important subsidy for practical assistance actions.

Theses, dissertations, abstracts, editorials and narrative reviews, as well as articles that did not meet the proposed topic, were excluded from the review.

3.2 Bibliographic search strategy

The search strategy was firstly performed through the definition of synonyms in English to the following indexed meshes (Decs/Mesh): "Health Services Administration", "Uterine Cervical Neoplasms" and "National Health Programs".

The electronic search for publications presenting the referred descriptors was performed in the following databases: US National Library of Medicine (PubMed), Portal Periódicos CAPES, Biblioteca Virtual em Saúde (BVS), EBSCO Information Services, and Scientific Eletronic Library Online (SciELO). Boolean expressions between descriptors, such as "AND" and "AND and OR" were used to conduct the search in the chosen databases. The expression "AND and OR" was only used in SciELO database due to the difficulty to find research results in it.

The search in the databases resulted in 607 articles: 86 in PubMed, 115 in Periódicos CAPES, 53 in BVS, 12 in EBSCO and 341 in SciELO. Selected-studies categorization was performed by reading the titles and abstracts. After the analysis, 47 articles were finally selected. After reading the articles, we observed that 16 of them were not related to the matter in question, 11 were narrative reviews, 1 was an editorial and 1 was an article about another one that was included in the selection; therefore, they were not included in the review (Figure 1).

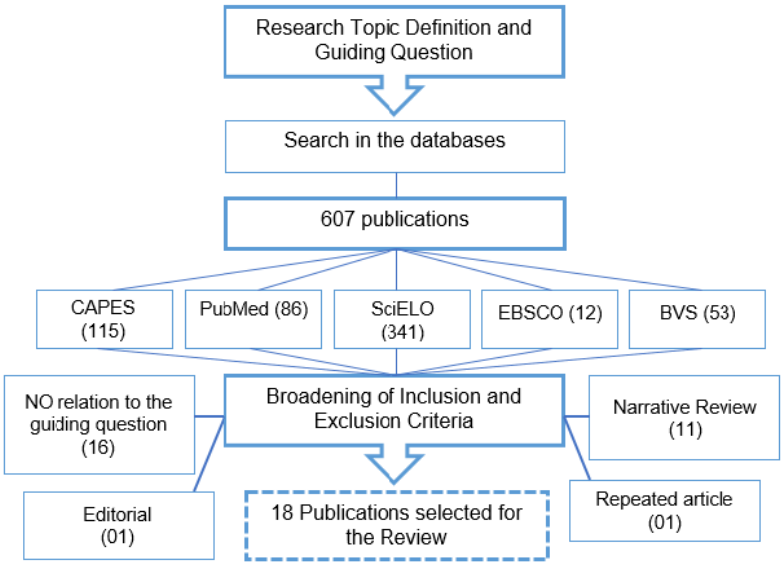

Figure 1 – Flowchart depicting the Selection of Articles in the Databases

The main results in the included studies were systematized based on similarities between the assessed data in each research. The following categories used to describe and discuss the results were developed from the initial systematization: (1) Organizing the cervical cancer prevention and control policies/programs, (2) Following-up and monitoring the actions taken and (3) Managing the Quality of Cytopathological exams for diagnostic and treatment.

Data synthesis and interpretation were substantiated by the results from a critical evaluation of the included studies. Results about the existing theoretical and scientific knowledge were compared based on the identification of implications and conclusions on the assessed studies.

4. Results

4.1 Characterizing the studies

Eighteen articles were selected and included in the research after the search in the defined databases was performed. Twelve articles out of this total were published in English and six in Portuguese. There were no publications in Spanish; therefore, only articles in English and Portuguese were included in the review.

Articles gathered during the search described research conducted in many countries around the world. Six studies were carried out in Brazil [13,14,15,16,17,18] and four in the United States [19,20,21,22]. There was only one article from each of the following countries: Argentina [23], Australia [24], Canada [25], England [26], Italy [27], Malawi [28], Zambia [29] and United Kingdom [30]. Thus, the final sample comprised 18 articles. Publication years varied from 2004 to 2017, 22.2% (04 articles) in 2015 and 16.6% (03 articles) in 2014, in all databases. Forty percent (40.0%) (08 articles) of the articles were published in journals about Public Health and Epidemiology.

With regard to the method and design, 50% (09 articles) of the articles were quantitative, 16.6% (03) were quali-quantitative, 16.6% (03) were documental research, 11.1% (02) were qualitative and 5.5% (01) were retrospective studies.

Based on the aims of our study, 33.3% (06) of the selected articles addressed the qualitative assessment and management of health services and actions taken to prevent and control UCN, and 27% (05) of them aimed at assessing UCN prevention and control programs (Chart 1).

Chart 1 – Main features of the selected scientific productions

Number	Author/Year	Study Site	Journal	Study method and design	Database	Aim(s)
01	ARROSSI; PAOLINO; SANKARANARAYANAN, 2010	Argentina (AR)	Revista Panamericana Salud Publica	Quantitative/cross sectional	BVS	Situational analysis of cervical cancer prevention activities in Argentina: (a) the organization chart of UCN prevention activities; (b) Pap smear coverage; (c) organization in cytology laboratories; and (d) follow-up / treatment of women with abnormal lesions.
02	BOTTARI; VASCONCELOS; MENDONÇA, 2008	Brazil (BR)	Caderno de Saúde Pública	Quali-quatitative	BVS	Reasoning about the possibilities of UCN markers as a mechanism to assess Basic attention as a strategy in *SUS* (Unified Health System)
03	MASEKO; CHIRWA; MUULA, 2015	Malawi (MW)	Pan African Medical Journal	Qualitative	BVS	Setting health and national sexual and reproduction rights (SDSR) to mitigate challenges to UCN prevention and control in Malawi.
04	MAAR et al, 2013	Canada (CA)	Womens Health Issues	Qualitative – Action research	CAPES	Examining the structural barriers stopping indigenous women participation in UCN screening.
05	OLESEN et al, 2012	Australia (AU)	BMC Health Services Research	Quantitative/ cross sectional	EBSCO	Approaching limitations and broadening the existing research focused on examining rates and correlated of cervical screening in a big epidemiologic research based on bonded management data.
06	CASTANHEIRA et al, 2014	Brazil (BR)	Saúde Debate	Quantitative	SciELO	Presenting results of the evaluating research that developed and assessed

						the QualiAB questionnaire in its first application in 2007. It was applied to APS public services in 115 counties in São Paulo State.
07	OHIRA; JUNIOR; NUNES, 2014	Brazil (BR)	Ciência & Saúde Coletiva	Quantitative	SciELO	Describing the management practices in primary health attention (APS) in 49 small counties (up to 20,000 inhabitants) in Northern Parana State.
08	BARCELOS et al, 2017	Brazil (BR)	Revista de Saúde Pública	Quantitative - Inquirer	PubMed	Assessing whether demographic, socioeconomic and organizational variables are associated with the quality of UCN screening.
09	BRITO-SILVA et al, 2014	Brazil (BR)	Revista de Saúde Pública	Quali-Quantitative	PubMed	Assessing integrality in the access to UCN prevention, diagnostic and treatment.
10	DeGROFF et al 2014	United States (EUA)	Wiley Online Library	Quali-Quantitative	PubMed	Assessing the effectiveness of the management performance of the National Program for Early Detection of Breast and Cervical Cancer (NBCCEDP) and exploring the reasons why it works out well.
11	PARHAM et al., 2015	Zambia (ZM)	PLOS ONE	Documental research	PubMed	Answering the implementation research question by assessing the Zambia Cervical Cancer Prevention Program (CCPPZ), which was launched in 2006 by the public sector.
12	HERBERT; HOLDSWORTH; KUBBA, 2008	England (EG)	J Fam Plann Reprod Health Care	Documental research	PubMed	Assessing the recommendation from the screening program to the availability of cervical screening in women in the age group 20-24 years.
13	MILES-RICHARDSON; BLUMENTHAL; ALEMA-MENSAH, 2012	United States (EUA)	Journal Health Care Poor Underserved	Documental research	PubMed	Exploring the effect of the recent legislation on the cervical and breast cancer rates in Georgia, North Carolina and South Carolina

14	RONCO et al., 2007	Italy (IT)	Epidemiol Prev	Quantitative	PubMed	Registering cervical cancer screening processes
15	SABATINO et al., 2015	United States (EUA)	Morbidity and Mortality Weekly Report	Quantitative	PubMed	Presenting data and indicator of UCN screening
16	UCHIMURA et al., 2009	Brazil (BR)	Revista Associação Medica Brasileira	Retrospective	PubMed	Estimating the prevalence and assessing the quality and performance of colpocytology performed by Program for the Prevention of Cervical Cancer in Maringa-PR
17	WHITE et al., 2017	United States (EUA)	Morbidity and Mortality Weekly Report	Quantitative/cross sectional	PubMed	Presenting data about UCN screening
18	CANFELL et al., 2004	United Kingdom (UK)	British Journal of Cancer	Quantitative cohort	PudMed	Assessing recommendations from the National Cervical Screening Program of Health Service (NHSCSP) and possible additional changes in UCN screening practices.

4.2 Organization of UCN prevention and control policies/programs

The organization of UCN prevention and control policies/programs is different from country to country. The articles based on studies performed in the United States concern different guidelines base on topics such as the National Breast and Cervical Cancer Early Detection Program (NBCCEDP) - a program in the Centers for Disease Control and Prevention's (CDC) [31] -, and Healthy People [32]. However, there is no consensus about the use of a single guideline as the main reference and subsidy in public health. Each health service chooses the guideline it will follow, and the chosen ones can differ from state to state.

Ronco et al (2007) and Canfell et al (2004) [27,30] conducted a study in United Kingdom countries based on using the European Guidelines Cervical Cancer Screening [3] in health systems, although each country in this group has its own UCN prevention and control program.

All research performed in Brazil described in the selected articles follow the protocol proposed by the cervical and breast cancer prevention and control program of the Ministry of Health. All public health services in Brazilian states are subsidized by this program.

4.3 Following-up and monitoring the actions taken

With regard to analysis of factors related to actions taken in order to prevent and control UCN: 88.8% (16 articles) of the selected articles presented data about (1) the coverage of Pap smear exam screening in the target population, (2) health education and promotion, (3) follow-up about the guidelines proposed by the programs, (4) risk factors, barriers and accessibility of the target population to health services and exams.

Arrossi et al (2010), Brito-Silva et al (2014) and Uchimura et al (2009) conducted studies in Latin American Countries (Argentina and Brazil) and found low screening coverage through Pap smear exams [23,17,18]: Brito-Silva et al (2014) and Uchimura et al (2009) recorded 20% and 16% coverage, respectively. Sabatino et al (2015) and White et al (2017) also reported low coverage results in North America (U.S.A) [21,22]. However, Miles-Richardson, Blumenthal and Alema-Mensah (2012) (U.S.A) and Bottari, Vasconcelos and Mendonça (2008) (BR) recorded good screening coverage [20,13]: Miles-Richardson, Blumenthal and Alema-Mensah recorded 87% target-population coverage, on average.

Maseko et al (2015) (MW) mention that the existing policy from 2009 in the country does not approach all components focused on preventing cervical cancer such as health education, screening, treatment and palliative care when they analyzed data related to programs, guidelines and the legislation about the topic in their country [28]. On the other hand, Maar et al (2013) (CA) identified lack of indigenous women description as special population in the country's policy [25].

There were differences in the screening references between studies. According to the study conducted by Olesen et al. (2012), the guidelines in the country are oriented to screen the disease through Pap smear exam (every two years), one or two years after the beginning of the sexual activity until de age of 70. The guideline also recommends the HPV vaccine [24].

The UCN prevention program in the United Kingdom cited by Canfell et al (2004) suggests screening from the age of 25 until the age of 49, with three years interval between exams, and in women in the age group 50-64 years, with five years interval between exams. In England, which also belongs to the United Kingdom group, the research conducted by Herbert, Holdsworth and Kubba (2008) evidences the need of starting the screening in women in the age group 20-24 years, since the program in the country recommends starting the screening after such age [30,26].

The lack of access to health services and of active search, as well as socio-demographic, economic and race differences between target populations, physical and structural barriers, and lack of health education and promotion were factors evidenced in three (3) Brazilian studies [13,17,16], in three (3) American ones [20,21,22], in one Canadian research [25] and in one Australian article [24]. One of the main crossroads in one of the Brazilian studies concerns services' structural accessibilities such as lack of gynecology outpatient clinics in all health services [13].

4.4 Quality management of Cytopathological Exams for diagnosis and treatment

There were fragilities in the quality screening and laboratory control of exams in three of the selected studies. The study conducted in Argentina showed no quality control in laboratories responsible for the analysis of material collected for cytopathological exams, as well as lack of data about the segment and treatment of women diagnosed with UCN precursor lesions [23].

Barcelos and colleagues (2017) (BR) mention increased number of screening quality issues related to HDI decrease in some regions in the country, besides association with population growth, with Family Health Strategies coverage and with the public health strategies adopted in Brazil [16].

Ronco et al (2007) (IT) identified a small amount of unsatisfactory smears (3.1%) in comparison to the recommended rate in the country. In Italy, the percentage of unsatisfactory smears is lower than 7%, which

is acceptable, but the desired rate is 5%. Approximately 9% of health services reached acceptable rates and 81% reached the desired rate [27].

With regard to the treatment and diagnostic of precursor lesions identified in the target population, data from three Brazilian [16,18,17], one Zambian [29] and one British studies [26] were identified.

Bottari, Vasconcelos and Mendonça (2008) report the difficulty in treating changes identified in the performed cytopathological exams, without mentioning the amount of the most prevailing changes and/or alteration rates. These data are found in the study by Uchimura et al (2009), who recorded low colpocytologic change and ASCUS (Atypical Squamous Cells of Undetermined Significance) index in the following year. However, they state that this result can be linked to low quality diagnostics, and it increases the rate of false-negative exams [16,18].

Brito-Silva et al (2014) showed the prevalence of malignant changes between women at the age of 50. Adenocarcinoma / Carcinoma diagnostics were mainly detected among women in the age group 50-59. On the other hand, the diagnostic of benign and/or pre-malignant changes was mainly recorded in women in the age group 23-39 years [17].

Pharam et al (2015) conducted a screening in Zambia through cytopathological exam to get the diagnostic and treatment necessary for high and low degree lesions. They found extremely satisfactory results due to the agility of the processes. They also identified a larger number of histological exams in HIV-positive women than in HIV-negative ones, who were part of the population in their research [29].

Herbert, Holdsworth and Kubba (2008) found that NIC 3 (advanced pre-malignant lesion) was the alteration recording the highest index, mainly in women between 20 and 39 years old. Growing NIC 3 rates were recorded for women in the age group 20.24 years in the last decade (3000-4000 cases/year), despite the drop in screening coverage [26].

5. Discussion

The results of the searches highlighted many research on the topic of interest in many countries around the world. Each country has a different way to organize their UCN prevention and control policies/programs, as well as their public health organization.

In the United States, where we found four articles about the herein addressed topic, the public health system is featured as a sub-system based on health insurances and plans. Thus, there are public and private health plans. The most common public health plans are Medicaid and Medicare; they give free access to services, assistance and procedures and are only available for individuals with proven low income [33]. The adhesion of guidelines related to the topic change from state to state in the whole country, i.e., each state chooses one of the guidelines available in the country; there is national consensus.

The United Kingdom and Canada have a public health system based on a common guideline, such as the European Guidelines (United Kingdom) and the Canadian Task Force on Preventive Health Care (CTFPHC) [3,34]. Public health in Brazil is organized by SUS (Unified Health System), which is ruled by the Federal Government. Both the guidelines and the UCN prevention and control, as well as procedures adopted for other diseases, are performed by the Ministry of Health in the country. The most recent guidelines about the topic are: Cervical and Breast Cancer Basic Attention Guide (2013) and the Brazilian Guidelines for

Cervical Cancer Screening (2016) [2,6].

Most studies carried out in Latin America (Brazil and Argentina) recorded low screening rates in the target population: between 20% and 16%. These rates are quite below the recommended by WHO, which suggests 80% minimal relative coverage for the target population [35]. Some studies in North America (USA) show satisfactory indices.

Countries in Latin America and in the Caribbean, which are considered developing countries, present mortality rate due to cervical cancer three times higher than developed countries in North America; 85% of death recorded due to this cancer type are also recorded in poorer countries [36,37].

Studies conducted in Malawi and Canada reported fragilities and gaps in the accomplishment of contents proposed by the programs. When some factors are analyzed, a new evaluation of such factors is also performed. Many studies focused on these evaluations can identify and report gaps and deficiencies in the system, or even show that the target population of the program is not well defined [38]. This reality is often found in the selected research, and it evidences fragmentation in the health programs and services. It is an important obstacle for the assistance model [39].

Aspects related to the barriers and fragilities in the accessibility (health education, active search, socio-economic and race inequalities) to health services are recorded both in developed and developing countries. However, a recent research pointed out that countries in Latin America and the Caribbean (developed and developing ones) record the highest economic inequality rates among women [40], fact that goes against the high mortality rates due to UCN in these countries.

With regard to guidelines addressed in the studies, it is possible noticing that there is no consensus about the age to start screening the disease and for performing exams for its prevention and diagnostic in women. In the United States, after redefinitions applied by experts to many guidelines in 2012, new screening recommendations were concluded. Women should start having their Pap smear exams at the age of 21, and it must be repeated every three years up to the age of 29. Pap smear associated with DNA-HPV screening should be performed every five years after this age (in case they both present negative results) or Pap smear must be performed every three years in women older than 30 years. Screening can stop in women in the age group 65-years or older, when there is no history of high-grade intraepithelial lesions (LSIL) in the last twenty years [41].

In Brazil, Ministry of Health recommendation in the latest elaborated and recommended guidelines lie on screening through Pap smear in women in the age group 25-64 every three years after two consecutive negative cytological results. Screening must stop after the age of 64 after the last negative results [2].

European countries follow the European Guidelines, which recommend start screening in the age group 20-30 years through Pap smear every three years, and through Pap smear associated with DNA-HPV test after the age of 30 until 60-65 years old, every five years [3].

There is no international consensus about the topic; however, according to Jin and colleagues (2013), DNA-HPV tests have better precursor lesion diagnostic than some cytological exams. Besides, emphasis could be given to screening in women presenting higher risk to develop precursor lesions, such as the ones presenting high HPV risk. It is recommended to carry out the test in women older than 30 years, when there is chance of HPV persistence and, consequently, higher risk to develop lesions and cancer [41].

Some of the main measures to overcome health barriers and to fill the gaps between the target population in the planet would be to provide this test due to cost reduction and associate it with HPV vaccination programs subsidized by the government to the whole population [41].

Regarding the analysis of factors related to UCN screening quality, human development inequality between different regions in the country and the lack of laboratory control over the analysis of cytopathological exams were identified in Brazilian and Argentinian studies, respectively [16,18,23].

HDI variations in Brazil and in other countries in Latin America remain a reality [42]. The unbalanced investments made by authorities in health, as well as the deficiencies in UCN prevention and control policies, became the main factors triggering the unsatisfactory results [43].

The studies highlighted the difficulty to provide treatment to women with alterations in the screening exams and low-quality diagnostics. On the other hand, recent studies assessed the development of UCN care procedures and recorded deficit in the production of screening exams and biopsy, as well as a large number of colposcopy exams in most Brazilian regions, mainly in Northern and Northeastern Brazil [44]. These findings evidence the need of reinforcing the continuous education of cytotechnologists, as well as of health professionals responsible for screening the target population. Good laboratory infrastructure and quality control standardization are also necessary [43].

Different from Latin American countries, Europe records better screening results [27]: acceptable and desired coverage rates by 81% and 90% in health services. Assumingly, such outcomes result from the better organization of their programs, although they also have gaps to be filled and improvements to be put in place [45].

5. Conclusion

It is worth to have health services managers and government authorities following-up the policies and program adopted by the public health system by systematically assessing the actions, the production, accessibility and barriers to be identified. Moreover, investments must be optimized in order to qualify the technical procedures and health professionals, as well as to boost health education in the target population. Accordingly, the possibility to reach better results in UCN prevention and control will be much higher.

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Utilizing a discovery learning, real-world based fruit juice clarification experiment to enhance teaching and learning of biological enzyme concepts

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Abstract

Discovery learning is an approach that encourages students to become active participants in the learning process by exploring concepts and answering questions through experience. It is one of several inquiry-based learning techniques that seems particularly suited to the instruction of science since performing experiments is one of the key methods in discovery learning. However, the efficacy of discovery learning projects have not been explored much in Malaysia. In this study, an experiment integrated with real-world biotechnology industry example focusing on the function of the enzyme pectinase in the clarification of fruit (apple) juice was adapted and introduced to a group of urban, international secondary school science students who had undergone prior direct instructional guidance on the biological role and function of enzymes. The students were asked to complete a set of pre-experiment and post-experiment questions in order to analyse the impact of the experiment on their understanding of this topic. Results suggest that this discovery learning project do strengthen the learners' prior knowledge and understanding of the function of biological enzymes through application of concept based on real world practice. High level of positive feedback was received (86.2%), with the students commenting on the "fun aspect", being excited about being able to perform the experiment and expanding their understanding by linking their findings with a real-world, industrial application. Given the reported steady decline of Malaysian students enrolled in STEM (Science, Technology, Engineering and Mathematics) courses at secondary and tertiary levels, our findings suggest that developing and including more real-world, discovery type projects in secondary schools may help to effectively raise student interests in science subjects such as biology through new learning approaches.

Keywords: discovery learning, biological concept, experimental approach

1. Introduction

Many reviews have been performed in the past few decades on the teaching and learning of science subjects, resulting in recommendations to adopt more active learning, student-centered learning approaches to actively engage students in the learning process with the major aim to create more long lasting, meaningful learning (Michael 2006 and references therein). Indeed, an increased trend has been noted with the supplementation (and even replacement) of conventional direct/explicit instruction with more constructivist-based approaches (Alfieri et al. 2011), such as the American Association for the Advancement of Science (AAAS, 1993) and the National Research Council (NRC, 1996) endorsement of a science curricula that actively engage science students by using an inquiry-based approach (Gibson and Chase 2002). Constructivist-based approaches focus on less guidance but more engagement to encourage learners to participate, discover and construct their own knowledge (Michael 2006; Alfieri et al. 2011).

Discovery learning is one of several inquiry-based learning techniques that seems particularly suited to the instruction of science, more closely aligned with concepts of exploration, discovery, and invention. Hodson (1990) suggested that inquiry-based learning was a more effective way for students to learn science. Performing experiments (e.g. practicals, research projects) are an integral part of science subjects such as Biology where learners acquire specialized knowledge and skills through participation and observation. Students are provided with ample opportunities to notice patterns and discover underlying causalities/explanations during their practice of interacting with materials, manipulating variables, exploring phenomena and applying concepts/principles (Alfieri et al. 2011), which are indeed embedded as the learning outcomes of many science practical sessions. The learner is expected to discover the target information within the confines of the task and its material (Alfieri et al. 2011).

Koksal and Berberoglu (2014) found a significant effect of guided discovery approach on students' achievement in science. Several studies investigated and also reported the positive effect of guided discovery approach on students' achievement in specific science subjects such as chemistry, physics, mathematics and biology (Inuwa et al. 2016 and references therein). In fact, it was reported that students who learn science using an inquiry approach scored higher on science achievement tests, have improved science process skills, and have more positive attitudes towards science when compared to students taught using a traditional approach (Gibson and Chase 2002 and references therein). However, pedagogical and cognitive concerns have questioned the efficacy and limitations of discovery learning approaches, especially on the amount of guidance or support provided to the learners (Klahr and Nigam, 2004; Mayer, 2004; Kirschner et al. 2006; Sweller et al. 2007).

In a lower-division biology course, better student test performance on questions related to topics incorporating some discovery learning was observed when compared with topics learned in lecture (Wilke and Straits 2001). Ajewole (1991) and Oghenevwede (2010) found that guided discovery approach had significant effects on Nigerian students' achievement in biology. Positive effects of guided inquiry instruction on students' achievement and understanding of environmental biology was also observed by

Hasan (2012). Similarly, Conway (2014) reported that there was a statistically significant difference in the mean achievement scores of students in Biochemistry that were exposed to guided discovery approach compared to those taught using a conventional approach. However, a non-exhaustive search of current literature revealed only few studies related to inquiry or discovery learning in Malaysia, none of which focused on the effect of discovery approach in a science subject.

The aim of this small study was to explore the aspects of discovery learning that impacted learners' prior knowledge based on concept application within the context of an experiment integrated with real-world biotechnology industry example (biological function of the enzyme pectinase in apple juice clarification). Results provide a more evidence based approach on the positive impact of discovery learning on Malaysian students.

2. Methodology

Participants of this study were three cohorts (2016, 2017, 2018; total number of students was 61) of Year 10 (~16 years old) science students from a non-profit Cambridge International School offering the Cambridge curriculum in Kuala Lumpur. The discovery learning project consisted of an experiment integrated with real-world biotechnology industry example focusing on the function of the enzyme pectinase in apple juice clarification. The students had undergone prior direct instructional guidance (pre-requisite knowledge) on the biological role and function of enzymes. After a brief introductory talk on biotechnology (10 mins), the students were given the experiment handout to read (Apple fruit juice clarification, see Appendix 1) followed by a short practical briefing (5 mins).

Then, the students were asked to complete a set of five pre-experiment questions (Appendix 2) prior to the hands-on activities. Experimental activities were designed to illustrate the importance of two main factors (temperature and pH) on enzyme activities in apple juice clarification, while reinforcing content knowledge. Students were allocated 60 mins, working in two teams (~ 15-16 students per team) and left to independently organize, participate and perform the various tasks associated with the experiment. Upon completion of the experiment, the students were asked to complete a set of post-experiment questions comprising of the five pre-experiment questions (supplemented with experimental trigger questions) and an additional open-ended question relating to comments on this experience/experiment (Appendix 3).

Answers of the pre- and post-experiment questions were scored as part of the learning assessment with one mark awarded for each correctly answered question (Marking rubric, see Appendix 4). Descriptive statistics for overall total score and total score for each question pre- and post-experiment were determined using a paired T-test with the significant value set at $P < 0.05$ in Statistical Package for the Social Sciences (SPSS) v. 11.5 (IBM Corporation, United States of America). For test data where the distribution of the differences in the dependent variable between the two related groups were found to be not normally distributed, a non-parametric Wilcoxon-Signed test with significant value set at $P < 0.05$ was used to compare the two related

groups. The number of positive, neutral, negative feedback types from the learners were also tabulated, and selected comments presented.

3. Results/ Findings

Students' performance pre- and post-experiment were evaluated to assess the impact of a discovery learning project towards the reinforcement of learners' knowledge. Results indicate significant improvements in overall total post-experiment scores compared to the pre-experiment scores for all three cohorts. Overall score increase ranged from 12.8% to 43.7% with p values of < 0.001, 0.003 and 0.001 respectively (Table 1). For individual questions that the students have prerequisite knowledge (Questions 2, 3, 4 and 5), variation in significant increase for post-experiment scores were observed among the three cohorts. A total of 1.125-, 4.3- and 8-folds higher post experiment scores were attained for Question 1 that suggests better understanding about Biotechnology after the introductory talk and discovery activity. Altogether, the experimental activity had strengthened the learners' prior knowledge as well as application of concept. Nevertheless, it is noted that a higher sample size is needed to further prove the effect (moderate effect size).

Table 1: Descriptive statistics of students' learning assessment

	Experiment		**P value**	**Normality test**	**Wilcoxon-Signed test**	**Effect size**	**Interpretation**
	Pre	Post					
Question 1	0.19 ± 0.40 0.08 ± 0.29 0.80 ± 0.37	0.81 ± 0.40 0.67 ± 0.49 0.90 ± 0.28	< 0.001 0.007 0.189	< 0.001 <0.005 -	< 0.001 0.014 -	0.745 0.707 0.387	Significant, effective Significant, effective Not significant
Question 2	0.82 ± 0.28 0.96 ± 0.14 1.00 ± 0.00	0.98 ± 0.09 1.00 ± 0.00 1.00 ± 0.00	0.002 0.330 -	< 0.001 - -	0.004 - -	0.519 - -	Some difference, larger size needed Not significant -
Question 3	0.77 ± 0.43 1.00 ± 0.00 1.00 ± 0.00	0.97 ± 0.18 1.00 ± 0.00 1.00 ± 0.00	0.031 - -	< 0.001 - -	0.034 - -	0.381 - -	Some difference, larger size needed Not significant -

Question 4	0.87 ± 0.34 1.00 ± 0.00 0.70 ± 0.37	0.84 ± 0.38 1.00 ± 0.00 0.93 ± 0.18	0.745 - 0.104	- - -	- - -	0.059 - 0.488	Not significant - Not significant
Question 5	0.35 ± 0.49 0.46 ± 0.50 0.67 ± 0.24	0.74 ± 0.44 0.92 ± 0.29 0.87 ± 0.35	0.001 0.039 0.111	< 0.001 < 0.001 -	0.001 0.046 -	0.576 0.577 0.440	Some difference, larger size needed Some difference, larger size needed Not significant
Overall score	3.02 ± 0.92 3.71 ± 0.69 4.17 ± 0.56	4.34 ± 0.62 4.58 ± 0.67 4.70 ± 0.65	< 0.001 0.003 0.001	0.001 0.001 0.293	< 0.001 < 0.010 -	0.801 0.740 1.033	Significant, effective Significant, effective Significant, effective

From the three cohorts of students, a total of 58 feedback comments were received (Q6 post-experiment) where 50 were positive comments (86.2%) regarding the experimental experience. There were eight neutral comments (13.8%) related to learning the reason for clear apple juice, industrial use of enzymes, biotechnology…*etc*. In particular, students commented on the fun aspect, were excited about being able to perform the experiment and linking their findings with a real-world, industrial application. Below are selections of the students' comments:

''Fun and educational"

"This workshop is helpful and fun. It does help us to expand our knowledge on enzymes and also biotechnology"

"It was very fun and entertaining experiment. It taught us to be responsible and accurate in our experiment…"

"The experiment was really fun and insightful. We got to see an actual process in industrial biotechnology"

"it was fun and a very good experience"

"knowledgeable, very fun"

"My understanding of enzyme activity has improved a lot through this experiment. I've also learnt ways in which enzymes are used to make daily use products"

"It was a very educational and fun experience. I would like to do this more often"

"I really enjoyed and I hope we can do more interesting experiments in the future"

"It was interesting and knowledgeable. I had loads of fun and I learned a lot. Please come back!!"

"I understand better about enzymes. More aware about biotechnology applications in our daily life. Fun Experience !!"
"It was nice and I gained a lot of knowledge from it"
"It was fun and a great experience…."
"Thank you. I appreciate the knowledge and I loved the experiment very much"
"It was fun and interesting and also informative"

5. Discussion

The positive influence of a discovery learning project on improving students' learning performance of a biological concept found in this small study is consistent with previous findings that reported the efficacy and significant positive effect of guided discovery approach on enhancing secondary school students' achievement for subjects such as chemistry, physics, biology and mathematics (Inuwa et al. 2016 and references therein). Other studies had also found that inquiry-based science activities not only had positive effects on middle and high school students' science achievement, but also contributed positively to cognitive development, laboratory skills, science process skills, and understanding of science knowledge as a whole when compared to students taught using a traditional approach (Gibson and Chase 2002 and references therein).

The many positive comments received on the experiment suggests an indirect positive impact of the discovery learning experience on students' attitudes and interest towards science. This also strongly agrees with past findings that students who used an inquiry approach have improved attitudes towards science compared to negative attitudes resulting from traditional methods (Gibson and Chase 2002 and references therein). Interestingly, a long term study found that a 2-week inquiry based summer science exploration program using an inquiry-based approach helped students maintain a more positive attitude towards science and a higher interest in science careers later (Gibson and Chase 2002). Certainly this context could be helpful in Malaysia, as it was recently reported that there has been a steady decline of Malaysian students enrolled in STEM (Science, Technology, Engineering and Mathematics) courses in secondary (Science stream) and tertiary levels. Only 21% of upper secondary school students chose to study science subjects in the year 2014, which is far from the 60:40 ratio of science to non-science students at upper secondary level target set by the country (Academy of Sciences Malaysia 2015).

5. Conclusion

This study found positive impacts of a discovery-based experiment on students' understanding of the function of biological enzymes through the application of concept using a real world example. More interestingly, a high level of motivation was detected from the feedback comments, showing that this discovery approach can generate a positive experience towards learning biology. Given the reported current decline of Malaysian students enrolled in STEM (Science, Technology, Engineering and Mathematics) courses, developing and doing more real-world, discovery type projects in secondary schools is

recommended. Certainly it aligns with the first of three main measures highlighted in the STEM initiative of the Malaysia Education Blueprint (2013-2025) to raise student interests through new learning approaches (and enhanced curriculum) (Ministry of Education Malaysia).

6. Acknowledgement

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Appendix

Appendix 1: Experiment manual for apple fruit juice clarification

Title: Apple fruit juice clarification

Introduction

Enzymes

Enzymes are biological molecules (proteins) that responsible for the metabolic processes that sustain life. They are highly selective and catalyses complex reactions occur everywhere in life. Enzymes function is affected by factors such as temperature and pH. The optimum temperature for pectinase to function falls between 45 to 55 °C and work well at a pH of 3.0 to 6.5 (acidic range).

Biotechnology Application

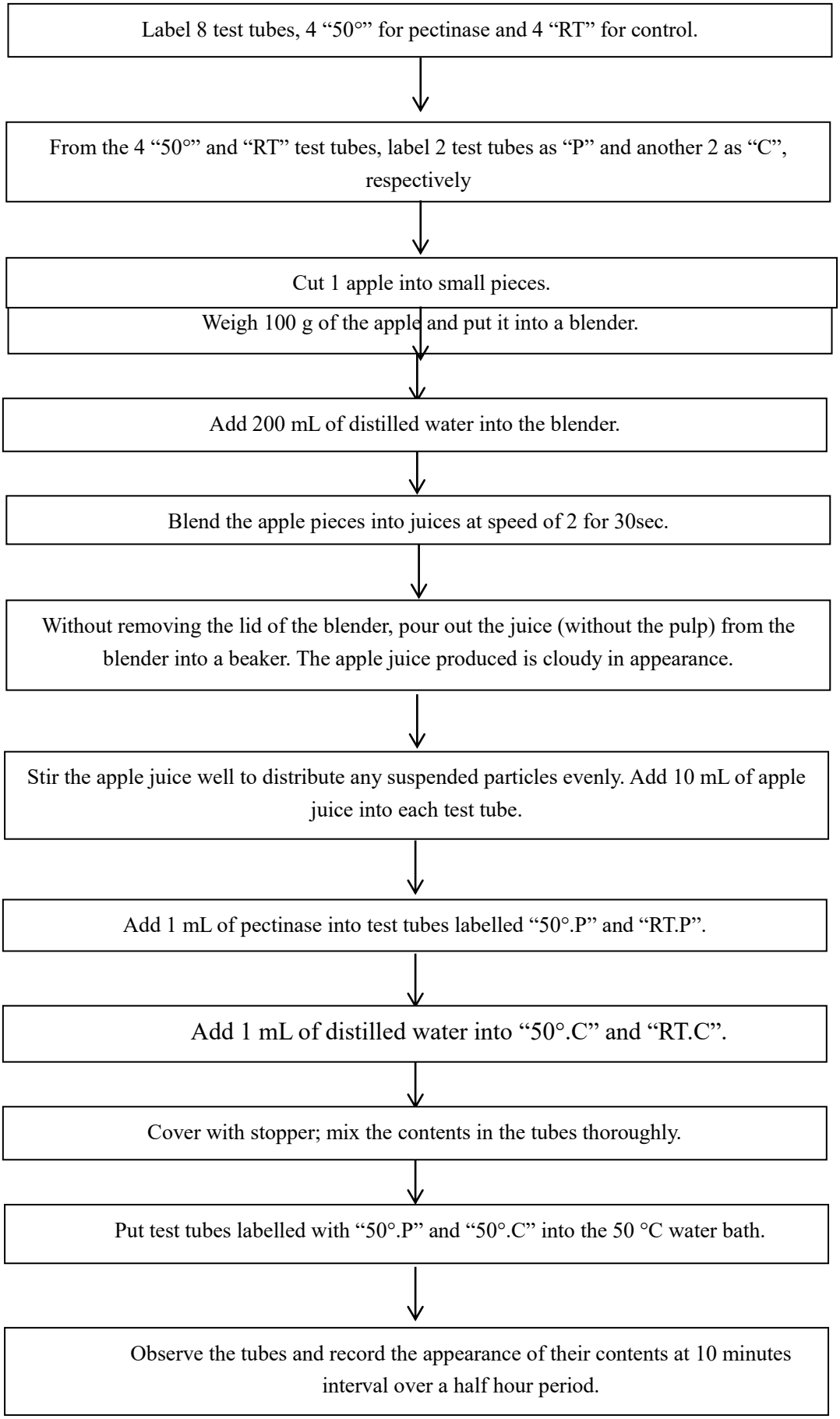
Fruit juices are products for direct consumption and are obtained by the extraction of cellular juice from fruit upon pressing. Nearly all fruits and berries contain pectin and other polysaccharides. Pectin is a structural polysaccharide contained in the cell wall of plant. The presence of soluble pectin in juice causes hazy appearance. The addition of pectinase enzyme in the juice industry increases the yield of juice and helps to maximize the production of CLEAR juice. Production of fruit juice with enzymes is an essential practice in the juice industry today.

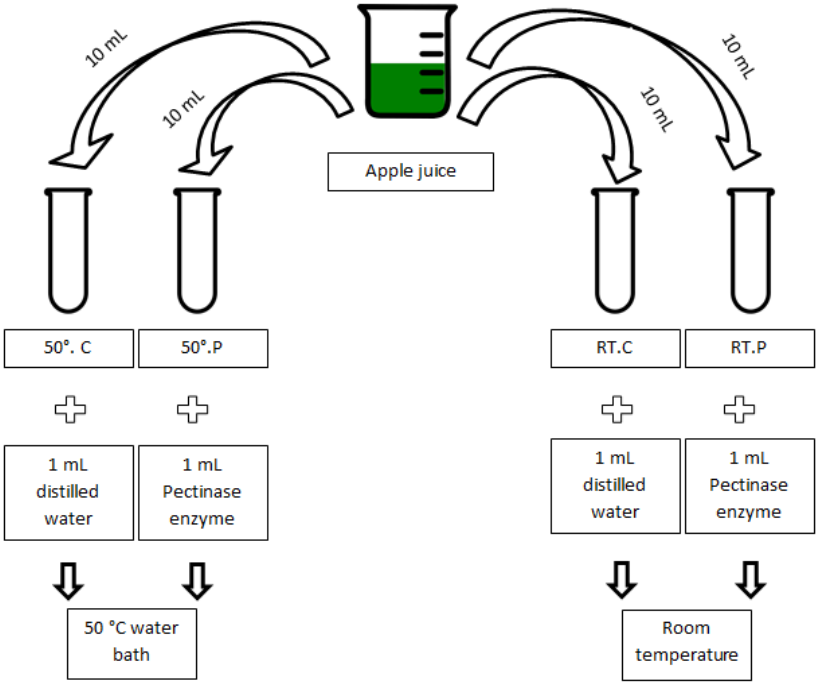
Objective

To study the effect of temperature and pH of pectinase enzyme for the production of clear apple juice.

Procedure 1

Effect of temperature





C=Control

P= Pectinase

Procedure 2

Effect of pH

Label 8 test tubes, 4 “acid” for pectinase and 4 “alkaline” for control.

↓

From the 4 “acid” and “alkaline” test tubes, label 2 test tubes as “P” and another 2 as “C”, respectively

↓

Cut 1 apple into small pieces.

↓

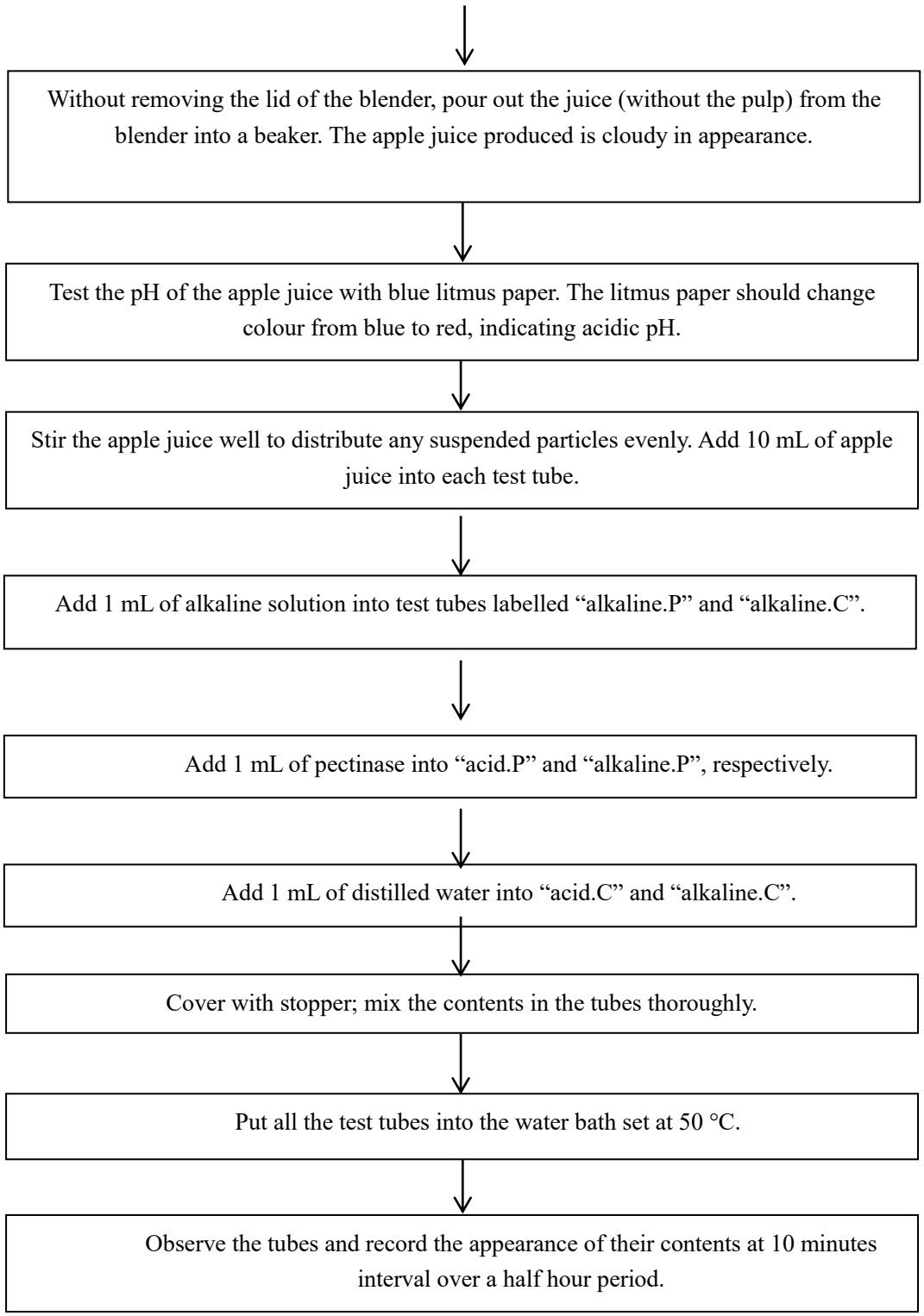
Weigh 100 g of the apple and put it into a blender.

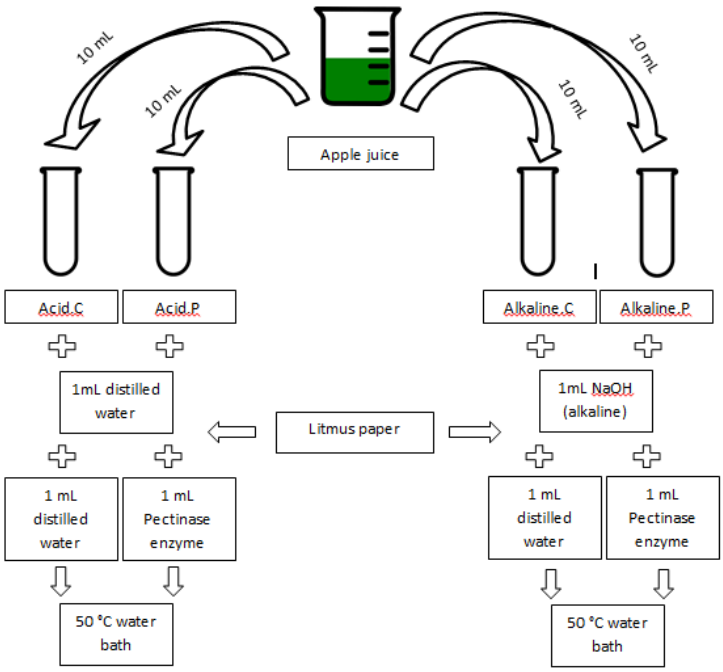
↓

Add 200 mL of distilled water into the blender.

↓

Blend the apple pieces into juices at speed of 2 for 30sec.


Without removing the lid of the blender, pour out the juice (without the pulp) from the blender into a beaker. The apple juice produced is cloudy in appearance.
Test the pH of the apple juice with blue litmus paper. The litmus paper should change colour from blue to red, indicating acidic pH.
Stir the apple juice well to distribute any suspended particles evenly. Add 10 mL of apple juice into each test tube.
Add 1 mL of alkaline solution into test tubes labelled “alkaline.P” and “alkaline.C”.
Add 1 mL of pectinase into “acid.P” and “alkaline.P”, respectively.
Add 1 mL of distilled water into “acid.C” and “alkaline.C”.
Cover with stopper; mix the contents in the tubes thoroughly.
Put all the test tubes into the water bath set at 50 °C.
Observe the tubes and record the appearance of their contents at 10 minutes interval over a half hour period.



Expected observation

50°.P Acid.P	50°.C RT.C RT.P Acid.C Alkaline.C Alkaline.P

Thank you

Reference: (i) Enzymes in fruit juice production. In a jam and out of juice. www.ncbe.reading.ac.uk/ncbe/protocols/inajam/pdf/jam01.pdf

Appendix 2: Pre-experiment questions

Pre experiment questions: Fruit juice clarification using pectinase

1 What is Biotechnology?

2 Define what are enzymes and explain their general role.

3 Are the roles of enzymes specific?

4 In general, how is an enzyme affected by high temperatures?

5 In general, how is an enzyme affected by changes in pH?

Appendix 3: Post experiment questions

Post experiment questions: Fruit juice clarification using pectinase

1 What is Biotechnology?	
2 Define what are enzymes and explain their general role.	Example of pectinase in this experiment, and you see the apple juice going from cloudy to clear
3 Are the roles of enzymes specific?	In this case, can you replace the pectinase with another type of enzyme and expect to see the same results?
4 In general, how is an enzyme affected by different temperatures?	In this case, warming the pectinase to 50°C and leaving it at RT
5 In general, how is an enzyme affected by changes in pH?	Did the adding alkali to the juice-enzyme mixture change the results?
6 Comments on this experience/experiment:	Egs. Did this Juice workshop help you better understand enzyme activity? Did this Juice workshop help expand your knowledge on the application of enzyme in the industry?

Appendix 4: Marking rubric

Post experiment questions: Fruit juice clarification using pectinase

1 What is Biotechnology?

Biotechnology is the science of using living organisms, or the products of living organisms, for human benefit — to make a product or solve a problem / Biotechnology is the manipulation of living organisms (or parts of organisms) to make products useful to humans.

2 Define what are enzymes and explain their general role.

An enzyme is a protein that function as a biological catalyst; enzyme is the biological catalyst that increases the rate of a chemical reaction and is not changed by the reaction. [In this case, it involves enzyme catalyzed depectinization of suspended pectin particles stemming from the plant cell walls, other disrupted cell wall and cell materials that contribute to juice turbidity]

3 Are the roles of enzymes specific?

Yes, enzymes show specificity in terms of the complementary shape and fit of the active site with the substrate (enzyme-substrate complex), substrate and product

4 In general, how is an enzyme affected by high temperatures?

Increased temperature has an impact on enzyme activity in terms of kinetic energy, shape and fit, frequency of effective collisions and ultimately, denaturation

5 In general, how is an enzyme affected by changes in pH?

Changes in pH such as alkali will impact enzyme activity in terms of shape and fit and denaturation

Universal-Filtered Multi-Carrier: A Waveform Candidate for 5G

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Abstract

The emerging Internet of Things will make the next generation 5G systems to support a broad range of diverse needs with greater efficiency requirements. The new class of services will need a higher data rates, to handle these demands, the lowest layer of the 5G systems must be flexible. Therefore, the waveform will have an important role in offering these new requirements. These waveforms should enable efficient multiple access to handle the requirements of the future wireless communication system. This means that the corresponding required waveforms should be able to handle as much different type of traffic as possible in the same band. In this paper we compare three candidate multicarrier waveforms for the air interface of 5G: the original cyclic prefix OFDM applied in the 4G systems today, the Filter Bank Multicarrier (FBMC) heavily discussed in previous papers, and Universal Filtered Multi-Carrier (UFMC) a new contender making its appearance recently. These new waveforms will be more robust against the time frequency synchronization problem, it has the potential for mixing different traffic specifications, and supports the scenarios of spectrum fragmentation, due to the improvement in the localization of spectrum. In the same time, they support all multiple input and multiple output (MIMO) scenarios and applications. The simulation results shown that there is a good difference in the time frequency efficiency for transmitting very small bursts where the response time is required (like car-to-car communications). Due to the cyclic prefix the FBMC and CP-OFDM suffer when transmitting short bursts, the UFMC outperforms CP-OFDM by 10% for any case and FBMC for the very short packets and it is similar to FBMC for long sequences. Other simulation results are shown, which demonstrate the potential of this waveform.

Keywords: 5G; OFDM; LTE; spectral efficiency; Cyclic Prefix;

1. Introduction

The 4G systems, LTE, use the OFDM technique which is considered as an elegant solution to face the frequency selective problem and to improve the efficiency of the spectrum [1]. CP-OFDM is the most known and applied for multicarrier systems, where the modulation is based on the IFFT, and symbols are guarded by the use of Cyclic Prefix (CP). The 4G LTE standard arrived sometime around 2010 and offered new services worldwide, like wireless broadband data service, which is considered as an important innovation in the digital wireless communication systems. Since approximatively every ten years, a new generation is introduced to meet spectral specifications and the increasing in the data rates requirements,

the industry should ask about the future applications and where LTE has fall short to meet the requirements. In the introduction of the new 5G standard, some new multicarrier schemes have gained high attraction as a potential candidate. Indeed, UFMC is a promising contender since it has some advantageous characteristics, where the filtering process is applied on a per sub-band basis. The subcarriers are shaped by a sinc-filter in frequency domain or instead of sinc-shapes they have a more suitable form according to the filter design with reduced side-lobe levels [2]. With the Internet of Things (IoT) being served by a 5G system, the characteristics of the bursts to be transported and of the nodes connected to the network are much more varying in various aspects: Packet size, required response time, packet frequentness, device capabilities, and number of devices just to name a few. It becomes clear that the waveform of 5G should offer but not only the following: 1. Dedicated services for different needs and characteristics of channel, 2. Emission with reduced out of band, 3. tolerance to misalignment in the time-frequency [3, 4]. The objectives targeted by the European Union METIS project are to provide, at the 2020 horizon, 1000 times more mobile data volume per area, 10–100 times more connected devices, 10–100 times higher user data rates, 10 times longer battery life for low-power massive machine communication, and 5 times reduced end-to-end latency [5]. All these increases will be possible only by combining several factors: better usage of the available spectrum, use a new spectrum (above 6GHz), small cells generalization, introduction of massive MIMO, ... In addition to that there is a need to define a new air interface. The 4G system is based on CP-OFDM modulation which has two main drawbacks - a bad spectral confinement and a flexibility lack in the waveform - which are serious in the perspective of multi-services offered by the future 5G communication system. Dynamic spectrum aggregation is necessary to get an optimum usage of the available bandwidths below 6 GHz [6], the CP-OFDM based approach suffers from a high emission in the Out Of Band (OOB) and also from the granularity of the resource block which affects the allocation of a single subcarrier to low data rate communication services. And there are other problems which may also occur with frequency shifts due to Doppler effects in the case of the high mobility applications. As mentioned by Wunder et al. [7], obtain a significant reduction in the latency is a problematic in CP-OFDM. In addition, to the spectral efficiency reduction when the cyclic prefix is used to avoid interference problems. For all these reasons, if is urgent to design a new system based on good flexibility of the waveform which can solve the challenges of 5G in its physical layer. In this paper, we analyze and compare the waveform contenders: The Universal Filtered Multi-Carrier (UFMC) and the Filter Bank Multicarrier (FBMC) to CP-OFDM with respect to their probability of error when changing some parameters mentioned later on.

The remainder of this paper is organized as follows. In Section II, we introduce the three waveforms to be compared – CP-OFDM, Universal Filtered Multi-Carrier (UFMC), and the Filter Bank Multi-Carrier (FBMC). Section III presents the block diagrams of these three systems. The comparison metrics, like the time frequency efficiency, are also presented in Section IV. The system performance is investigated in Section V through extensive trace-driven simulation. Finally, conclusions are given in Section VI along with the suggestions for future work.

2. Theoretical Background

Without any discussion, CP-OFDM became the reference Multi Carrier Modulation (MCM). In the same

time, two variants with a lower degree of maturity was available, the filtered multi-tone (FMT) and the filter bank multi-carrier (FBMC). More recently, a new scheme named FOFDM is also entering the debate for the fifth generation. Instead to be filtered subcarrier by subcarrier the new one correspond to be sub-band filtered. In this section, we briefly go through this list of waveforms and to be complete we will present the basic CP-OFDM. But before, we will define some parameters used in the formulation below:

M: Maximum number of subcarriers = Size of the (I)FFT)

K: Number of sub-symbols in the case of block transmission

T_s: Sampling period which is considered here as unity

T: Duration of each single OFDM symbol

c: Symbol transmitted over each carrier in complex constellation

a: Symbol transmitted over each carrier in real valued constellation

2.1 Orthogonal Frequency Division Multiplexing

The fundamental advantage of OFDM is the usage of subcarriers overlapped to modulate parallel data streams, which makes it more efficient in bandwidth efficient than the conventional technique. These subcarriers need to be orthogonal, to avoid the inter-carrier interference. The fast Fourier transform (FFT) is used to derive this set of orthogonal subcarriers. By modulating low rate data streams onto these subcarriers, OFDM system can ensure flat fading condition on each subcarrier. OFDM is a simple MCM technique which is widely used in many applications, in a single carrier modulation the transmitted data occupies the entire available bandwidth, the OFDM data are modulated over a number of narrow subcarriers each of them has a bandwidth smaller than the coherent bandwidth of the channel, giving an approximately flat fading channel at each subcarrier. In addition, a cyclic prefix is inserted after each symbol, which is a copy of a certain number of samples from the tail, with L_{cp} is its length. This further improves the flatness of the channel at each subcarrier, which enhances the robustness against the frequency selectivity of the channel. In OFDM, the transmission is done symbol-by-symbol which means that K=1, so the baseband symbol of CP-OFDM is expressed, for $k \in [-L_{cp}, M-1]$, as

$$s_{CP-OFDM}(k) = \sum_{m=0}^{M-1} c_m e^{\frac{j2\pi mk}{M}} \tag{1}$$

where c_m are the transmitted complex symbols at each subcarrier m, like QAM constellations. The overall operation can be realized by FFT and IFFT. One of the advantage of CP-OFDM is maintaining the orthogonality for the transmission over channel which is dispersive in time. Consequently, a simple method for channel estimation and equalization is used to recover orthogonality at the receiver. However, the rectangular pulse used in CP-OFDM has several disadvantages, so, implicitly the pulse shaping will be realized by the Fourier transform.

2.2 Filter Bank Multi-Carrier

The introduction of structured transmission is the remarkable contribution of FBMC, which allow the system to escape the Balian-Low theorem requirements [8]. The FBMC technique employ a better pulse shape, keeping the orthogonality, and transmitting at the Nyquist rate. In OFDM technique we transmit

complex symbols at subcarriers, but in the structured technique we transmit the real and imaginary parts of the complex symbols separately with a half symbol duration delay, $T/2$. Better details of FBMC concept is in Le Floch et al. and [9]. The baseband signal in FBMC can be presented, for any integer k, as in [10]:

$$s_{FBMC}(k)=\sum_{n\in Z}\sum_{m=0}^{M-1}a_{m,n}\underbrace{g(k-nN_1)e^{j\frac{2\pi}{M}mk}e^{j\phi_{m,n}}}_{g_{m,n}(k)} \tag{2}$$

with g the filter, $N_1 = M/2$ the offset of the discrete-time, $\varphi_{m,n}$ an additional phase term at subcarrier m and symbol index n, which can be expressed as $\pi/2(n+m)$. $a_{m,n}$ the real value of the transmitted symbols, and obtained from the real and imaginary parts of a QAM constellation. For perfect reconstruction, the filter g must satisfy the orthogonality condition:

$$\Re\left\{\sum_{k\in Z}g_{m,n}(k).g^{*}_{p,q}(k)\right\}=\delta_{m,p}\delta_{n,q} \tag{3}$$

where $*$ is the complex conjugation, $\delta_{m,p} = 1$ if $m = p$ and $\delta_{m,p} = 0$ if $m \neq p$.

As plain OFDM, FBMC takes advantage of fast IFFT/FFT algorithms. But, it has an extra complexity compared to OFDM. This complexity comes from the fact of working with half duration real symbols which means performing the IFFT/FFT at twice rate, and from the additional blocks of filters. This additional complexity depends on the selected scheme in the implementation.

2.3 Universal Filtered Multi-Carrier

In the UFMC case the total available bandwidth is partitioned into B sub-bands; each sub-band is separately modulated using classical OFDM modulation [11]. Then a FIR filtering of length L is applied to each sub-band modulated signal. Finally, the UFMC signal is a summation of B filtered sub-band modulated signals. For each resulting block of length $L+M-1$, the baseband UFMC signal can be written, for $k\in[0, M+L-1]$, as follows:

$$s_{UFMC}(k)=\sum_{i=1}^{B}\sum_{l=0}^{L-1}\sum_{m=0}^{M-1}c^{i}_{m}e^{j\frac{2\pi(k-l)m}{M}}f_i(l) \tag{4}$$

with c^i_m the complex-valued symbols for subcarrier m and sub-band i. Note that in the UFMC proposal, the definition of sub-band is imposed as one physical resource block (PRB).

As the successive blocks do not overlap, for a back-to-back system, orthogonality in time is ensured, while orthogonality in frequency depends on the precise features of the filter being used. Note also that the transition interval between consecutive blocks, resulting from filtering, plays the role of a guard interval and protects the transmitted symbols as long as L is greater or equal to the maximum delay spread introduced by a multipath channel.

However, concerning the implementation aspects, one has to refer to a more recent publication [12], which proposes a realization scheme that outperforms the one resulting from a direct implementation based on equation (4). Nevertheless, it appears that even with this later implementation scheme, the extra cost compared to a CP-OFDM reference goes up at least to a factor two in the uplink case, assuming the usage of a minimum number of resource blocks, and up to eight or ten for the downlink.

3. Systems Models

3.1 CP-OFDM

In a digital domain, binary input data (bits) are collected and coded with a channel coding schemes such as convolutional codes. After that the coded bit stream is interleaved to obtain diversity gain. Afterwards, a group of interleaved bits are grouped together (1 for BPSK, 2 for QPSK, 4 for 16QAM, ...) and mapped with the corresponding points in the constellation. At this instant, the data in complex numbers representation and they are in serial. So, the known pilot symbols mapped with known mapping schemes can be inserted at this time, and we obtained the modulated data stream mentioned in the Figure 1. After applying a serial to parallel converter, the IFFT operator is performed on this parallel complex data. The transformed data is grouped together again, as per the number of required transmission subcarriers. Cyclic prefix is inserted in every block of data according to the system specification and the data is multiplexed to a serial order. Here, the data can be considered OFDM modulated and ready to be transmitted. A Digital/Analog Converter (DAC) is used to transform the digital data to time domain analog data. RF modulation is performed and the signal is up-converted to transmission frequency. When transmitted by the antenna, the OFDM signals go through all the impairments of the wireless channel.

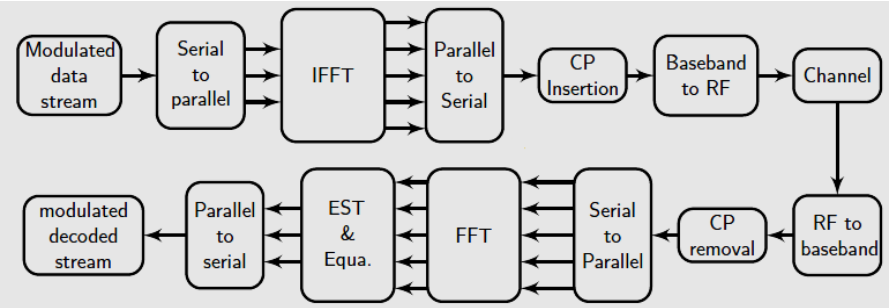

Figure 1. CP-OFDM transceiver scheme.

At the receiver, they will be down-converted and reconverted to digital using an Analog/Digital converter (ADC). We should make attention to frequency offset due to channel and mobility, so a carrier frequency recovery should be performed when the down-conversion operation is working. After the digitization process, the symbol timing synchronization is achieved. Then the FFT operator is used to demodulate the OFDM signal. After that, channel estimation is performed using the demodulated pilots. Using the estimations, the complex received data is obtained which are de-mapped according to the transmission constellation diagram. At this moment, FEC decoding and de-interleaving are used to recover the originally transmitted bit stream. The CP-OFDM is the most commonly known and applied multicarrier format (in 3GPP LTE and IEEE 802.11).

3.2 FBMC

The simple block diagram shown in Figure 1 can be adapted to implement the filter bank, it is just sufficient to extend the IFFT and the FFT. In section 3.1, a data stream is applied to one input of the IFFT and it modulates one carrier. In a filter bank with overlapping factor K, as shown in Figure 3 a data stream modulates $2K$-1 carriers. Thus, the filter bank in the transmitter can be implemented with an extended IFFT

of size KM, to generate all the necessary carriers; and each data element, after multiplication by the filter frequency coefficients, is sent to the $(2K\text{-}1)$ inputs of the IFFT from $(i-1)K+1$ to $(i+1)K-1$. So, the data element is spread over several IFFT inputs, as shown in Figure 2. For each set of input data, the output of the IFFT is a block of KM samples and, since the symbol rate is $1/M$, K consecutive IFFT outputs overlap in the time domain. Therefore, the filter bank output is provided by an overlap and sum operation, as shown in Figure 3.

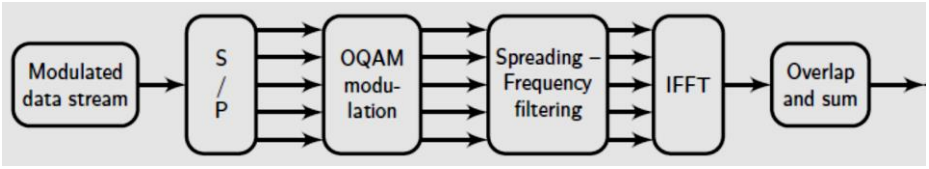

Figure 2. FBMC transmitter scheme.

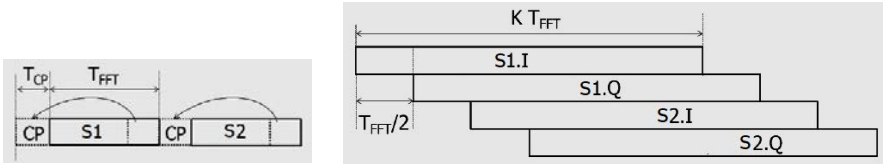

Figure 3. CP-OFDM vs FBMC frames.

The implementation of the receiver is also based on an extended FFT, of size KM. In that case, the FFT input blocks overlap, it is the classical sliding window situation. At the output of the FFT, the data elements are recovered with the help of a weighted de-spreading operation. In fact, the data recovery rests on the property of the frequency coefficients of the Nyquist filter. The delay of the whole system, when the transmitter and the receiver are connected, is KM samples, or K multicarrier symbols.

A remarkable feature of the scheme presented in Figure 2 is its simplicity: it is just the scheme shown in Figure 1 completed by minor operations before and after the IFFT/FFT. In fact, the key difference is the complexity, due to the increasing of the FFT size from M to KM. Due to the overlapping in the time domain of the IFFT outputs and FFT inputs, a lot of redundancy is present in the computations which can be reduced by using certain scheme or idea.

3.3 UFMC

UFMC applies filtering to subsets of the complete band instead of single subcarriers or the complete band. Figure 4 depicts an UFMC transmitter with B sub-bands (single antenna case). The i-th UFMC sub-module, with $i \in \{1,2, ..., B\}$, generates the $(N+N_{filter}\text{-}1)$-dimensional time-domain baseband vector x_i following the UFMC design criteria for the respective sub-band carrying the complex QAM symbol vector s_i with dimension $n_i \times 1$. N is the required number of samples per symbol to represent all sub-bands without introducing aliasing (N depends on the overall covered bandwidth), the sample rates of the single sub-bands naturally have to be aligned to each other, N_{filter} the length of the filter.

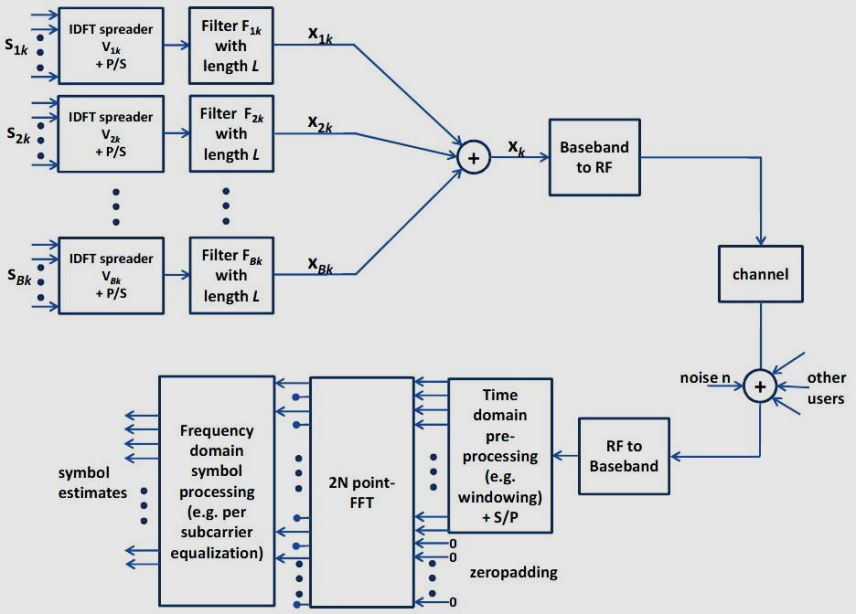

Figure 4. UFMC transceiver.

We consider one multi-carrier symbol out of a consecutive stream of symbol vectors, dropping the temporal symbol index for the ease of notation. The single sub-band signals are combined to synthesize the transmit vector x. In case of downlink (DL) the single sub-modules cover the complete available frequency band(s), transporting data to multiple users. In uplink (UL) the single sub-modules cover only the frequency portion the respective user has been allocated to. The n_i complex QAM symbols are transformed to time-domain using an IDFT spreader. Then the sub-band filter is applied.

The choice of B depends on the spectral settings the UFMC transmitter has to deal with and on the system design targets. If the system is to be applied to a scenario with fragmented spectrum, B may be chosen according to the number of available spectral sub-bands (B may even vary in time in case of some of the spectral sub-bands being populated by other wireless services only occasionally).

4. Comparison Metrics

In this section, we provide a comparison of the different waveform presented in this paper. The comparison includes several metrics: the spectral efficiency, the tail issue, the spectrum confinement, the mobility, the latency, the complexity, and the compatibility with 4G (LTE). This comparison is necessary to provide a global view of the advantages/drawbacks of schemes.

4.1 The Spectral Efficiency

The spectral efficiency analysis for part of the 5G waveforms is done by Lin and Siohan. CP-OFDM cannot achieve this maximum value due to the addition of a CP of length TCP. This leads to an overall efficiency reduction:

$$\eta_{CP-OFDM} = \frac{T}{T + T_{CP}} < 1 \tag{5}$$

In contrast, the FBMC scheme respects the Nyquist rate and no CP is used. Hence it is possible to achieve the maximum efficiency:

$$\eta_{FBMC} = \frac{1}{T.F} = 1 \tag{6}$$

Where F is the spacing between subcarriers, The maximum efficiency for an orthogonal system is reached when: $T.F$=1.

Finally, The UFMC scheme does not imply any CP. But nevertheless, a zero-padding is employed after OFDM modulation, which ensures an isolation between consecutive symbols after time-domain FIR filtering. The number of padded zeros is equal to the FIR filter length minus 1, making the overall spectral efficiency the same as CP-OFDM:

$$\eta_{UFMC} = \frac{1}{(T + T_{ZP}).F} = \frac{T}{T + T_{CP}} < 1 \tag{7}$$

where T_{ZP} is the zero-padding duration, which is equal to T_{CP} of the CP-OFDM case.

4.2 The Time-Frequency Efficiency

The time-frequency efficiency η_{tf} is defined as follows: $\eta_{tf} = \eta_f.\eta t$, where η_t is the efficiency in time direction relating the information carrying body of the burst to its overall length including the tails, and η_f is the efficiency in frequency direction relating the number of usable subcarriers to the overall number of subcarriers within the usable band.

In a later publication the time-frequency efficiency will be extended taking realistic transmission aspects into account. In conclusion, UFMC outperforms CP-OFDM for any setting by about 10% and brings additional benefits such as higher robustness to time and frequency misalignments and improves spectral properties. FBMC is very efficient with long bursts. However, the time-frequency efficiency degrades significantly in case of small burst in contrast to UFMC and CP-OFDM. So, UFMC is the best choice for a system targeting to include an option for short burst transmissions into the overall design.

4.3 The Tail Issue

In a burst transmission, the tail issue mainly reflects the potential overlap between two bursts, which means symbols are not completely isolated in the time domain but instead part of the symbols is overlapped. This issue has been identified for the FBMC scheme. In CP-OFDM, each symbol is completely isolated in the time domain so that it does not have any tail issue. The UFMC controls the filter length and utilizes zero padding to absorb the filtering tails. UFMC has similar properties to OFDM in this respect: each UFMC symbol is completely isolated in the time domain so that it does not have any tail issue.

4.4 The Spectrum Confinement

Two main problems with CP-OFDM lead to bad spectrum confinement: Spectral leakage due to the waveform discontinuity, and the rectangular pulse shape for CP-OFDM. The first problem can be solved when the envelope of the symbol edges is smoothly decreasing to zero. To solve the second one in FBMC, the rectangular filter is replaced with a prototype filter that has good frequency localization and a length

longer than the FFT size. For UFMC, the discontinuity issue can be overcome by FIR filtering. However, the improvement in spectrum confinement is less than for FBMC.

4.5 The Mobility

Mobility robustness is also a very important criterion for 5G, the FBMC schemes have, in general, better robustness against the Doppler effect due to the subcarrier filtering process. On the other hand, the UFMC scheme handle the Doppler effect in the same manner as CP-OFDM, the claimed advantage is that the subcarrier spacing can be made wider for a particular sub-band in order to serve high-mobility users.

4.6 The Latency

Latency is another important consideration for 5G networks, CP-OFDM is advantageous because of its short transceiver latency, which is mainly due to the FFT transform and CP, in other words $T+T_{CP}$. Any additional filtering will naturally increase the latency. Moreover, latency and spectrum confinement are two competing factors. FBMC has the highest latency, UFMC trades CP with the filtering transition period, which makes UFMC have the same latency as CP-OFDM.

4.7 The Complexity

One important advantage of the CP-OFDM is its low modem complexity. It is obvious that when working on some new advanced modulation simplicity might need to be sacrificed. It is important to compare the new candidates to CP-OFDM. In the FBMC scheme, the complexity is more than double. Regarding the UFMC, a direct implementation will lead to significant complexity increases, mainly due to the fact that the modulation of each resource block will consume one FFT transform. Thus, in an LTE setting where 100 resource blocks are to be modulated, the additional complexity will easily reach a factor of hundreds. According to a recent report, a frequency-domain realization can remarkably reduce modulation complexity, by a factor of 30. The reported modulation complexity increase in comparison with the CP-OFDM modulation is a factor of 8–10 for downlink on the base-station side, and the demodulation complexity is slightly more than doubled in comparison to CP-OFDM demodulation.

4.8 The Compatibility with 4G

Another consideration, but it does not mean that the new receiver is able to decode LTE signals; it rather means that the new system should preferably be able to reuse existing LTE techniques, like reference signal (RS) design and MIMO coding, in a straightforward manner. However, for FBMC systems, only real-valued symbols are transmitted due to offset QAM signalling. It thus cannot directly reuse the LTE techniques. For the UFMC scheme, it is claimed that the signal within the sub-band has the same character as the OFDM signal, the system can maintain a good compatibility with LTE.

5. Simulation Results and Analysis

A key performance index to evaluate the capacity-approaching is the BER given a received SNR over an AWGN channel. We consider the following parameters (most used in the literature):

Table 1. Simulation Parameters

Overall Parameters		
FFT size	N_{FFT}	1024
Bit Per Symbol	m	2, 4, 6, 8
Resource block size	N_{sc}	12, 16
Number of active RBs	N_{RB}	50, 60
CP-OFDM Parameters		
Cyclic Prefix	N_{CP}	72 samples
UFMC Parameters		
Filter Length	$L=N_{CP}+1$	73
Stop band attenuation		40 dB
FBMC Parameters		
Overlapping Factor	K	2, 3, 4

In this section, we examine the performance of the FBMC and UFMC waveforms and compare the results with that of CP-OFDM. Our simulations have been carried out with parameters that are shown in Table 1. Monte Carlo simulation by MatLab is used to obtain the results shown in the following figures. For the evaluation, three performance metrics are considered the Power Spectral Density, the Probability of Error, and the Peak to Average Power Ratio. We can predict before simulations that in the first two metrics we will obtain some gain but in the PAPR metric the CP-OFDM will be better because of the filtering in both FBMC and UFMC which improves PAPR with respect to FBMC to became slightly worse than CP-OFDM.

5.1 Power Spectral Density – PSD

A comparison of the theoretical power spectrum density of CP-OFDM and UFMC for two different values of Resource blocks (NRB) and Number of subcarriers in each RB (NSC) is shown in Figure 5, where the PSD is represented in dBW/Hz and function of the normalized frequency. We can simply remark here two things, the first one the reduction of PSD in the Out of Band (OOB) region due to the filtering process used in UFMC, this reduction makes this new waveform more robust to the Inter-Carrier Interference, and the effect of the sub-band filtering which divided the overall PSD into a summation of sub-band PSDs.

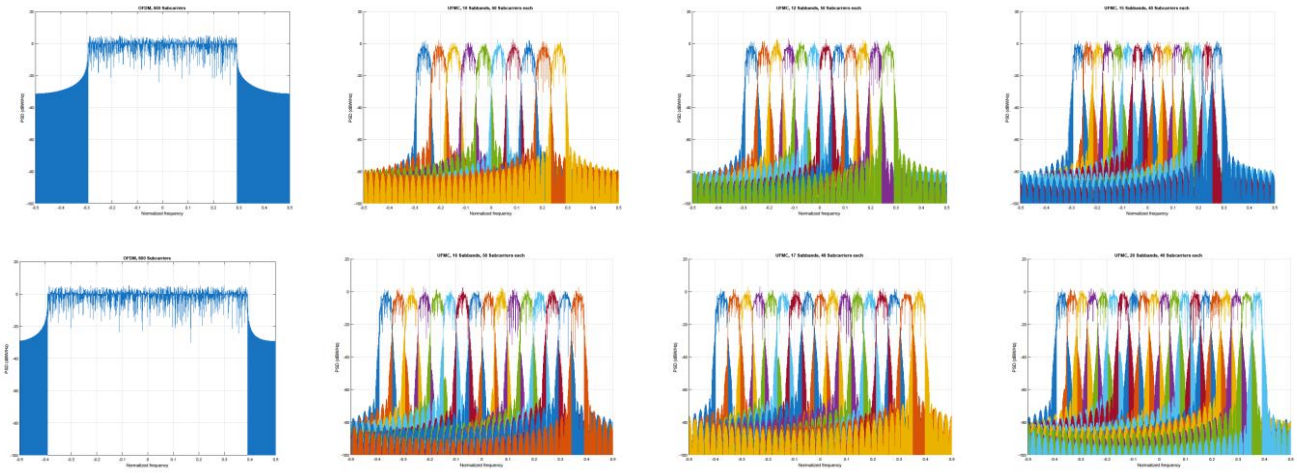

Figure 5. PSD Comparison between CP-OFDM and UFMC.

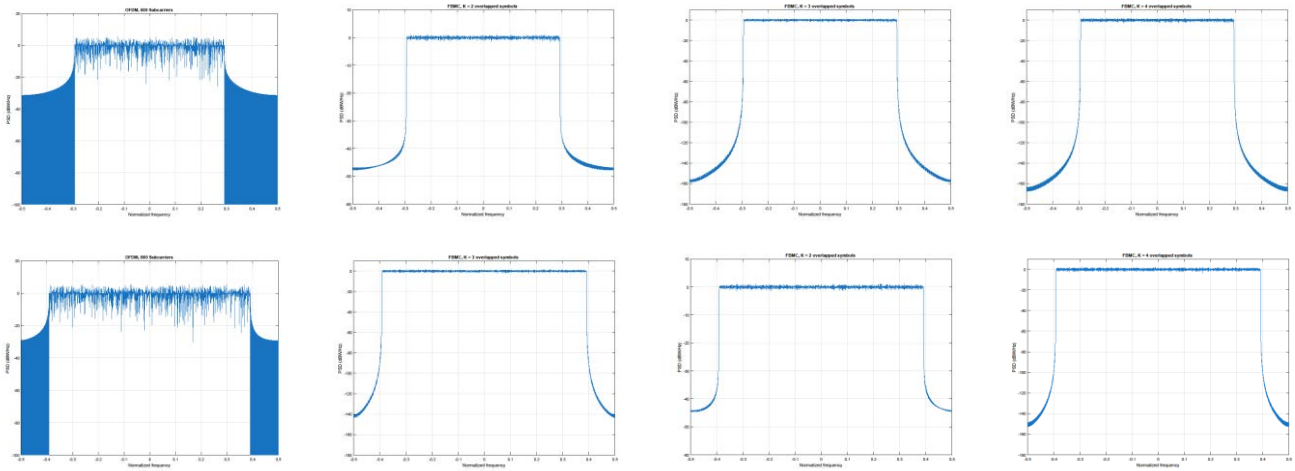

Figure 6. PSD Comparison between CP-OFDM and FBMC.

In Figure 6 the comparison of PSD between CP-OFDM with FBMC for various values of overlapping factor K is shown. Here, it is obviously shown that in FBMC the power in the OOB is very small compared to the power in the corresponding band. So, we can say that the FBMC has the best PSD when compared to the CP-OFDM and UFMC.

5.2 Bit Error Rate – BER

A comparison of the probability of error, which is presented by the BER, of UFMC and FBMC with respect to the different modulation levels from QPSK to 256QAM modulation is presented in Figure 7. This figure demonstrates what it was proved theoretically that when the modulation level increase the BER increase also.

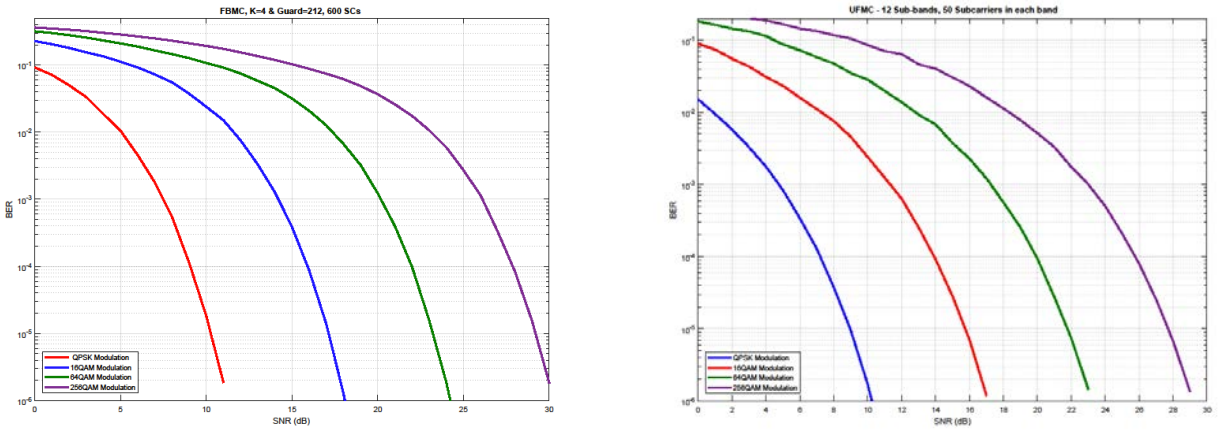

Figure 7. UFMC and FBMC performances with respect to modulation levels.

When compared to the CP-OFDM system the UFMC presents a net gain in all cases simulated in our work. Figure 8 shows that the UFMC using QPSK and different number of subcarriers has better BER from the CP-OFDM with approximately 2.5 dB at BER=10^{-5}. In the figure, the comparison between FBMC and CP-

OFDM for QPSK modulation is presented. The simulation results show that the CP-OFDM and the FBMC waveforms have the same performance with respect to the BER whatever is the modulation or the number of subcarriers. So, we can say that UFMC has the best BER when compared to the CP-OFDM and FBMC.

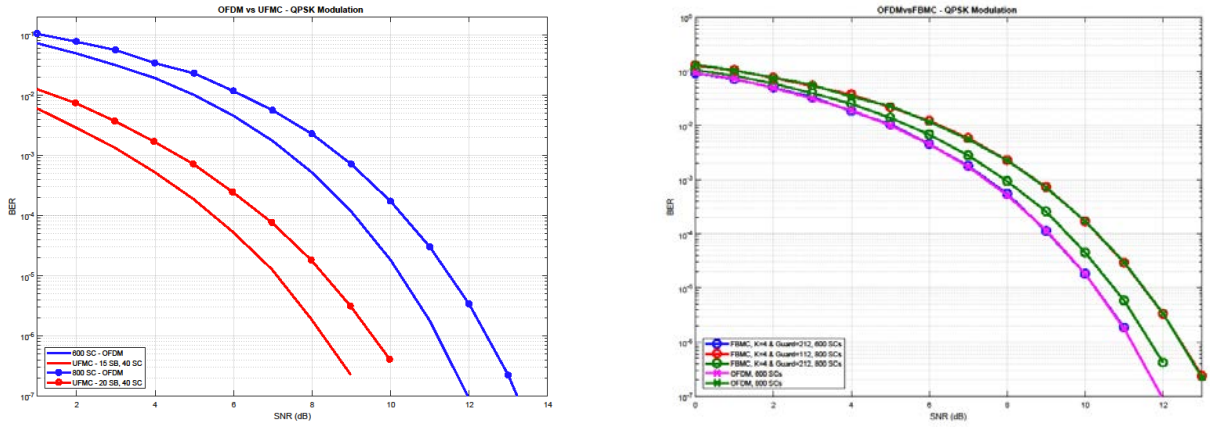

Figure 8. The comparison UFMC and FBMC vs CP-OFDM.

5.3 Peak-to-Average Power Ratio – PAPR

Theoretically, A CP provides a more constant amplitude, which reduces the peak to average power ratio (PAPR) and makes it appealing for power amplifiers. Furthermore, the CP allows for slightly smaller receive FFT sizes and potentially better coexistence with CP-OFDM.

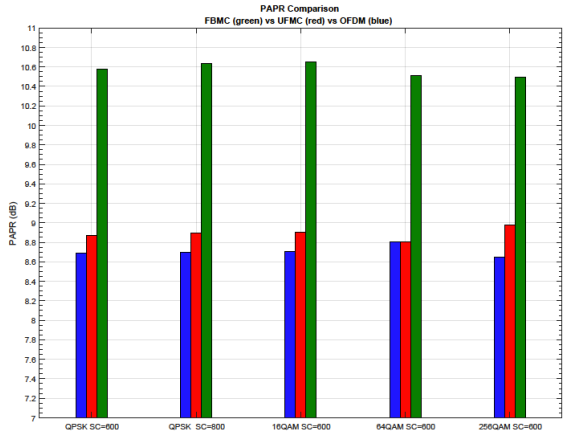

Figure 9. PAPR comparison between CP-OFDM, UFMC, and FBMC.

In the same time the filtering process increase the PAPR problem. So, we can expect that CP-OFDM will has the best PAPR ratio when comparing to the UFMC and FBMC, moreover, FBMC will have the worst PAPR ratio since it uses the filtering process and does not add a cyclic prefix to the symbols. The Figure 9 confirms our theoretical conclusion, where the PAPR ratio is presented in dB for different modulations used and different number of subcarriers. In all these cases the PAPR of CP-OFDM is between 8.4 and 8.8 dB where the PAPR of UFMC is slightly worse to be between 8.8 and 9 dB and the PAPR of FBMC is larger than 10 dB. We can remark also that the difference between UFMC and FBMC varies but the one

for UFMC is always near the one of CP-OFDM. So, when we use any waveform different that the CP-OFDM, we will lose in the PAPR, but with the UFMC the difference is not consequent.

6. Conclusion

In this paper, the implementation of two different candidates for the fifth generation, Universal-Filtered Multi-Carrier (UFMC) and Filter Bank Multi-Carrier (FBMC), is studied and presented. The first objective was to compare them with the conventional CP-OFDM but during our work, we have been capable to compare them between themselves. The simulation results show that each of the waveforms presented in this paper improves some parameters and deteriorates other parameters, so we need to take other criteria to choose the waveform for the next generation, like the tail issue, the complexity, the latency, and others. The FBMC and UFMC improve the PSD but deteriorate the PAPR ratio, in despite that UFMC has a PAPR ratio near to the one of CP-OFDM, in the same time the UFMC improve the BER rate, which push us to say that the UFMC represents a good candidate to the 5G system with respect to other metrics presented in this paper.

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Exploratory teaching method of college courses based on the module thought

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Abstract

Colleges and universities shoulder the important mission of training qualified contemporary college students. With the development of contemporary social and the rapid promotion of information level, teaching models and methods are faced with great challenges. Therefore, this paper analyzes the problems existing in the classroom teaching in Colleges and universities, combined with the students' thinking and learning ability. The module thought is introduced to the teaching process. A practical case is selected to illustrate the validity of the method. The results show that the teaching method proposed can enhance students' interest in learning professional knowledge and improve their communication skills.

Key words: Active learning; Module thought; Teaching Strategies; Higher education

1 Introduction

The popularization of higher education is a convenient way to improve the overall quality of the people of this country. The main purpose of higher education is to gain an in-depth understanding of professional knowledge and encourage further learning. The rapid growth of social economy has the potential to greatly accelerate and democratize the process of higher education popularization. However, the enrollment and graduation rates are blindly pursued by colleges and universities neglecting to cultivate students' ability of thinking and absorbing professional knowledge [1][2]. As a result, the gap between the service quality and the service quantity is increasing. Therefore, it is necessary to adopt a series of reasonable classroom teaching strategies to improve the quality of service. Advanced teaching projects and a set of effective teaching methods can improve students' innovative ability [3][4].

Students, in colleges or universities, have a relatively formed thinking mode. After getting rid of high school pressure, some students addict to their own information transmission networks, neglecting the importance of professional knowledge learning and teamwork[5][6]. Hence, how to improve the teaching efficiency and stimulate students learning enthusiasm is a critical issue considered in this paper. Modularity is a way to decompose complex systems into better managed modules. The main advantage of this method

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is that complex systems can be divided into simple management and control modules. Introducing the modular control method into the teaching process, students can be divided into several module groups. This method can increase cooperation and mutual assistance within modules, and it is of great significance to improve the teaching quality of university courses.

In this paper, an exploratory teaching method is proposed, integrating the modularity control concept and the advanced question thought, based on integrating the teaching content of the professional knowledge system. In detail, the number of the team and the quality are controlled by a simple process, and then, the project teaching method and the advanced question thought are adopted to instruct course teaching.

2 Modules of Employable Skill

In education teaching theory, small-class and discussion-based teaching are considered to be a good teaching method, and the teaching effect is welcomed and affirmed by students and teachers[7]. However, it is hard to come true when the teaching demand is higher. The idea of modularity is to divide a large group into several small modules for the convenience of management. This method can integrate small class and discussion teaching method scientifically and improve students' ability of cooperation and practice.

2.1 Module number determination

The division of the students' modules in the teaching course has a direct impact on the teaching quality. If the number of students in the module group is too large, some students cannot be integrated into group activities due to personality problems, else, it cannot realize the effective communication among the members of the group and the improvement of students' teamwork ability. According to the practical experience, 5 to 8 students per module is the best size. The specific process is shown in Fig. 1, taking 5 students in each module as an example.

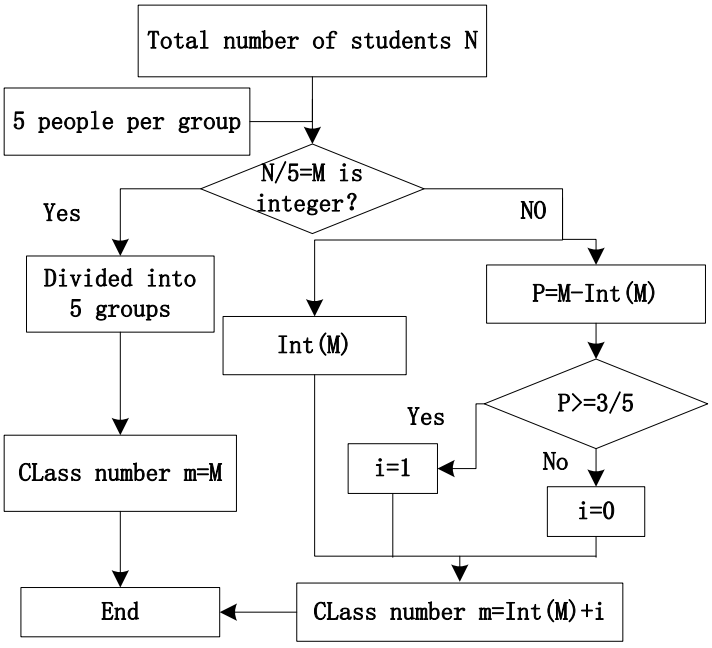

Fig. 1. Student grouping process.

From Fig. 1, the detailed procedures are presented as follows.

Step 1. The number of students choosing the tasted course is computed before the teacher are taking on class teaching. Students in the teaching class are grouped into different module. Each module has 5 students. Turn to Step 2.

Step 2. If the number of students is an integer multiple of 5, turn to Step 3, else, turn to Step 4.

Step 3. The number of modules is N/5=M=m. Turn to Step 9.

Step 4. The integer and fraction parts of N/5=M are extracted respectively. In detail, the integer and decimal can be shown as Int (M) and P=M-Int (M). Turn to Step 5.

Step 5. If the P is greater than or equal to 3/5, the rest of the students can be independent, turn to Step 6, else, turn to Step 7.

Step 6. Additional module number is 1. The number of modules is m=Int (M)+1. Turn to Step 8.

Step 7. The number of modules is m=M. Turn to Step 8.

Step 8. End of grouping process.

2.2 Project tracking strategy

In order to enhance teamwork and deepen professional knowledge in the teaching process, it is necessary to set up some practical courses according to the requirements of the course knowledge system. In detail, the practical project themes are set based on the professional course content and the project feasibility. Then students can design the implementation of the program and formulate specific construction process through a series of discussion and discussion assessment in their module. Teacher as a director is responsible for monitoring project progress and quality.

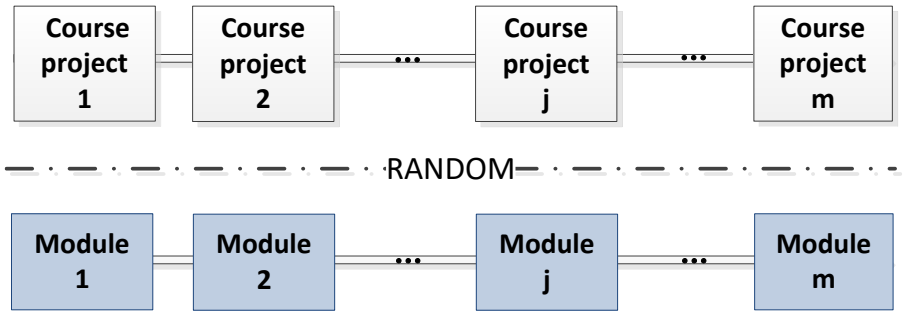

Fig. 2. Project setup and assignment.

In Fig. 2, the number of course projects is equal to the number of modules. These course projects are randomly assigned to each module group. Furthermore, each module's topic is different, but relevant. In the process of project implementation, the teamwork can improve the ability of course acceptance. In addition, each module needs to hand in a series of project material and results report.

2.3 Advanced classroom teaching

The advanced classroom teaching as a part of modular course teaching, mainly considers the classroom teaching and interaction. The method focuses on strengthening the interaction between module groups and students' subjective initiative. The advanced classroom teaching concept is shown as Fig. 3.

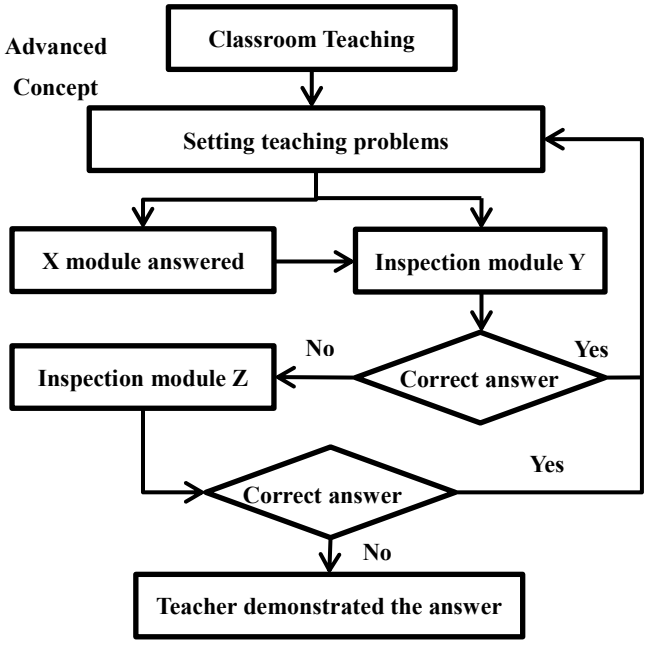

Fig. 3. Problem solving process.

According to Fig. 3, the process of advanced classroom teaching is presented as follows.

First, teacher should set a series of questions based on the professional demand. In class, a question is set to students and the module X is randomly selected to answer this question. Second, teacher may randomly choose the module Y to check the answer of the module X given. If the answer the module X given is right by the module Y proved, the class is continue, else, the module Z will be chose to check the answer of .the module Y. Similarly, if the answer the module Y given is right by the module Z proved, the class is continue, else, teacher will analyze the question and give the right answer.

3 Education practice

Take the course "Transportation planning and design" as an example, which is a compulsory course for undergraduate students of university. The basic information of course is shown in table 1.

Table 1. Basic information of course teaching.

Course title	Level	Period	Credit	Evaluation	Major
Transportation planning and design	undergraduate course	32	2	examination	Transportation

There are 46 students studying for "Transportation planning and design". According to the flow of module number determination, students are divided into 9 modules. In addition, there are 10 people in one module and 9 people in the other eight modules. The name of each module is given as Table 2.

Table 2. Name code.

Module name	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6	Module 7	Module 8	Module 9
Number	10 人	9 人	9 人	9 人	9 人	9 人	9 人	9 人	9 人
Name	Surprise	AK	Hulk	Fire	No.1	Secret	Cold	Alien	Wind

At the beginning of first lesson, teacher presented 10 projects interrelated (e.g. “Analysis on the current situation of enterprise transportation line planning”, “ Urban traffic distribution strategy in Yangpu district of Shanghai” ,“Transportation enterprise location” and “Traffic demand analysis for medium business district”). In addition, a representative of each module randomly selected a project title. The students of each module would work out project plans and task assignments based on a series of research, discussion and analysis using the time after class. The teacher explained the basic research directions of different project subjects, and reminds the project time nodes and materials to be submitted timely in class time. All students in each module finished the corresponding project by adopting the method of team division and collaboration. Before the fourth class, the teachers has evaluated the programs of each module and given some suggestions for modification. In the following courses, teacher kept following up the project progress and guiding the project progress. The project gradually realizes the transition from teacher's guidance to student's leading during the process of project research, in order to improving students' ability to learn actively and cooperate with each other.

Classroom teaching is an important step to increase the knowledge of technical knowledge and terminology for students. In this practice segment, the advanced classroom teaching approach proposed in this class was applied to make teaching in class more active and convenient. With the amount of questions, a simple question was selected to specifically illuminate.

There are four stages from the generation of traffic to the distribution of traffic flow. Forecasting the four stages is called the four stages forecasting method. The question was given as “Please list which four parts are included in the four-stage method” in class teaching. Based on the advanced classroom teaching method, module AK was selected to answer this question, and then module Fire was chose to check the answer. The results show that the module AK gives a right answer which has be proven by module Fire. In addition, teacher presents the related explanation.

4 Conclusions

Exploratory teaching model of college courses based on the module thought can effectively mobilize students' enthusiasm in class and their initiative in knowledge learning and exploration. It fully embodies the student-oriented teaching mode and realizes the teaching mode of both in-class and off-course teaching. In detail, teaching after class is based on relevant subject projects of the course, which can make the knowledge learned in class be applied, and also stimulate students' ability to explore knowledge. On the basis of modular grouping, the teaching in class is integrated with the advanced teaching idea, which can promote the cooperative work of the members in the module group. However, the application of this teaching mode requires that the teachers can fully master the curriculum knowledge system.

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The Central Limit Theorem in the Sociology Classroom: A Constructivist Approach

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Abstract

To undergraduate students of sociology, and who are required to take at least one course in research methods, understanding of the CLT requires the successful negotiation of a number of hurdles, lack of training in mathematics in general and mathematical statistics in particular, and a sociological aversion to the "bell curve" or normal distribution. This paper critiques the "sweetening" approaches to conduct experiments that construct the Central Limit Theorem in the classroom. It proceeds to outline a simple type of experiment based on a discrete rectangular population distribution, and offers a proof, understandable to sociology undergraduates, of how a discrete rectangular population distribution gives rise to a continuous sampling distribution.

1. Introduction

The Central Limit Theorem (CLT) is a fundamental theorem of mathematical statistics. It has the characteristic of fundamental theorems in other branches of mathematics in that it conveys a profound and partly surprising finding. While some statisticians point out that there are two fundamental theorems in mathematical statistics—the Law of Large Numbers (LLN) and the CLT—and refer to the CLT as the "second" fundamental theory of statistics (e.g. Grimstead and Snell 1997), they would not dispute the much more surprising result of the CLT compared to the LLN (Wicklin 2014). Indeed, the LLN says that large random samples reflect the population. This result is not all that unexpected. It is also often confused with the much more extensive result of the CLT, that in repeated large (simple) random samples taken from a population, the distribution of the sample mean is normal, with a mean equal to that of the population (μ) and a standard deviation equal to that of the population divided by the square root of the sample size. The most exhilarating part of the result is that this holds *regardless of the population distribution.* When we consider that the normal distribution is a continuous distribution, with the range of real numbers on the horizontal axis, while the population distribution may be very non-normal (e.g. a rectangular or uniform distribution), with only a few discrete values, this results is definitely not intuitively obvious.

For undergraduate students of sociology, and who are required to take at least one course in research methods, understanding of the CLT requires the successful negotiation of a number of hurdles, lack of training in mathematics in general and mathematical statistics in particular, and a sociological aversion to the "bell curve" or normal distribution. As a representation of actual populations, the normal distribution

has known its heyday. Notably, the famous Belgian statistician and sociologist Adolphe Quetelet (1796-1874) utilized it to compute deviations in human behavior and characteristics (see Landau and Lazarsfeld 1968). Today, the average sociology student is understandably weary of the use of the normal distribution in describing human traits as average or deviating from the average in a negative or positive direction, and the research methods professor's task partly involves re-introduction of the normal distribution as a vital one for quantitative data analysis. The larger task is to convey the "truth" of the CLT to sociology students without having to rely on the formal proof. While some form of experimentation is often used in "constructivist" approaches that constitute a relatively easy alternative to a formal proof, this method requires a leap from the classroom experiment to the situation where many more and larger samples are taken from the population. While this leap can be taken constructively by applying combinatorics, sociology students do not typically possess skills in this area.

During the 15 years I spent as an economics professor, I found it rather easy to introduce students to the Central Limit Theorem, by means of (1) a simple experiment of drawing chips or marbles of four colors from a closed container of a fixed total number of them, usually 100; (2) using combinatorics to demonstrate that the rudimentary normal-looking curve generated via our experiment becomes more "normal" as the number of samples increases indefinitely; and (3) relying on a statistical program—such as TSP—to simulate the sample selection of larger-size samples out of non-normal populations. I often relied on a section in my own textbook (Author 1989, pp. 257-261) to show the outcome of the second step and to formulate the Central Limit Theorem. For other situations than the CLT, such as confidence intervals, it is relatively easy to incorporate computer simulations in the classroom, and these are also covered in the literature, as exemplified by Dambolena (1986), Kennedy, Olinsky, and Schumacher (1990), Ng and Wong (1995), West and Ogden (1998), and Paret and Martz (2008). A review of the relevant literature is provided by Mills (2002). The CLT is not so straightforward to convey by simulation, since the computer simulation has to include a routine that selects random samples of a given size. When students can only see the end result of such random sample selection, they may not necessarily be convinced that the outcome is truly illustrating the theorem or concept at hand.

After joining the sociology group of a multidisciplinary department in 1997, I began to look for ways to explain the meaning of the CLT using essentially only the first of these three steps. At the same time, I noticed that professors teaching research methods to sociology students often "sweetened" the CLT by taking samples from a population of M&Ms, with the accompanying objective that the students can eat the experiment. Nearly two decades later, I remain convinced that M&Ms do not lend themselves well to such experiments, as explained in the next section.

2. Sweetening the CLT?

Let us start with the consideration that the majority of students would only want to eat M&Ms that only they have touched. That does not leave many options for a constructivist experiment. Suppose that we purchase a number of small packages of the popular candy, let each student open their bag and count the

number of reds out of the total. That result can then be compared with the number of reds that are in the population produced by the Mars Company, a number it is willing to share with the public. There are three problems with this experiment. The first problem is that we are making the implicit assumption that each bag constitutes a simple random sample of the total M&Ms produced. Since the bags are filled by a machine that distributes colored candies according to preset percentages for each color, this is not a valid assumption. The second problem is that we would not clearly be able to illustrate how the continuous normal distribution is associated with non-normal and discrete distributions. The third problem relates to the first, and that is that this experiment is more appropriate to construct the law of large numbers than the CLT, i.e. in repeated trials, the population frequency of any color of the M&Ms is approximated, as the mean of the means for the students' relative frequencies of "red" will reveal.

M&Ms can be used for experiments in the classroom, in experiments that require each candy bag to be examined by one student only, and only once (they do get sticky after a while, despite their hard shell). For example, one can test by means of a Chi-squared test whether the counts for each color per bag are the same. This is a fun exercise, and the candy does not get germ-covered or sticky in the process, culminating in an enjoyable snack in addition to increased understanding of the Chi-squared test. Paret and Martz (2008) provide a nice overview of ways in which statistics can be sweetened, using Minitab 16. Not surprisingly, the Central Limit Theorem is not one of the five tests reviewed in their paper. This does not mean that M&Ms cannot be used at all in a constructionist experiment to demonstrate the CLT. However, the M&Ms will (1) be touched by more than one student (yuck) and (2) become sticky before the experiment is concluded. Here are the steps of one such experiment: (1) open a number of small M&M bags, and empty them in a container that does not reveal the colors (There is no need to have a bag for each student); (2) count the number of each color represented by the M&Ms in the bowl; (3) give a numerical code to each color (e.g. red = 1, brown = 2, and so on); (3) construct the frequency distribution for this population and compute the population mean and variance; (4) let each student draw a given number of M&Ms at random, with replacement (here is where the stickiness comes in); (5) shake the container and move on to the next student; (6) let each student compute $\overline{X}$ using the numerical codes associated with each color[2]; (7) let students plot their own value of $\overline{X}$ in a graph on the blackboard, and voila. It is doubtful that students will want to eat any of the pieces of candy after the experiment is concluded. To be fair, such experiment can be conducted with candies wrapped in solid-color cellophane, which would allow step (8): divide the candies among the students and eat away.

3. A Useful Constructionist Approach

It is easier to do the experiment described at the end of the previous section if one uses a well-defined population that is non-normal. After all, while a normal population distribution also results in a normal sampling distribution, it is much more exhilarating for students (and their teachers) to begin with a very non-normal distribution. For CLT experiments, I keep a bag of 100 glass beads in my filing cabinet, with

[2] This part of the experiment is also a useful way to show how qualitative information such as a color can be given a numerical code.

equal numbers of each of the colors clear (white), yellow, blue and green.[3] The population is easily visualized and plotted, and its mean and standard deviation easily computed. In fact, this is a good review for students who have difficulty computing variances and standard deviations. We assign codes as follows: clear = 1, yellow = 2, blue = 3, and green = 4. The population mean μ equals 25 x (1 + 2 + 3 + 4) divided by 100, which yields 2.5. The variance and standard deviation are then computed as in the following familiar worksheet:[4]

X	**μ**	**X – μ**	**(X – μ) squared**
1	2.5	-1.5	2.25
2	2.5	-0.5	.25
3	2.5	0.5	.25
4	2.5	1.5	2.25

This is a good place to remind students that the sum of the absolute deviations (X – μ) will always be zero, so we square the deviations prior to computing the variance, which is the sum of the last column divided by 4, or 5/4 = 1.25. The standard deviation is √1.25 or 1.12, rather large, considering that the range of values is from 1 to 4, and the difference between the highest (or lowest) values and the mean is 1.5 in absolute value. The outcome that for the rectangular distribution the variance is identical to this difference is not to be expected for all rectangular distributions. The formula for the variance of a discrete uniform distribution is $(k^2 -1)/12$, where k = highest value – lowest value + 1 (in our case, 4 – 1 + 1 = is 4. 1/12 of k^2 -1 equals 1.25, which is the same as we computed in our little worksheet above.

The beads are placed in a dark-colored envelope or bag, which is mixed before each student draws the assigned number of beads in one grab, counts the beads, records the colors, and computes her $\overline{X}$ with the number codes. The results are recorded in tables, such as Tables 1-4 that are the outcome of four such experiments. We can easily see that the mean of the sampling distribution is very close to that of the population, and we can compute the standard deviation using SPSS or another computer or calculator, and see that it is indeed substantially smaller than that of the population. Plotting our results often yields a frequency distribution that indeed seems to approach a normal distribution. Let us not forget that the experiments presented in Tables 1-4 are based on very small samples. If n increases to the rule of thumb value for a large sample, 30, the results will be very striking indeed. However, such experiment would require the aid of a computer program.[5]

[3] I have used variants of this experiment since the 1980s (Bechtold and Johnson 1989), and do not make a claim to its originality.
[4] This provides an opportunity to review the fact that, if there are 25 beads of each color in this rectangular distribution, the variance and standard deviation can be computed as if there were only one of each color.
[5] This can be done with Minitab, for example.

TABLE 1

25 Simple Random Draws from a Rectangular Population of 100 Beads

(25 Each White, Yellow, Blue, and Green; Coded as W=1, Y=2, B=3, G=4)

n = 3

Draw	Colors	Numbers	$\overline{X}$	Draw	Colors	Numbers	$\overline{X}$
1	WBG	1 3 4	2.67	14	WWG	1 1 4	2
2	WBY	1 3 2	2	15	YYW	2 2 1	1.67
3	BBY	3 3 2	2.67	16	GGY	4 4 2	3.33
4	WBB	1 3 3	2.33	17	YGB	2 4 3	3
5	WWY	1 1 2	1.33	18	GGB	4 4 3	3.67
6	WGB	1 4 3	2.67	19	WYY	1 2 2	1.67
7	WGB	1 4 3	2.67	20	YGB	2 4 3	3
8	YGB	2 4 3	3	21	WWB	1 1 3	1.67
9	WYB	1 2 3	2	22	YYB	2 2 3	2.33
10	YYY	2 2 2	2	23	WGB	1 4 3	2.67
11	WGG	1 4 4	3	24	GGB	4 4 3	3.67
12	YGB	2 4 3	3	25	GBY	4 3 2	3
13	WWW	1 1 1	1				

μ_{Xbar} = 2.48 μ = 2.5

TABLE 2

25 Simple Random Draws from a Rectangular Population of 100 Beads

(25 Each White, Yellow, Blue, and Green, Coded as W=1, Y=2, B=3, G=4)

n = 4

Draw	Colors	Numbers	$\overline{X}$	Draw	Colors	Numbers	$\overline{X}$
1	BBYY	3 3 2 2	2.5	14	GBBB	4 3 3 3	3.25
2	GGGY	4 4 4 2	3.5	15	WWWG	1 1 1 4	1.75
3	WYGB	1 2 4 3	2.5	16	WYGG	1 2 4 4	2.75
4	GGGW	4 4 4 1	3.25	17	WYGG	1 2 4 4	2.75
5	WYGB	1 2 4 3	2.5	18	GGYB	4 4 2 3	3.25
6	WGGY	1 4 4 2	2.75	19	GGYB	4 4 2 3	3.25
7	WGGB	1 4 4 3	3	20	GGGW	4 4 4 1	3.25
8	BBBB	3 3 3 3	3	21	BBWW	3 3 1 1	2
9	GYBW	4 2 3 1	2.5	22	GGGB	4 4 4 3	3.75
10	WYBB	1 2 3 3	2.25	23	WYGB	1 2 4 3	2.5
11	WYBG	1 2 3 4	2.5	24	GGGY	4 4 4 2	3.5
12	WYGG	1 2 4 4	2.75	25	WWYY	1 1 2 2	1.5
13	WWYB	1 1 2 3	1.75				

$\mu_{Xbar} = 2.51$ $\mu = 2.5$

TABLE 3

25 Simple Random Draws) From a Rectangular Population of 100 Beads

(25 Each White, Yellow, Blue, and Green, Coded as W=1, Y=2, B=3, G=4)

n = 5

Draw	Colors	Numbers	$\overline{X}$	Draw	Colors	Numbers	$\overline{X}$
1	BBWWY	3 3 1 1 2	2	14	WWWBB	1 1 1 3 3	1.8
2	GWYBB	4 1 2 3 3	2.6	15	GBBYY	4 3 3 2 2	2.8
3	YYYYG	2 2 2 2 4	2.4	16	WWWBB	1 1 1 3 3	1.8
4	WWBBB	1 1 3 3 3	2.2	17	WWYBG	1 1 2 3 4	2.2
5	YBBBG	2 3 3 3 4	3	18	WYBBG	1 2 3 3 4	2.6
6	YYBBG	2 2 3 3 4	2.8	19	YYGGB	2 2 4 4 3	3
7	YYYGB	2 2 2 4 3	2.6	20	BBGGW	3 3 4 4 1	3
8	WBBGG	1 3 3 4 4	2.8	21	GGGBY	4 4 4 3 2	3.4
9	GGBYW	4 4 3 2 1	2.8	22	YYYGB	2 2 2 4 3	2.6
10	YYWGB	2 2 1 4 3	2.4	23	WWWBY	1 1 1 3 2	1.6
11	WWYYG	1 1 2 2 4	2	24	WGGGB	1 4 4 4 3	3.2
12	GYWWB	4 2 1 1 3	2.2	25	YBGGG	2 3 4 4 4	3.4
13	WYYYG	1 2 2 2 4	2.2				

$\mu_{Xbar} = 2.55$ $\mu = 2.5$

TABLE 4

25 Simple Random Draws) From a Rectangular Population of 100 Beads

(25 Each White, Yellow, Blue, and Green, Coded as W=1, Y=2, B=3, G=4)

n = 6

Draw	Colors	Numbers	$\overline{X}$	Draw	Colors	Numbers	$\overline{X}$
1	YYBBGG	2 2 3 3 4 4	3	14	WWYBBG	1 1 2 3 3 4	2.33
2	WWWBBB	1 1 1 3 3 3	2	15	WWBBBG	1 1 3 3 3 4	2.5
3	YYYBBG	2 2 2 3 3 4	2.67	16	YBBBGG	2 3 3 3 4 4	3.17
4	WYYGGB	1 2 2 4 4 3	2.67	17	WWWYYB	1 1 1 2 2 3	1.67
5	WWWYYB	1 1 1 2 2 3	1.67	18	WWYGGG	1 1 2 4 4 4	2.67
6	WYYYBG	1 2 2 2 3 4	2.33	19	WWWYBG	1 1 1 2 3 4	2
7	WWYYBG	1 1 2 2 3 4	2.17	20	WWYBBG	1 1 2 3 3 4	2.33
8	WWYBGG	1 1 2 3 4 4	2.5	21	WYBBGG	1 2 3 3 4 4	2.83
9	WYYBBG	1 2 2 3 3 4	2.33	22	YYBBGG	2 2 3 3 4 4	3

10	WYBGGG	1 2 3 4 4 4	3	23	WYYBBB	1 2 2 3 3 3	2.33
11	WWWYBB	1 1 1 2 3 3	1.3	24	WYYYBB	1 2 2 2 3 3	2.17
12	WYYBGG	1 2 2 3 4 4	2.67	25	WYYBBB	1 2 2 3 3 3	2.33
13	WYBBGG	1 2 3 3 4 4	2.83				

$\mu_{Xbar} = 2.49$ $\mu = 2.5$

4. The Standard Deviation of the Mean, or the Standard Error

While the experiment also clearly shows that the standard error of the mean is much smaller than the population standard deviation, students are not automatically convinced that it equals $\sigma/\sqrt{n}$. This part of the theorem can be demonstrated very straightforwardly, however. Many sociology students possess sufficient mathematical skills to understand that (1) the variance of a constant times a variable, or Var(CX) equals the square of the constant times the variance, or C^2 Var(X). Most also remember the quadratic formula from their high school years, so that it becomes clear that the X need to be independent (as in simple random samples) for the covariances to disappear. Accordingly, Var ($\overline{X}$) = $1/n^2$ Var ($X_1 + \ldots + X_n$) = n/n^2 Var (X), so that the standard deviation of the sample mean equals $\sigma/\sqrt{n}$. Most of the students in a sociology research methods class can derive this result.

5. Another and More Exciting Part of the Theorem

Our experiment outlined in Section 3 and illustrated by four actual classroom experiments presented in Tables 1-4 does not provide a clear way to show how the discrete population distribution gets transformed into a sampling distribution of the mean that is continuous. It is clear from the experiments, however, that increasingly large sample sizes yield an increasing number of possible values on the $\overline{X}$ axis. We can do better than this, however, and introduce an actual proof that is within the realm of understanding of the typical sociology student.

The method of mathematical proof by induction relies directly on the properties of natural numbers, which progress in a clear pattern 1, 2, 3, and so on. Proof by induction can be envisaged when something needs to be proved where a progression of the natural numbers plays a crucial role. Such is the case when we think about taking larger and larger samples out of a population. The sample size thus increases from the smallest possible size of 1 to 2, 3, 4, and going on to infinity. We need to convince students that, even though there are only four distinct (discrete) values on the horizontal axis for the population, an infinite number of values on the horizontal axis results for an infinitely large sample size.

It is certainly possible to construct part of this argument experimentally. Table 1 shows that when n = 3, we have values for $\overline{X}$ that include the original four values in the population, 1, 2, 3, and 4, and the

additional values of 1.33, 1.67, 2.33, 2.67, 3.33, and 3.67. While 6 new values are occupied on the X-axis, they are nicely spread out, with two new values between any given values in the population. Thus, a sample size of n = 3 has added n – 1 additional values between each population value. This finding carries over to the larger sample sizes in Tables 2-4. When n = 4, the values between the population values are now 1.25 (not all possible outcomes for the sample mean appear in the experiment shown in the table, but they are easily explained as possible outcomes for $\overline{X}$), 1.5, 1.75, 2.25, 2.5, 2.75, … , 3.25, 3.5, and 3.75. By now, students have also noticed how evenly spread these "in-between" $\overline{X}$ outcomes are in relation to the population values. It is easy to verify in a class experiment that n = 4 leads to n – 1 = 3 such in-between values, n = 5 leads to 4 in-between values, and n = 6 has 5 in-between values. For example, in this latter case, we have between 2 and 3 the five new values 2.17, 2.33, 2.5, 2.67, and 2.87.

The formal extension and proof that each addition to the sample size also adds one additional outcome for $\overline{X}$ is fairly straightforward. Any proof by induction has only two steps. The first is to demonstrate the result for the smallest value of the natural number involved, and the second (harder) is to show that the result holds for any two consecutive values of the natural number involved. If these two steps are demonstrated, the result holds for any value of the natural number. This proof is outlined below for the case of the 4-value discrete uniform distribution, with the incremental sample size following the progression of natural numbers, that is, a sample size of 1, or 2, or 3, or 30, or 5000, etc.

In the first step of the proof, we demonstrate that the result holds for n = 1. Indeed, when n = 1, only the outcomes 1, 2, 3, or 4 are possible, and zero additional values are possible for $\overline{X}$**.** This completes the first step.

In the second step, we pick a sample size n = k. The sample mean $\overline{X}$ is the sum of k natural numbers for our uniform discrete distribution. The smallest possible $\overline{X}$ occurs when each item picked is the white one, with a value of 1. So 1 occurs k times, and $\overline{X}$ = k (1)/k = 1. The next highest value for $\overline{X}$ occurs when all but one of the items picked is the white one (value of 1), and one is yellow (value of 2), so that we get $\overline{X}$ = (k – 1 + 2)/k = (k + 1)/k = 1 + 1/k. The next largest value is (k + 2)/k = 2 – 1/k, and so on, until we get the largest possible outcome of 2k/k = 2. Thus, gathering the results together, there are k – 1 new values for $\overline{X}$ between the values 1 and 2. Extending the same reasoning to the possible values between 2 and 3 again yields k – 1 new values, and the same goes for the values between 3 and 4. Since we have demonstrated the result for steps 1 and 2 of the proof, we have established the proof for the rectangular distribution. The proof can easily be extended to other types of discrete distributions.

6. Conclusion

The meaning of the Central Limit Theorem is notoriously difficult to convey to students who are not well versed in mathematical statistics, and undergraduate sociology students certain are among these. A well-designed experiment, however, can help students to "construct" the theory rather than to formally prove it. The portion of the theorem that implies that discrete population distributions nevertheless have sample distributions for the mean that approach a normal and therefore continuous distribution, can be understood by the constructivist approach of the classroom experiment, but students can learn to prove this part of the theorem with tools no more extensive than those obtained in the very basic mathematics competency program that exists in all universities.

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Virtual Standardized Patient

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Abstract

Background: Higher education nursing programs include a physical/health assessment course that prepares graduates to provide excellent care based on data collected through assessment. Finding a teaching strategy that engages students as well as educates them in health assessment techniques is a challenge that all nurse educators share.

Objectives: The objectives of this study were to determine the level of engagement and learning that occurred with undergraduate and graduate students who participated in a health assessment course that included the use of an online virtual standardized patient (VSP).

Design: Quantitative, descriptive survey research was utilized to determine student nurses' perception of the use of VSP in a physical assessment course.

Setting/Participants: Students in a traditional on-campus BSN program and students in an online RN to BSN and MSN program were included in this study.

Methods: After receiving IRB approval, course leaders provided students a standardized questionnaire of two (2) multiple choice and six (6) Likert-style questions. The questions evaluated the participants' ease of use, comparison of interaction between online virtual and live human patients, ability to perform an exam

on a virtual patient, and ability to communicate with a virtual patient. Questionnaires were administered to volunteers in the three identified health assessment courses (BSN, RN-BSN, and MSN). Also evaluated was the participant's perception of their ability to transfer knowledge from the VSP to the live patient. All students participated in the VSP with completion of the questionnaire optional.

Results: Findings in this study generally supported the educational value of using a virtual standardized patient in teaching both undergraduate and graduate students' health assessment. Variations between the groups were found.

Conclusion: Use of a virtual standardized patient is a positive teaching strategy for teaching health assessment in both undergraduate and graduate nursing programs.

Keywords: virtual standardized patient, survey research, health/physical assessment

Introduction

Use of technology in education is a global phenomenon. In no academic discipline is this more evident than in healthcare professional education. Use of high fidelity patient simulators (HFS) in clinical simulation experiences (CSE) has increasingly become recognized as an effective clinical teaching strategy for undergraduate and graduate health professional programs and interprofessional education in the United States of America (USA) and internationally (Cross, & Wilson, 2009; Kirkman, 2013; Warren, et al., 2016; Lockeman et al., 2017; Dennis et al., 2017; Cant & Cooper, 2017; Gilette, et al., 2017). One reason for use of HFS in CSE includes the ability of nursing clinical instructors to expose students to uncommon and infrequently encountered realistic clinical situations (Kirkman, 2013). Other issues addressed by HFS in CSE are the significant shortage of academically qualified nursing faculty to supervise actual clinical experiences and increased competition for use of relevant clinical facilities (Jenkins & Schaivone, 2007; Nardi & Gyurko, 2013; Byrne & Martin, 2014; Fang & Bednash, 2014).

Use of trained persons to act as standardized patients (SPs) is a lower technological teaching strategy that predates HFS and continues to be in use to the present (Jenkins & Schaivone, 2007; May, Park & Lee, 2009; Bolstad, et al., 2012; Lin, et al., 2013; Kowitlawakul, et al., 2015; Downar, et al., 2017). In this teaching strategy volunteers (paid or unpaid) or peers are trained to 'act' as a patient in a specific clinical situation (Jenkins & Schaivone, 2007; Lin, Chen, Chao & Chen, 2013). Use of SPs (especially peers) when teaching both undergraduate and graduate level health assessment is common (Jenkins & Schaivone, 2007). More recently, virtual simulated patients (VSP) technology, merging the concepts of HFS and SPs, is being used in the education of health professionals. Hubal, et al. (2000) describe VSP as "a computerized virtual person who interacts with medical practitioners in much the same way as actors hired to teach and evaluate patient assessment, diagnosis, and interviewing skills." Essentially VSP uses computer patient avatars to act as SPs. In 2012 an innovative VSP was created at the Innovation Hub at the University of Florida at Gainesville (Haselhurst, 2015). This virtual standardized patient was designed to be used in graduate and undergraduate health assessment courses. In fall 2015 our college of nursing incorporated this VSP in undergraduate (traditional and RN to BSN and graduate nursing (RN to MSN and MSN) health assessment courses. While the faculty responsible for these courses felt this addition had the

potential to increase engagement and learning, there was a dearth of research on this technology.

Literature Review

Although research on the VSP is sparse, the research that has been done indicates that students do report increased confidence, specifically when later taking a health history and performing a health assessment on a live patient (Bigelo, et al., 2014; Miskovsky & Miller, 2014; Mawhirter & Klainberg; 2014). Furthermore, faculty indicate that use of the VSP allows them to more effectively evaluate student learning (Kelley, 2015). Barnett, et. al. (2016), indicated that VSP was effective in increasing student self-confidence in medication documentation but demonstrated no benefits beyond that of paper case studies.

Other researchers have examined the effect VSP has on the development of clinical reasoning skills in nurses (Forsberg, et al., 2014; Forsberg, et al., 2016) and found that use of this technology is effective in developing clinical reasoning skills. Washburn, et al. (2016) found in a pilot study with social work students that VSP improved diagnostic accuracy and clinical interviewing skills. Botezatu, et al. (2010) found that VSP could be used confidently for medical student learning and evaluation as did Leung et al. (2015) in an anesthesia course. Finally, a study with pharmacy students in the US found that a combination of VPS and a pre-class video lecture (flipped classroom) was effective as an active learning strategy (Lichvar et al., 2016).

Purpose

The purpose of this study was to determine the level of engagement and learning that occurred with undergraduate and graduate students who participated in a health assessment course that included the use of a virtual standardized patient.

Methods

Design

Quantitative, descriptive survey research was utilized to determine student nurses' perception of the use of VSP in a physical assessment course. The independent variable identified was the use of a VSP and the dependent variable was the student responses.

Participants

For this study, participants were college level students enrolled in one of three classes: a pre-licensure traditional face-to-face baccalaureate of science in nursing (BSN) physical assessment course, online registered nurse-baccalaureate of science in nursing (RN-BSN) physical assessment course or online master of science in nursing (MSN) advanced physical assessment course. In each of these courses, a virtual standardized patient was used to supplement learning material. Participants' educational level varied based on the course level they were enrolled in, i.e., undergraduate versus graduate. Participants were recruited via email distributed through the learning management system by the respective course leader(s). The email included an electronic informed consent form. All enrolled students had the option to confidentially participate in a survey once informed consent was obtained. A total of sixty-one (61) students completed the survey.

Procedure

Prior to conducting the research and after Institutional Research Board approval, researchers discussed the study with individual course leaders. Once their approval to assist in the research was obtained, course leaders were provided a standardized email to send out to all enrolled students in the three identified physical assessment courses (BSN, RN-BSN, and MSN). The email initially explained the research study to the enrolled students and contained an electronic informed consent as well as a link to an confidential survey. If students agreed to participate, the survey provided consisted of two (2) multiple choice and six (6) Likert-style questions that could take up to five minutes to complete. An initial email was sent by course leaders mid-semester followed by a reminder email approximately two (2) weeks later. The survey was closed at the end of the physical assessment course (end of the semester).

Instrument

The eight (8) question survey included the following. One question determined the participant's course enrollment (multiple choice). Six Likert scale questions evaluated the participants ease of using the web-based program, interaction comparison between the virtual and live patient, ability to perform an exam on a virtual patient, and the ability to communicate with the virtual patient. Also evaluated was the participant's perception of their ability to transfer knowledge from the VSP to the live patient. One last question (multiple choice) evaluated the participant's preference in performing a head-to-toe physical assessment, on a VSP or a human.

Results

Eligible participants in this study included all traditional and online nursing students enrolled in a Health and Physical Assessment course, including 38 MSN students, 28 RN-BSN students, and 110 traditional BSN students. An overall survey response rate of 35% was achieved ($n = 61$), the final sample consisted of 11 RN-BSN students, 13 MSN students, and 37 traditional BSN students. The response rate for MSN students was 34%, RN-BSN students 39%, and traditional BSN students 34%.

When comparing the groups regarding the ease of navigation and ability to learn using the virtual clinical experiences software the results were similar, with 100% of MSN answering strongly agree or agree, 91% of RN-BSN answering strongly agree or agree, and 86% BSN students answering strongly agree or agree. Fewer MSN students (46%, n = 6) strongly agreed or agreed that the VSP was comparable to a live patient than those students in the RN-BSN (82%, n = 9) and BSN (73%, n = 27). Interestingly, a higher percentage of students enrolled in the traditional BSN program (92%; n = 34) felt confident in their ability to perform a head to toe physical examination on a live patient than those enrolled in the MSN program (84%; n = 11) and the RN-BSN program (73%; n = 8). Conversely, a higher percentage of MSN students (100%, n = 13) felt confident in their ability to perform a focused (systems) assessment on a live patient than those RN-BSN students (82%, n = 9) and BSN students (86%, n = 32). Regarding the ability to effectively communicate with the VSP, 62% (n = 8) of the MSN students answered strongly agree or agree, 91% (n = 10) of the RN-BSN students answered strongly agree or agree and 70% (n = 26) of the BSN students answered strongly agree or agree. When asked about the ability to transfer learning from the VSP assessment to a live patient assessment 92% (n = 12) of MSN students strongly agreed or agreed, 91%

(n = 10) of the RN-BSN students strongly agreed or agreed and 96% (n = 32) of the BSN students strongly agreed or agreed (Table 1). Lastly, students were asked if they preferred to demonstrate their assessment skills to their instructor on a live patient or a VSP. Forty-six percent of MSN students preferred a VSP, while 55% RN-BSN students and 19% BSN students preferred a VSP (Table 2).

Table 1 Student Responses to Survey Questions 2 – 8

	Strongly agree/Agree	Neither agree or disagree	Strongly disagree/ Disagree
Q1 – VSP Software is easy to navigate and learn.			
MSN	100%		
RN-BSN	91%	9%	
BSN	87%	5%	8%
Q2 - My interaction with the VSP is comparable to that of a real patient.			
MSN	46%	31%	23%
RN-BSN	82%	9%	9%
BSN	73%	8%	19%
Q3 – I am confident in my ability to perform a complete head-to-toe physical examination on a live patient.			
MSN	84%	8%	8%
RN-BSN	73%	18%	9%
BSN	92%	3%	5%
Q4 – I am confident in my ability to perform a focused (systems) physical assessment on a live patient.			
MSN	100%		
RN-BSN	82%	9%	9%
BSN	86%	14%	
Q5 – I am able to communicate effectively with the VSP.			
MSN	62%	15%	23%
RN-BSN	91%		9%
BSN	70%	16%	14%
Q6 – I am able to transfer what I am learning from assessing the digital standardized patient to my current clinical setting.			
MSN	92%		8%
RN-BSN	91%	9%	
BSN	86%	14%	

Table 2 Student preference for VSP versus Live Patient

	Virtual Standardized patient	Live Patient	Either
MSN	46% (n=6)	31% (n=4)	23% (n=3)

RN-BSN	55% (n=6)	18% (n=2)	27% (n=3)
BSN	19% (n=7)	41% (n=15)	41% (n=15)

Discussion

Overall this research supports the positive findings from several studies (Bigelo, Pardee, Kuzma, & Boucher, 2014; Miskovsky & Miller, 2014; Mawhirter & Klainberg; 2014; Kelley, 2015). Students' responses indicated that the VSP was easy to navigate and comparable to a live patient. Respondents indicated increased confidence in their ability to perform a head to toe physical examination and effectively communicate with a live patient. This was consistent with the findings from (Mawhirter & Klainberg; 2014; Kelley, 2015). Transfer of learning from the VSP to a live patient was reported to be good, consistent with Kirkman (2013). Finally, regarding the assessment of student learning a majority of students felt the VSP was comparable to the live patient assessment, however, although 73% of BSN students felt the VSP was comparable to the live patient, only 19% preferred assessment using the VSP versus a live person. The programs will continue to use online virtual standardized patients in physical assessment courses.

This study did not explore the role that VSP could have in the development of clinical reasoning and thus did not support the literature that examined this relationship (Forsberg, et al., 2014; Ying, et al., 2014; Forsberg, et al., 2016). This examination could be a very useful area of further research.

Conclusion

Based on the data, use of a virtual standardized patient has positive educational effects and is a positive teaching strategy for teaching health assessment in both undergraduate and graduate nursing programs.

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Gamification as a Concrete Strategy for Teaching in a Vocational Education Setting

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Abstract

This Gamification has emerged in the latest years as an alternative support and assistance for the process of learning. Our goal with this experience was to bring the concepts related to the concepts of gamification and game-based learning to provide motivation for students in basic computer learning. Through an exploratory research and the qualitative approach using the cartographic research method, we developed a specific workshop for students enrolled in a technical background course. The main results found in this study confirm the research carried out by Schlemmer [10], in which design-cognition concepts are used in teaching, in a context of configuration of Hybrid and Multimodal Living Spaces, from the perspective of Gamification.

Keywords: Gamification; Cyberculture; Education Professional; engagement

1. Introduction

The challenges that education has been suffering due to the great social changes, especially in a global and technological world with a view to the world of work, go through new forms in the process of learning of students who long for an education that is in harmony with their way of life and within its reality, in which it can give immediate answers, thus fulfilling its desires within this instantaneous and connected context.

The inclusion of subjects related to information technology in technical and technological courses at the Federal Institute of Education, Science and Technology, has become a necessary practice in the various areas of knowledge of this institution. But the simple inclusion of these curricular components does not guarantee by itself an effective learning of its students in the context of digital inclusion. In practice, these curricular components are offered in an instrumental format and this methodology does not provide an adequate motivation for learning.

In this sense, the objective of this work is to propose, from a practical workshop, a dynamics of learning based on gamification for a computer discipline of instrumental format of the technical course on Safety at Work of the Federal Institute of Education, Science and Technology of Rio Grande do Sul - Campus Porto Alegre, seeking to provide a playful and enjoyable learning in which the student can have a greater motivation in teaching digital technologies.

This paper is structured in this and five other sections. In the second one the theoretical reference is presented on the importance of gamification with teaching and learning method. It demonstrates the

importance of vocational training courses in Brazil and, finally, the research method used. The third section shows the problem that you want to investigate. Workshop descriptions and methodology are also presented in this section. In the fourth section the mechanics and dynamics of gamification are presented. In addition, final dialogues are presented on the experience of the participants. In the fifth section are presented the results of the workshop and, finally, the sixth section, where conclusions are made about the work done.

2. Theoretical Approach

Looking through the perspective of Cyberculture, people's lives are changing dramatically in their individual and social aspects. So, it's important to think how influential digital technologies are into the relation between us and other people and objects (increasingly smart). Lemos [6] refers to connections, people and network as "navigators in the network open seas, when distant from cities, must face three main challenges: the need of establishing a type of epistemology no longer systemic, but reticular and connective".

According to Schlemmer [12], biologists from 1920's were the pioneers of the systemic thinking for the human development by emphasizing the concept of living organisms as a whole integrated system. Piaget anticipated the importance of an interdisciplinary approach, based on the integration and relationship among the sciences in order to attain the overcoming of dichotomies that lead to compartmentalization and fragile theories with little power of explanation (Maraschin and Nevado, 1994).

For the systemic thinking, when the reality is perceived as a network of relationships, our descriptions don't rely on disconnected concepts, but on a network where the notions are interconnected. The criteria of the systemic thinking are all interdependent. Everything is seen as an interconnected web of relations, described by a system of concepts and models in which everything has the same importance and the identification of objects depends on the observer and the process of knowing.

Felice [3] highlights the need for a new understanding or rising of the concept of systemic epistemology represented by a set of interelated concepts which communicate each other into the same system in order to have a reticular and connective epistemology. Understanding this change is crucial to understand the new relational and communication processes. Lemos [6] says: "Humans communicate. So do things. And we communicate with things and they make us do things, whether we like or not".

This is the context we have in our contemporary society in which gamification is placed and managing these connections, relations and communications between the actants [6]. However, Hamari et al. [4] emphasizes that at the same time, the studies pointed to negative outcomes which need to be paid attention to, such as the effects of increased competition, task evaluation difficulties, and design features.

Finally, the gamification has been used, according to Shiralkar, Shreekant W [13], as motivational strategies in companies: "Business environments are rapidly changing, and information technology (IT) is at the core of such a change. Innovations in technology, along with completely new business models, are part of the rapid change that is forcing corporate and management professionals to learn, deploy, and adopt IT for survival and competitive advantage. IT is no longer just a back-office function, but a strategic business function as well."

The professional and technological education in Brazil gained a great impulse with regard to the expansion

in the offering of vacancies, since the institution of the law 11.892 of December 29, 2008 that gave rise to the Federal Institutes (IFs). In order to get an idea of the importance of the expansion of the Federal Network of Professional, Technical and Technological Education in the last years, from a historical retrospective, from 1909 to 2002 were built 140 technical schools in Brazil. Between 2003 and 2016, the Brazilian Government built more than 500 new technical schools, making a total of 644 campuses [1].

In recent years, professional training has become an important development factor in Brazil, especially after the creation of the Network of Federal Institutes, increasing the number of places in technical and technological courses. Pacheco [7] sums up the spirit of this technical formation: "Our central goal is not to form a professional for the market, but a citizen for the world of work - a citizen who could be as much a technician as a philosopher, a writer or everything that."

As a research development methodology we will make use of cartography. Cartography or cartographic method of intervention research is considered as a research-intervention method. The orientation of the researcher's work is not done in a prescriptive way, but every action has a direction. Kastrup [5] defines cartography as a method formulated by Gilles Deleuze and Félix Guattari [15] who intends to follow a process and not represent an object.

3. Indentifying and undestanding the problem

Nowadays we live in a society that experiences different kinds of virtual or digital technologies, for work, for relationships and for studying, among several other dimensions of our daily life. These technologies are present everywhere: when you turn on the TV or call a friend, when you go to a bank or even buy through internet. However, the school curriculum and methodology still don't reflect this dimension and still reflect a formal model and a traditional pedagogical proposal.

Domínguez et al. [2] define gamification as the use of the logic of the games and the elements that are present in games, such as mechanics and dynamics in a non-game context, which goal is to engage and motivate people as well as solve problems and promote learning. Hamari et al. [4] presents several concepts in which we highlight: "Gamification has been defined as process of enhancing services with (motivational) affordances in order to invoke gameful experiences and further behavioral outcomes" . Muntean [14] identifies that the level of engagement of the subject is preponderant for success in gamification.

Schlemmer [11] points out for the need of knowing and understanding the subjects of this context and for the existing gap between the generations that mediate the computational changing. On the one hand, we have people born under the rising of digital technologies and that use these almost as a physical extension of their body. On the other hand, in a former generation, people are still learning and acquiring a new language and its codes.

3.1 Empirical Field

Our goal with this section is show a general idea of the institution where the workshop was held. The Federal Institutes were created in 2008. Taking the Federal Centers of Technological Education and Federal Agricultural and Technical Schools as the focal points for a new proposal of Professional and Vocational Studies, the Ministry of Education rearranged these schools and promoted a great expansion in this field of

Education.

The Federal Institute of Rio Grande do Sul is located in Rio Grande do Sul in the South of Brazil and it has 17 campuses from the North to the South of the state. There are almost fifteen thousand students in regular programs. Campus Porto Alegre is one of its campuses and accounts for almost three thousand students in different levels and modalities, from qualification programs to master degree programs (Environmental, Chemical, Computing, Business and Work Safety). Porto Alegre is the capital of the state and the campus lies downtown.

3.2 The Program and the Students

The Work Safety Program is designed for students who have finished High School and want to specialize in this field of working or to get a better job or promotion. The curriculum of the program is varied and is designed to cope with different job positions in the market, being an employee or an entrepreneurial. One of the regular and mandatory course is Computing II, in which students are supposed to learn how to work with Excel.

The students, as said, finished High School and the class has a great range of age (young, middle-age and aged people). Other important issue about the class is its variety in terms of professional and cultural background. We can find people who are only students and trainees of the program, self-employed professionals, retail business workers and even retired people.

So, it's important to observe that this class had the typical gap between generations regarding the digital world. Beside this, the students face difficulties in getting the basic concepts of Excel, the main content of the course. In most cases, it's possible to identify the lack of interest for this course, either because it's not part of the central core of the program or even because the course is at night, when the students are naturally tired after a day of working (fatigue).

This way, the motivation of these students in the basic computer learning according to the presented context, is necessary so that they can appropriate the knowledge inherent in cyberculture.

3.3 The workshop

For this experiment we used the gamification concept. Following the different dimensions for gamification, we developed an educational practice which has the goal of instigate and engage students in specific learning, considering the perspective of m-learning and u-learning [9] in interactions that promote collaboration and cooperation between members of the group.

According to Saccol [9], u-learning corresponds to a broader concept than m-learning. U-learning corresponds to a third wave computing where several digital processing units are manipulated by a single person, ie individuals are always connected through these computational devices. And this third-wave computational structure transports us and enables us to use new pedagogical methodologies such as gamification. Therefore, the concept of u-learning transcends technology itself and makes us broaden its concepts, using logical knowledge of technology, in this case computer games, in areas of knowledge such as education, business, among others.

Although there are differences between the traditional games and the gamified systems, in the definition of

the latter, researchers and professionals have been based on formalized concepts of theoretical game design, such as the mechanics, dynamics and aesthetics (MDA). Mechanics are described as rules and the specific components of the game in terms of the actions players can take; Means the laws governing the actions of the players. Dynamics describes how rules manifest themselves during the game in realtime, according to players' system inputs as well as interactions between players. Aesthetics describes the results presented by the users when they interact with the gamified system.In this way, we use these concepts in our experience [8].

The problem posed for this workshop arose from the need to encourage the interest of students during the classes of Computing II – Excel and to enable students to experience the gamification in order to engage them, give them new possibilities of connexions and meanings regarding the Work Safety Program and the Computing II Course – using Excel as a tool.

The main issue of the class is related to the difficulty students have in understanding and relating the contents with real life tasks. They are not able to work with simple data sheets and basic operations in Excel. It's not unusual they ask two or three times for the same explanation about tasks. It means that either they don't understand or don't give meaning to the content, trying to learn it by heart or memorizing it step by step. They only realize that something is wrong when the memorized action doesn't lead them to the solution for the task. This behaviour could be related to the application of teaching traditional approaches to digital technologies learning which are based in empiricist epistemologies [9].

Our practice had the goal to engage students into the learning process and to make them understand the importance of the contents in their professional activities. It was really important that this process could take place in an environment of collaboration and cooperation and based in exchanging information and sharing experiences.

The gamification process involved elements from IT area (like Excel tools and techniques, use and management of QR-code apps for cell phones), from Work safety (basic knowledge) and also some dynamic work techniques that could put the students into the right pathway for reaching the goals of the workshop.

The Excel contents related to the workshop were extracted from the Computing II course curriculum, which were: formatting, formulas and functions, conditional formatting, IF condition, PROVC, validation, subtotals, graphics, auto-filter and protection. It was also mandatory that the students got the QR-Code app for cell phone and got familiar with it.

In our proposal we also wanted to reach some goals related to competence and abilities development. As important as these, we emphasize the desired competences for the workshop: understanding the proper use of Excel, identifying potential problems/issues for solution through Excel and solving everyday problems through Excel.

3.4 The methodology

Although gamification is not a game itself, it arises from the implicit way of thinking that is present in the games and its styles, strategies, mechanics, dynamics and aesthetics (MDA) [8] in a non-game context. According to Schlemmer [11], gamification in an educational setting consists basically in using the way of

thinking in games, the game styles and the elements of the games as a mean to engage subjects in solving problems. Muntean [14] also reinforces that motivation on the part of students is an essential factor for the success of gamification. Our goal is to have the learning subjects motivated, engaged in the process of the knowledge building through interactions between human actors and non-human actors. “The actor is the network and the network is the actor, both mediators into an association” [6].

Due to the time we had and the practical aspect of the workshop, we chose a set of mechanics and dynamics that started with a narrative and to which were linked the others M&D, such as: clues, puzzles, pathways, challenges and missions to push the students towards the solutions of the problems and obstacles and also the self organization into clans and guilds.

The workshop was developed in a computing lab of Campus Porto Alegre (IFRS). The students group themselves through negotiation and affinities. After this step, they were asked to solve a set of four missions, which led them to four challenges. These challenges were available in a Virtual Learning Environment called Moodle Platform (a free software with a system of online learning management used by educators for supporting their courses).

Each mission had the final goal of solving a challenge (find a password and solve a task). To reach this challenge, there was an intermediate step consisting in following a clue, i.e. each mission started with a clue. Understanding properly the clue, the students were guided to a specific place inside the campus where they could find a puzzle. They could solve the puzzle using the QR-code reader and then got a password. This password would lead them to the proper challenge. The Figure 1 below shows the guidance for the game. related to the workshop as they were presented to students:

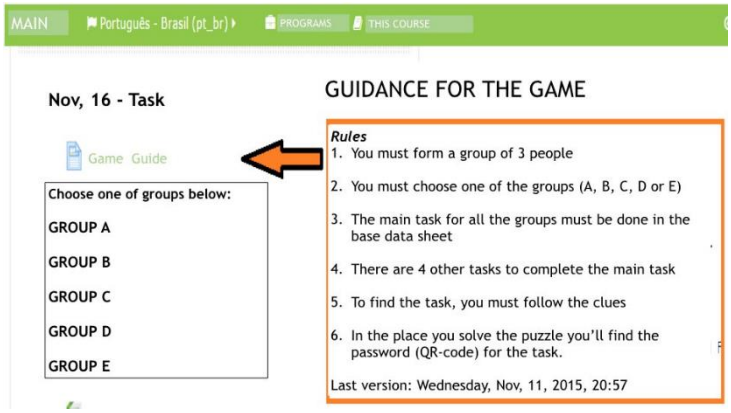

Figure 1: Guidance for the game (Mechanics)

Each group received four missions that had as objectives in the end the resolution of one task, each. Figure 2 shows the structure of these missions. Our intention was to have the groups solve at least three missions.

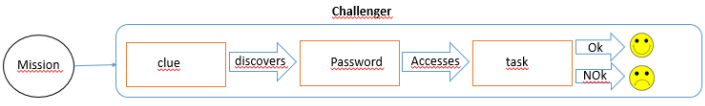

Figure 2: structure of these missions

In order to start the workshop and put the students into the context of the mission, we developed a narrative which was presented by the teacher at the beginning of the class. Below we can find a short version of this narrative:

Table 1: Narrative proposed to the students

Narrative structure	Presentation
Description of the general context	Some years ago, right after the invention of the computer system, three colleagues of the company SAFEJOB Inc. came to a conclusion that it was really tiring to perform some of the daily tasks they did always in the same way. They decided to use their knowledge to improve and ease their performance. The idea was to get more free time for talking, practicing sports, going to the movies as everybody did. In the end they got all day filling out forms and sheets by hand. They asked themselves if there wasn't any way to use the new technological machine that was coming to the market to improve the quality of the job they did. All they needed was to join their efforts and build a faster solution for the tasks. Do you want to understand how they did it and help them with your ideas?
Mission definition	So, you got a mission! First of all, you must form a group with two other colleagues and give this group a name. After that, get the QR-code app in your cell phone. THIS IS REALLY IMPORTANT TO HELP YOUR COLLEAGUES IN BUILDING A NEW TECHNOLOGICAL SOLUTION. You must use a base Excel sheet and start building a much better one from it. What do you think about it? Is it ok? Can we start? your challenge begins with searching for the password through the clues left by the campus. Once you've deciphered this clue from your safety knowledge at work, you'll find a password. With the password in hand you will discover your task that must be performed in the excel worksheet.

4. Pathways, experiences and sensations

As we have said before, we use the cartography as the research method and in this way, which are flexible and adaptable to the subjetcs' characteristics, culture and experience, take into consideration that the participants are curious and also that through colaboration and cooperation they can reach a good level of autonomy and authoring [9]. We can see below the relation between the mechanics, dynamics aesthetics used in this workshop:

Table 2: Relation between the mechanics and dynamics of this gamification workshop

Mechanics	Dynamics	Aesthetics
Students had autonomy for choosing the	From this choice, which was related to affinities or familiarity, they could	Students chose their groups based on

members of the group	enhance their personal relationships to have a better level of collaboration and also share their ideas and efforts.	affinities and friendships.
Each mission started with a clue. Without it students couldn't reach their specific challenge	Although it was related to IT tools, the gamification process needed the students' knowledge about Work Safety, their probable field of work, for solving the clues.	Even without knowledge of the technologies used, students used their life experiences to solve problems.
Gamification workshop was carried on both inside the computer lab (moodle) and the halls or the floors of the campus due to the need to solve the puzzles and follow the clues.	The groups used different strategies and showed distinct perceptions to solve similar problems. Some of them worked and solved their questions together. Others divided themselves by the expertise of each member. It could show them that there was not only one way to solve problems.	The answers varied according to the level of knowledge in technologies. Although everyone has solved the clues, each group solved in its time and according to its capacities.

The attentive recognition in the cartographic method [5] is constituted as the narrative writing itself of the attention of the researcher to the researched field. In this way, we can not close our eyes to pre-defined concepts and we must observe with greater attention and sensitivity what the students have provided. We registered it in a narrative form to give a better sense of what happened in class.Which were the true impressions left by gamification in this workshop? What couldn't we realize at some point in assessing the process of gamification? What was behind all this work? What was the meaning of this activity for students? We could have some hints or evidences. Below we report a dialogue promoted by the teacher at the end of the workshop with the whole class as a kind of assessment.

Table 3: Narrative based on the dialogue after the workshop, Inspired by the cartographic method.

After the workshop, the teacher talks to the students.
Teacher says: it's almost 10:15 p.m.
The students seem to be tired and worried about public transportation and safety in the bus stops.
A student with a hopeful face and smile asks the teacher: It's time. Can we go?
The teacher answers: yes. First he asks a question: what do you think happened in class today?
Preparing their materials to go home, the students stop and look at the teacher.
One of them asks: what do you mean, teacher? Are you talking about this competition?
Another student says: I think it was very cool, we had an interation that is not common in our regular classes.

The teacher asks again: ok, but to what this class looks like?
The student's answer is: oh, teacher, as a game, isn't it? It was funny, although I've been worried to solve the puzzles, because if I didn't do it, I would be in trouble (laughs).
The teacher asks: But did you like or not?
And the student answers: Yes... At first I didn't like it very much because we have to go around the campus, but after this I liked it.
Another student says: I liked so much that I took some coffee to the teacher (laughs).
The teacher asks again: Someone didn't like this activity?
A student that seems to be one of the oldest in class answers with an inconclusive face: I don't know much about Excel and I don't like to leave my comfort zone either. But I got what the teacher wanted with this activity: he wanted us to learn how solving the problems even they appear in an unexpected way. That's what I got, isn't it, teacher?
The teacher answers: My goal with this class is going to depend on what each of you understand, on your interests, on your knowledge and your culture, but above all, our goal must be to have your class worth it.
They talk for more than ten minutes and they forget they had to go home. With or without understanding what happened in class, it seems that everyone was touched by the Excel workshop in different ways.

5. Results obtained

In this section we will describe the results obtained at the end of the workshop. The ultimate goal was for groups to solve at least 3 of the 4 challenges. In this item, all groups had their goals achieved. Groups A, C and D solved 4 challenges and groups B and E solved 3 challenges only.

This result demonstrates that its components were engaged in the proposed activities. This is possible to be observed because these students did not show interest in activities carried out before the workshop. According to the professor of the course, students with more domain in the information technology area were in groups A and E. In general, prior knowledge of information technology was not dominant in the final result.

From a careful recognition [5], we observed the dynamics of the groups in which each component collaborated in what was understood as the most expert, evidencing a natural engagement of the components in the various groups, without demonstrating competitiveness. Collaboration and co-operation were important aspects during the workshop and they forged complicity even between members of different groups.

6. Conclusion

Quantitative and qualitative research may constitute cartographic practices, since they are proposed to follow processes. Cartography as a research method is the drawing of this plan of experience, following the effects (on the object, the researcher and the knowledge production) of the own Research. In this spirit it was held a practice in the classroom that had the goal of trying to understand the strategies of gamification

process in a real educational environment. Digital culture is a movement without a turning point. Their strategies, behaviors, connections, networks and related technologies are increasingly integrated into our society. In education, this movement is also a reality. Much more important than quantifying an experiment is tracking the process. [5].

In this context, we resolve to challenge in practice the concepts involving gamification, through a workshop. The answers are far more comprehensive than we can imagine. Gamification is a process where the focus is on the connections between the objects that are involved here. The artifacts used by the students are also part of the game and its end result will raise a new learning awareness for its participants, both teachers and students.

After this, we can say that there isn't a right or wrong path, or approaches, or tools that could be included or disposable. The pathway is open and the challenge of choosing a new knowledge building process involves some fear, distress and frustration because it's the new, the unknown. By the other hand, we hope and we are willing that using new strategies in class could be a different and joyful experience for us and for students, besides its own quantitative results.

It's also important for all the teachers to know that we have to face the challenge of integrating digital tools to these new generations that are arriving to school. Otherwise, the education as a system could just stand like it is today: a way to reproduce knowledge with no connections to the real life.

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Strategic Change Management and Performance of Non-Governmental Organizations in Mandera County, Kenya

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ABSTRACT

Organizational change is seen as any observation that is empirical in nature within a firm of any variations in form of quality, shape and state over time as a result of deliberate introduction of new acting, operating as well as the thinking. The general objective of this study was to establish the influence of strategic change management on NGO`s performance in Mandera County. The purpose of this study was to establish how organization structure influences on NGO`s performance in Mandera County, to examine the effect of leadership on NGO`s performance in Mandera County, finding the impact of organizational structure on NGO`s performance in Mandera County and to determine the effect of environment on NGO`s performance in Mandera County. The study design was a descriptive survey. The study targeted by the study was 215 people from two category groups' thus county government employees and NGOs in Mandera County. The sample size for this study was 129 chosen randomly from the two groups which are 60% of the target population. Primary data was used exclusively in this research. Data collected in this study was analysed qualitatively and quantitatively. Before analysis, qualitative data was put together in terms of similar themes and presentation was done using graphs, charts and frequency distribution tables. In order to arrive at inferences content, analysis was used in a systematic and objective way to bring together message sought. On the other hand data collected quantitatively was analyzed by the use of correlations, descriptive statistics and linear regression analysis with the support of STATA software package used in social research. The output was presented on figures and tables. The study found a strong correlation coefficient between NGOs performance and organizational culture. There exists a significant positive relationship between leadership and NGOs performance in Mandera County. There was a positive correlation coefficient between NGOs performance in Mandera County and organization structure. There was a positive correlation between employee participation and NGOs performance in Mandera County. The study concludes that all dimensions of organization culture namely teamwork; communication, reward and recognition as well as training and development are important determinants of performance. Organizational culture is an important internal environmental aspect that can lead an organization either to succeed or fail. The study concludes organizational structures address the organization of work activities, including both personnel and production systems. That the absence of quality leadership in an organizational setting negatively affect performance and this leads to stagnation in organizational operations leading to missed organizational objectives. Employee participation not only

get the involvement of employees but enhances the feeling that they matter in their opinion while at the same time provide valuable information required by the managers to make better and informed decisions in regards to implementing change. The study recommends further studies on effect of strategic change management on performance of public organization as well as profit making organizations so as to be able to compare the results.

Keywords: Organizational Structure, Employee Participation, Organizational Culture

1.0 Introduction

The management of strategic change is seen as one of the main concerns in modern businesses both in practice and theory. Owing to changes in economic and technological advances in the past decade there has been a new dynamism covering important aspects of business operations leading to a new body of thoughts in the development of strategic change. These relates to how businesses should redirect their activities from out-moded ways so as to cope with changes on global markets, technological advancements as well as international competition that's why management of strategic change comes into play (Burnes, 2004). Organizations are formed to pursue a given purpose for which they align themselves to achieve during their life. Continuous evaluation of internal processes and the external environment is crucial to survival in the ever turbulent environment. To succeed, in achieving their goals, organizations need to formulate and implement strategies through management of strategic change (Koigi, 2002).

Change management in strategy value has over time been seen as not only a cognitive firm reorientation but also a shift in processes and structures (Demarie & Mullane, 2004) which touches on a redefinition of a firm`s purpose, mission or shifting on goals and priorities. The success of strategic change management is attributed to not only the ability of the firm to come up with and implement new structures or process but also the ability of the firm to pass its new mission and goals to its stakeholders.

The improvement of performance has become ever more critical to NGOs leave alone the considerable amount of attention and research by various people in the past two decades. As pointed out by Smyth (2010) many countries have seen various ranges of initiatives in the past 10 to 15 years seeking the introduction of strategic change management in order to improve performance of NGOs. The performance of an organization is dependent upon its capability to adjust to changes in its environment and the expctation its customers. The demands of the government, stakeholders and the institutions employees change continuously depending on the changes in their operating environment and consequently, there is need for the organization to align its operations to the changes in order to improve its performance (Hodge & Johnson, 2007).

Non-governmental organizations in Mandera County are facing serious challenges in enhancing their performance through strategic change management occasioned by among others irregular occurances that impact on an individual organization circumstance, fast spread of new technology, leadership shifts, outside

border initiatives, services and products that are new causing unpredictable issues among the NGOs operating in the slum. In addition to these it is necessary to look into many interests relating to stakeholder than before, increasing global presence, information overload, not having the necessary information on how results and actions relating to day to day activities of managers working in an environment that is not conducive is the common issue among NGOs which is affecting their performance (Ali, 2012).

1.1 Motivations for Research

Several strategic change management factors have been adopted by firms seeking to improve on their performance. Among these practices are powerful management teams with a strong visionary leadership from the top, a well-motivated, skilled, committed and flexible employees as well as optimal organizational structure. This is addition to a clearly defined mission, objectives and vision, and a sound base financially (Armstrong, 2006). Despite this NGOs in Mandera have been performing poorly in regards to achieving their objectives. Various studies have been carried out on this topic for example Ali, (2011) carried out a study on the what influences sustainable funding of NGOs in Kenya and found out that management is core among them, Weerawardena, (2008) in his study sought to establish reasons why organizations leverage their competitive advantage leading to superior performance financially and ensure organizational survival and growth and Koigi (2002) argues in his study that to succeed, in achieving their goals, organizations need to formulate and implement strategies through strategic change management.

While the above studies have touched on strategic change management practices; still there is quite a gap among profit making enterprises and non-profit making organizations in the sense that the desire for excellence is not reflected in a similar emphasis in investment of resources and significance in as much as there is threats to continuance of the firm and increased vulnerability. Thus, this study set out to fill the knowledge gap. The question answered was what is the how strategic change management influences on the performance of NGOs in Mandera County, Kenya?

This study focused on the broad objective of establishing the effect of strategic change management on performance of NGOs in Mandera County.

2.0 LITERATURE REVIEW

2.1 Theoretical Review

The theoretical underpinnings for this study are grounded in Kotter`s theory. Kotter in (1996) proposed the Kotter`s theory which is considered in organizational change vision so as to transform how the organization operates. This model is best used at the strategic level of a firm. According to the users of this model the process of chance passes through many different stages which go on for sometime and have an influence on the failure or success of change in the organization.The theory proposes eight steps approach to change management. According to this model people prefer status-quo and that change means uncertainty in relation to the future. In most cases people do not trust things which are uncertain leading to them avoid change. For organizations to encourage employees to assist in change they need to create urgency in

change itself (Davis, 2002). This stage is considered to be the same as when a person is going for drug treatment to intervene on some sickness. Organizations can intervene by putting resistance using powerful managerial coalitions to work with those likely to resist change (Kotter, 1998). It is always much simpler to get things working out according to plan with a clear cut plan being in place than working with a clear plan to be followed.

2.2 Organization Culture and Performance

Roos and Eeden (2010) argued in their study that corprate culture affects on how workers behave as much as they feel and think about the organization. According to James and Glission (20020 and Martins and Manetje (2009) are of the opinion that organizational culture provides the guide on the experiences of employees and explains why it is important for organizations to seek to influence how well individuals are in the organization, behaviour and attitudes. La Grange and Geldenhuys (2008) found out that it's important for institutions to implement changes in organizational culture corresponding to their strategies and adapting to changing circumstance.

According to Manetje and Martins (2009) changes in business world are constant and that are the major implication of how organizations are able to function and these affects organizational commitment and culture. Similarly, Pool (2000) argues that culture in an organization has a significant role to play in relation to organizational change. Weeks (2010) maintains that strategies of organizations are likely to fail if the firms face challenges in realigning continuous changes to management responses while at the same time reengineering efforts will lack clarity and fail.

La Grange and Geldenhuys (2008) states that since culture is an important aspect for organizational uniqueness, therefore if it cannot be strongly defined and managed effectively creating alliances will result in more problems. Munck (2001) found out that one of the most fundamental challenges facing organizations is changing their organizational culture owing to the fact that employees are naturally inclined to put in place onto anything well known even with best options existing.

According to Schein (1992) organizational culture is defined as essential assumptions of a pattern that has been invented or discovered by a group so as to be able to cope with problems that relate to internal integration as well as external adaptation having worked to the satisfaction of the inventors and seen to be valid. This is then taught to to new individuals as the best way of perception, thought and how one feels in regards to challenges faced. Organizational culture in most cases is influenced by organizational leaders who are key. This has over time emerged as one of the most pivotal activity in determining how successful the implementation of change is carried out in an organization.

In regards to the key features of successful firms Peters and Waterman (1982) were of the opinion that culture which involves the states of the mind and the values of the organization. These shared values play an important role which is persistent and can be in place even when the group membership has changed.

Since organizational culture involves both formal and formal structural components it is seen as the most difficult and important dimension of change management. Organizational cultures are not static or uniform and over time they evolve thus all the cultural systems exhibit changes that are continuous that are punctuated on occasion with more obvious changes that are also radical (Weick & Quinn, 1999).

Mumford, Scott, Gaddis and Strange (2002) in their study opinioned that organizational culture is a representation of collective social construction that leaders of organizations have control which is substantial. This is viewed widely as a competitive advantage source to firms. Amabile (1998) argued that the nature of leaders can influence organizational through how their attitudes are to motivation and work of members. However, one of the major challenges that the leaders are faced by is selecting the action set that is realistic in regards to the firms` capability to absorb any changes. Therefore, getting to a decision where an organization is able to get to the better culture change which must also be seen as the act of balancing in organizations.

Belias and Koustelios (2013) carried out a study on among the Greek banking firms on organizational culture. In their study it was established that the leading firms' culture in firms is seen to be hierarchical but employees prefer the clan type. Aycan, Kanungo and Sinha (1999) argue that the culture of a firm is an important aspect for the internal environmental which can either lead to organizational success or failure. From evidence it is clear culture dictates the the inside operating environment of the firm and shows the degree to which employees and managers assumptions are in agreement. Furthermore, understanding organizational culture assists in the identification of the beliefs of workers as well as the structure that is beneficial in relation to how leadership is implemented.

2.3 Performance of NGOs

According to Armstrong and Baron (2006) performance in an organization should always consider the inputs, analyzing the behaviors, and the outputs, focusing on the results. An organization performs once it covers the competency levels and achievements as well as accomplishes the objectives of the organization strategy. However, the factors that affect performance, the processes for managing performance, and how performance is measured will vary according to each author and special depending on each organization (Bruijin, 2002). NGOs performance is described as an organization's ability to acquire and utilize its scarce resources and valuables as expeditiously as possible in the pursuit of its operations goals (Griffins, 2006).

3.0 METHODOLOGY

The current study used the cross sectional research design. This study targeted 215 people from two category groups' thus county government employees overseeing performance of NGOs and NGOs in Mandera County. The study sought to sample 129 chosen randomly from the two groups which was 60% of the target population. Primary sources of data were exclusively used in the study. Questionnaires were the sources of primary data formulated to target people in charge of target groups. Analysis of data was done both quantitatively and qualitatively. Common themes of qualitative data was put together and

presented through graphs, charts and frequency distribution tables. In addition the identification of objectives and inferences were carried out through content analysis. The quantitative information gathered was analyzed through linear regression analaysis, correlations and descriptive statistics achieved by the use of SPSS version 22.0 software package. The data analaysis was necessary in answering the research questions sought by the researcher.The findings interpretation was done through presenting a synopsis of the results followed by an explanation of key findings. Presentatation of results was in form of figures and tables.

4.0 RESULTS AND DISCUSSIONS

4.1 Inferential Statistics

The focus of hypothesis one was to determine the relationship between organizational cultures on NGOs performance. It was hypothesised that organizational culture has a positive effect on NGOs performance. This hypothesis was tested using Pearson's Moment Correlation as shown in the tables 1.

Table 1 The effect of Organizational Culture on NGOs Performance

Variable		NGOs Performance	Organizational Culture
NGOS	Pearson Correlation	1	.598
Performance	Sig. (1-tailed)		.046
	N	94	94
Organizational	Pearson Correlation	.598	1
culture	Sig. (1-tailed)	.046	
	N	94	94

The study found a strong correlation coefficient between NGOs performance and organizational culture as shown by correlation factor of 0.598. This strong relationship was found to be statistically significant as the significant value was 0.046 which is less than 0.05.

The aim of hypothesis two was to establish the relationship between leadership and NGOs performance in Mandera County. To test the second hypothesis, the index of NGOs performance as index of dependent variable was correlated upon leadership a composite of independent variable using Pearson's Moment Correlation as shown in table 2.

Table 2 The effect of Leadership on NGOs Performance

Variable		NGOs Performance	Leadership
NGOs	Pearson Correlation	1	.843
Performance	Sig. (2-tailed)		.016
	N	94	94
Leadership	Pearson Correlation	.843	1
	Sig. (2-tailed)	.016	

The findings show that there was a strong positive correlation coefficient between NGOs performance in Mandera County and leadership as shown by correlation factor of 0.843. The P- value was 0.016 which is less than 0.05.

To test the third hypothesis Karl Pearson's Moment Correlation was used with NGOs performance being the dependent variable while organization structure was the independent variable as shown in table 3.

Table 3 The effect of Organizational Structure on NGOs Performance

Variable		NGO Performance	Organization Structure
NGOs Performance	Pearson Correlation	1	.802
	Sig. (1-tailed)		001
	N	94	94
Organization Structure	Pearson Correlation	.802	1
	Sig. (1-tailed)	.001	
	N	94	94

There was a positive correlation coefficient between NGOs performance in Mandera County and organization structure as shown by correlation factor of 0.802. This relationship was found to be statistically significant as the probability value was 0.001 which is less than 0.05.

It was then hypothesized that employee participation had a positive significant effect on NGOs performance in Mandera County. The hypothesis was tested using Pearson's moment correlation as shown in Table 4..

Table 4 The effect of Employee Participation on NGOs Performance

Variable		NGOs Performance	Employee Participation
NGOs Performance	Pearson Correlation	1	.722
	Sig. (2-tailed)		.008
	N	94	94
Employee Participation	Pearson Correlation	.722	1
	Sig. (2-tailed)	.008	
	N	94	94

The results indicate that there was a positive correlation (0.722) between employee participation and NGOs performance in Mandera County. The p-value was 0.008 and thus, less than the alpha level of 0.05 hence establishing a positive significant relationship between these variables.

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The study tested the significance of the model by use of ANOVA technique. The findings are tabulated in Table 5.

Table 5 ANOVA Results

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	8.552	4	2.138	5.717	.000[b]
	Residual	65.45	86	0.374		
	Total	74.002	93			

From the ANOVA statics, the regression model was found to be valid ($F = 5.717$, $P < 0.05$). This implies that the variables organizational culture, leadership, organization structure and employee participation are good predictors of NGOs performance in Mandera County.

In addition, the study used the coefficient table to determine the study model. The findings are presented in the Table 6.

Table 6 Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	0.176	0.067		2.627	.0121
Organizational Culture	0.571	0.166	0.532	3.442	.0013
Leadership	0.817	0.238	0.767	3.431	.0014
Organization Structure	0.782	0.301	0.694	2.590	.0032
Employee Participation	0.674	0.202	0.613	3.337	.0018

As per the SPSS generated output as presented in table above, the equation becomes:

$Y= 0.176+ 0.571X_1+ 0.817X_2 + 0.782X_3+ 0.674X_4$

From the regression model obtained above, a unit change in organizational culture holding the other factors constant would positively change NGOs performance in Mandera County by a factor of 0.571. These findings are in tandem with those of Martins and Manetje (2009) who were of the opinion that organizational culture provides the guide on the experiences of employees and explains why it is important for organizations to seek to influence how well individuals are in the organization, behaviour and attitudes. A unit change in leadership while holding the other factors constant would positively change NGOs performance in Mandera County by a factor of 0.817. These findings are in agreement with those of Mosia (2004) who argues that for the formulation and the implementation of change strategies to be

effective leadership must play a vital role since it is seen as a link relating to the process of strategic management process with the organization and its vision and objectives.

In current study a unit change in organization structure while holding the other factors constant would positively change NGOs performance in Mandera County by a factor of 0.782. These findings agree with the findings of Schwarz and Shulman (2007) who emphasized that structures in firms need to be the merchandise of not only of demands coordinated and imposed by advances in technologies that are complex but also through norms that are rationalized that are able to legitimize the adoption of appropriate structural models. A unit change in employee participation while holding the other factors constant would positively change NGOs performance in Mandera County by a factor of 0.674. These results agree with those of Lines (2004) states that employee participation not only getting the involvement of employees but enhances the feeling that they matter in their opinion while at the same time providing valuable information required by the managers to make better and informed decisions in regards to implementing a change.

5.0 POLICY IMPLICATION

All dimensions of organization culture namely teamwork; communication, reward and recognition, and training and development are important determinants of performance. The study concludes that absence of quality leadership in an organizational setting negatively affect performance and this leads to stagnation in organizational operations leading to missed organizational objectives. In order to effectively measure organizational performance; organizations need to be performed and delivered under certain constraints. The bottom focus for any organization is its structure, processes and systems. Employee participation not only gets the involvement of employees but enhances the feeling that they matter in their opinion while at the same time providing valuable information required by the managers to make better and informed decisions in regards to implementing a change.

The study recommends that since culture is an important aspect for organizational uniqueness and organization performance, therefore must be strongly defined and managed effectively creating since alliances will result in more problems. Organizations need to focus more on how to embrace the best culture. The study recommends that organization must be aware that leadership is essentially the core and spirit of organizations as it directs all other organizational resources towards the attainment of organizational objectives and more specifically performance. The study recommends that organizations should improve integration of its complex systems: organizational structure, management system processes, financial management systems and the human management system by providing models and methods to align meaning and propensities at the individual, team, leader and organizational levels to create resilient and sustainable organizations leading to their performance. Finally, the study recommends organizations need to ensure that their employees are participating actively in roles where they gain a lot of information regarding discrepancy and efficacy, being able to effectively build confidence through enactive mastery as well as employees being provide with a vicarious learning experience so as to be able to develop own confidence through carrying out new task successfully.

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International Sojourning in the U.S.: Perceptions from Children of a Visiting Scholar

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Abstract

The experiences of visiting university faculty have been documented in the literature, yet, there appears to be a dearth of studies concerning the impact of sojourning abroad on children of visiting scholars who join a parent for an extended visit to a host country. This article will present a case study that qualitatively examined the perceptions, expectations and reflections of two young Koreans who accompanied their father during his 10-month sabbatical at a large, public university in the South East United States. Specifically, data collected by the researchers through a series of interviews investigated socio-cultural and situational experiences and challenges reported by the participants who were living in a host country. The results of this study suggest that in order to have a successful international sojourn experience, prior to their departure, both visiting scholars and their accompanying family members should have a certain level of cultural competence and linguistic proficiency of the language of the host country, and be open to new life experiences and challenges that they will encounter abroad.

Keywords: visiting scholar, socio-cultural adjustment, acculturalization, situational challenges

1.0 Introduction

1.1 Visiting International Scholars

Although each U.S. institution of higher learning has its own particular definition of a *visiting scholar*, as does the literature (Bould et al., 2015; Sikes, 2006), for the purpose of this paper, this term will refer to a post-secondary scholar-professor from another university who is on paid-leave from his/her home institution who is engaged in an advanced research agenda that will be conducted at the host university. Whereby there are over 800 visiting scholars from 155 countries who receive Fulbright Scholar Grants (Fulbright, n.d.) to conduct advanced research at their host institutions, many U.S. universities and colleges sponsor international scholars who are funded either by their own governmental agencies and/or by their home institutions. Additionally, "Most visiting scholars bring their families to the host country" (Li & Chen, 2017, p. 39) as did the scholar in the present study.

1.2 Purpose of the Study

The purpose of this research study was to examine the personal experiences of a South Korean visiting scholar's children and their perceptions of their new lives as they attempted to adjust to the challenges they encountered in their new American environment during a 10-month sojourn in the U.S.

1.3 Research Questions

In order to examine the two South Korean children's perceptions as they adjusted to their new lives in the United States over an extended period of time abroad, the following research questions were used to guide the present study:

1. What were the sojourners' initial expectations for and perceptions of living in the U.S.?
2. What were their situational perceptions as newcomers to the U.S. during their sojourn?
3. What were their specific challenges as they attempted to acculturate to the host country?

2.0 Review of Relevant Literature

Sojourners to a host country are separated from their own familiar way of life, culture, language, family, friends and personal support networks. As such, they will need to negotiate particular challenges and learn how to adjust to an entirely new life abroad.

2.1 Cultural Adjustment Theories

As newcomers (i.e., "foreign-born students and their families who have arrived in the United States," U.S. DOE, 2017, p. 8) enter into a new culture, they will need to deal with various issues including proficiency in the new host country's language, and reconciling their own personal, social and even ethnic values with those of their new country (Finch, Kolody, & Vega, 2000; Romero & Roberts, 2003). Being members from one culture, they must learn to adapt or *acculturate* to the culture of the members of their new host country (Burnam, et al., 1987).

There is a variety of theories that describe the types and stages attributed to the inter-cultural adjustment process of sojourners (Berry, 1997; Giordano & Giordano, 1976; Goldlust & Richmond, 1974; Hoffman, Dana, & Bolton, 1985; Knight & Kagan, 1977; Mendoza & Martinez, 1981; Olmedo, 1979; Rosenthal & Hrynevich, 1985).

During the process of cultural adjustment, the majority of visitors to another country experience what is called *culture shock* (Barker, 1990; Pederson, 1995). This is "the trauma you experience when you move into a culture different from your home culture" (Chaney & Martin, 2000, p. 62) and "can be characterized by periods of frustration, adjustment, and even depression" (Swallow, 2010, p.1) in addition to feelings of elation, excitement and stimulation.

2.11 Swallow's (2010) Five Stages of Culture Shock

Whereby other researchers have identified different stages of the phenomenon known as cultural shock, Swallow (2010), who adapted her own paradigm based on from Barker's 1990 model, offers a five-stage process, consisting of the following.

- the *honeymoon stage* (feeling of euphoria and exhilaration for the new culture and environment);

- the *distress stage* (characterized by confusion with the new culture and isolation from the culture of the origin-country);
- the *reintegration stage* (sojourners begin to reject aspects of the host country's culture and consider it as inferior and inadequate compared with their own culture);
- the *autonomy stage* (also called the *emergence* stage, during which the visitors start to accept and appreciate the new host culture and its differences and begin to feel more confident and able to cope with issues that may occur); and lastly,
- the *independent stage* (when the sojourners "embrace the new culture and see everything in a new, yet realistic light,…."feel comfortable, confident,…and no longer feel alone and isolated" (Swallow, 2010).

2.2 Acculturating to a Host Country

"Student sojourners frequently face significant difficulties transitioning to the host culture, particularly at the initial stages of the sojourn" (Goldstein & Keller, 2015, pp. 187-188) as cited in Brown and Holloway (2008). Consequently, their social and academic success may be negatively impacted (Ward, Bochner, & Furnham, 2001) until which time they learn to acculturate to their non-origin country. Berry (1977) developed an acculturalization model which addressed specific attitudes and behaviors associated with specific coping strategies,

> …based on the negotiation of two underlying issues: a) *cultural maintenance*: the extent to which acculturating individuals and groups identify themselves with the host culture as opposed [to] their origin culture; b) *cultural contact:* the extent to which acculturating individuals and groups wish to involve in the host culture as opposed to their origin culture. (as cited in Li & Chen, 2017, p. 40)

Researchers Goldstein and Keller (2015) identified potential predictors of successful cultural adjustment that could assist sojourners in their acculturalization to their host country. These include self-efficacy (Bandura, 1977), openness to new experiences, an interest in world languages, and cross-cultural competence. Furthermore, to ease the acculturalization process, Cai and Hall (2016) suggest that it is highly recommended that sojourners receive pre-departure support for living in the new environment that are specific to the situation in which they will find themselves in the host country.

3.0 Method

3.1 Participants

Although the present study primarily focused on the acculturalization of the two school-aged, South Korean students who were children of a visiting scholar, as the main participants in this case study, two other secondary participants were the father of the children, the visiting scholar, and the part-time English language tutor of the eldest child.

The primary participants were Jin-a (pseudonym), 7th grade female who had very little English instruction (consisting of minor English survival skills) prior to her moving abroad. Jin-a was an energetic, outgoing child who appeared to be excited to be in the U.S. for the first time. Her brother, Yung-Su

(pseudonym), 19-year-old male, 1st year college student in a prestigious school in his origin-country, had good English proficiency skills but was not confident in his communication skills, extremely introverted and self-effacing, yet appeared to be motivated to attend school in the United States.

3.2 *Data Collection Procedures*

The data were collected using a series of semi-structured interviews, conducted over a period of 10 months in both Korean and English, by the second author of this article. Even though the interviewees had the opportunity to respond in English, responses to the interview questions, were not given in Korean but rather in English by the participants. Also, supplementary data were gathered through informal meetings between the participants and the researchers during shopping outings and family dinners in the host country and via semi-structured emails when the visiting scholar and his children had returned home.

4.0 Results

The findings of the data analysis will be framed by each of the three research questions that guided the present study.

4.1 What were the sojourners' initial expectations for and perceptions of living in the U.S. prior to their arrival?

4.1.1 Jin-a

Jin-a strongly expressed the desire to improve her English and make "a lot of American friends." Her first perceptions of Americans were extremely favorable; she thought that they were "nice, kind, and educated." When probed further about what she knew about America, Jin-a added that she thought that most Americans were White, based on the limited number of American TV shows and movies that she had watched while in Korea. Referring to her own country's homogenous ethnicity she commented, "People on TV in Korea are almost Whites. So I haven't thought about Black people."

4.1.2 Yung-Su

Compared with those of Jin-a, Yung-Su's initial perceptions about his new host country were not particularly positive. Due to his age (19) and knowledge of U.S. military personnel in South Korea (many of whom he had encountered were in their late teens and early 20s), he had a negative opinion about *Americans* prior to his arrival in the U.S. Yet, based on Hollywood's artificial projection of *American culture and life*, Yung-Su had had highly-positively inflated expectations about life in general in the United States.

4.2 What were their situational perceptions as newcomers to the U.S. during their sojourn?

4.2.1 Jin-a

Following a couple of months as a second semester 7th grader, Jin-a's initial perceptions of Americans she encountered had changed dramatically. "I thought they [Americans] were nice and kind even to strangers, but it was not true." When asked about her experiences in the classroom she responded, "There are many bad students." When further coaxed to elaborate, she commented about the lack of discipline in the local public school where she attended both daily ESL (English as a Second Language) classes and mainstream content area classes.

Jin-a's reported that her English skills had markedly improved, even after a few weeks, particularly with listening and speaking and writing. She smiled broadly when asked about her new ESL teacher and

shared, "Since we had [have] a new ESL teacher, we don't do worksheet activities anymore. We learned how to write an essay and also short story questions. Although I enjoy the class, I don't want to miss mainstream class[es]." Jin-a also spoke animatedly about her use of an electronic dictionary (that her father had given to her) and the internet, which she felt helped her English.

Jin-a felt that her English skills were improving, and she strongly shared her fondness for attending mainstream classes rather than being in the ESL class, "There are other Korean students [in the EL class] and when we have questions to answer, we exchange answers in Korean [with] each other…. We don't listen to teachers [the teacher] well because we can talk [to] each other."

When asked about her interactions with peers and teachers during an interview that took place during the fall when she was in 8th grade, Jin-a's optimistic and outgoing personality shone through.

Umm, I'm [the] same to [with] my family, but I more often talk to friends and hang out with them. It is more often than [when] I was in the 7th grade. I go to [the] mall every weekend with friends. Another testament to her successful acculturation to her new environment is evident in the following statement.

Teachers sit on their chairs and we solve our problems. I sometimes ask questions. If they talk to me, I answer. We became close. The other day, a teacher told me, my clothes is [are] pretty. So the next day I told her that her clothes is [are] pretty.

Jin-a had similar positive experiences with her peers, even during the initial month of her sojourn. She went to the mall with her new school friends and felt very comfortable and socialized with them. "My American friends are very similar to my Korean friends. They were [are] talking about school, teachers, friends and clothes. We also listen [to] music, and do the Internet, and play video games."

4.2.2 Yung-Su/"But it is not like this in American movies!"

The new city, to which his family moved while considered to be large for the South East U.S, was certainly not the fast-paced, exciting, and public-transportation-friendly major metropolis of Seoul, South Korea where he had previously been a new college student. Yung-Su was very dissatisfied with what he deemed to be "Small Town U.S.A." Due to his preconceived notions of what he thought U.S. life would be, he was extremely disappointed with living in what he viewed as being a small, quiet, provincial American city. To add to his dismay, he had to depend upon his father to transport him wherever he wanted to go, not having his own vehicle or access to public transportation in his new host environment.

Before I came here, I thought about wonderful buildings and fascinating cities like Chicago, something that you can see in Hollywood movies. In those surroundings, I thought I would have fun with foreign friends. Having fun with them, communicating with them without any difficulties, and going [to] some fun places.

In addition to his feelings about his new hometown, Yung-Su was extremely frustrated attending an English Language Institute (ELI) where he felt that he did not learn *authentic* English. "Even though my talk is not exact, they [the other non-native English speakers at the ELI] interpret it again into their language. Sometimes it's OK with me. But it's not a real English communication skill."

After attending the ELI during his first few months of his sojourn, Yung-Su was able to register at a local Community College the following fall where he was not happy with his lack of interactions with the other students (who were primarily American). Although he stated that he wanted to make friends at his new school venue, he was not successful.

I didn't try to make friends. First [there was the issue of] transportation and second, language. I was afraid that I could not understand them [the Americans] clearly….Everybody leaves right after class. Although they talk during the class, I don't think they are close outside the class.

Yung-Su stated emphatically that he wanted to meet Korean-Americans and to take classes at the university where his father was a visiting scholar.

4.3 What were their specific challenges as they attempted to acculturate to the host country?

4.3.1 Jin-a

According to an informal interview conducted with both Jin-a's English tutor, and Jin-a, the tutor acknowledged that initially, Jin-a did not like her ESL class, with her first ESL teacher. "Her English [ESL] class was [that] she hated it. It was awful. She just spoke Korean all the time. So that doesn't help her." Jin-a added, "There was a Korean student in the 7th grade and I copied her notebook…when I had her, I know what's going on clearly because she told me." In other words, she was allowed to speak Korean and not complete her own work, which obviously, did not present a challenge to her.

As explained by her English tutor, Jin-a experienced difficulty at first with the academic language or with understanding the content in her mainstream classes. "Her father helped her with basic academic English (i.e., identifying key vocabulary terms in math and science)." Jin-a's father corroborated this fact in another interview that took place with the researchers early during Jin-a's first semester at her new school.

> Math questions were so easy but she couldn't solve them. So I interpreted basic sample questions. For the first 2-3 weeks, I helped her like that. Her math grade got better and then, I looked at [the] geography [and] history stuff that she is learning. I read them [the subject information] and interpreted for her. [In particular] the vocabulary frequently used…I had her look [it] up [in] the dictionary and memorize them [the vocabulary words]. She continued it for a month and then she seemed to be O.K.

Even though the researchers felt that Jin-a was acculturating well to her new life in the U.S., it was understandable that she would she miss her Korean friends back home. "I miss my school, friends, I miss sleepover[s] the most, and also talking with teachers, and most [of the] things [that] happened in the school."

4.3.2 Yung-Su

In addition to his despondency with livening in a small, American city, one of the particular challenges that Jin-a's brother experienced in his acculturation journey was his lack of self-confidence in his English communication skills. He found it particularly difficult to make American friends, particularly at the community college where he attended classes during the fall, after his spring semester at the ELI. Yung-Su shared during an interview, "I just look at books and take some notes….Because of my English …my English is not good… "I was alone all the time. I ate lunch by myself."

Yung-Su's poor self-perception of his English skills, however, differed from the opinion of his English tutor who eventually stopped working with him, due to the fact that she felt that "His English was very good. So, it wasn't [doing any good]… I didn't feel like I was helping him at all."

As his 10-month sojourn continued, Yung-Su withdrew from physical interaction with Americans and appeared to feel more comfortable by vicariously interacting with his host country's community. "I watched TV a lot, for example, [the TV series, *Friends*]. I feel I lack advanced English, like some words on [the] News, I could not understand. But I could understand slang. I used online slang dictionary….Well, if you know a lot of slang, you would feel like you were more American."

5.0 Limitations, Discussion, and Conclusion

5.1 Limitations

The researchers accomplished what they set-out to do--explore specific aspects of the acculturalization process of a visiting scholar and his children to their new host country. Indeed, there were several inherent limitations to the present study. This was a simple case study, focusing on only one small family unit, during a 10-month period of time, in one city located in the South East U.S. Only three open-ended yet highly-focused research questions guided the study and they dealt with only specific stages of Berry's (1997) cultural adjustment theory and did not examine cultural integration (Boski, 2008).

Additionally, data were gathered through a series of semi-structured interviews and informal interactions. The primary participants in the study were two children of one visiting scholar; the secondary participants were the visiting scholar and one English language tutor who worked with the children for the first half of their sojourn experience. Whereby, the results of the study do augment the published research on the topic, caution must be taken when attempting to generalize any findings. Therefore, the researchers recommend that further research be conducted on the issues presented in this paper, including a larger group of participants, over a longer period of time and involving more in-depth ethnographic data collection measures.

5.2 Discussion

The results of this study corroborate both the results of Berry's (1977) Acculturation Model and Swallow's (2010) Five Stages of Cultural Shock. Berry purports that successful acculturation takes place once a sojourner has negotiated *cultural maintenance* and *cultural contact* with members of the host country. For Jin-a, this was evident. Indeed, mid-way through her time abroad, she was able to identify with the host country's culture (*cultural maintenance*) and was more than willing to be involved with its members (*cultural contact*). For her, during her 10-month stay abroad Jin-a was successful in adjusting to American culture in her host country. And, upon her re-entry to Korea, in an email to the researchers, she reflected upon her extremely positive experience, "It was good to live in America. It's also good to live in Korea. I wish I could go to [the] U.S. someday again."

Due to his hesitancy in trying to identify with his new American culture and his unwillingness to become more involved than he was with Americans, Jun-Su's experience abroad resulted in only a partially- successful sojourn experience, which was validated only after his arrival back to Korea. He emailed the researchers, "I miss the days that I lived there [U.S.]. Our family was very close. When we were in Korea, we lived in different places and did not get together often….I miss using English too."

Both children of the visiting scholar progressed through Swallow's (2010) Five Stages of Cultural Shock, although, Jin-a did so more easily than her brother; she arrived at the fifth and final stage, the *independent stage*, well before her departure home. In contrast with his sister, Jung-Suon only reached the third stage, and remained at the *reintegration stage* until the end of his sojourn.

Examining Jin-a's reactions to her new host country's environment from the interviews, the researchers determined that overall, she was open to cultural differences and had no major prejudices or biases to new cultural experiences. She had stable and frequent contacts with people inside and outside school (except during the summer break when she traveled with her father and brother). Unlike her brother, however, she did not have extremely high expectations (e.g., improving English conversation) and was pleasantly surprised with her improved language skills at the end of her sojourn. She left the United States on a proverbial high note and re-entered Korea in like manner.

Jun-Su's journey through part of the Five Stages was much more difficult for him, for the same reasons he was unable to successfully negotiate both Berry's (1997) *cultural maintenance* and *cultural*

contact with members of his host country. He did not see himself capable of embracing American culture nor did her ever feel comfortable or confident in his interactions with them, in both academic and social settings. The researchers suggest that perhaps his pre-sojourn inflated and somewhat unrealistic expectations of what his life would be like in the U.S. could have potentially negatively impacted his ability or willingness to adjust to the culture of his new host country in the beginning of his stay abroad and his introverted, non-risk-taking demeanor prevented him from arriving at even Swallow's (2010) fourth stage, the *autonomy stage.*

5.3 Conclusion

Visiting scholars "do not receive adequate preparation prior to their departure" from their origin country (Cai & Hall, 2016). Furthermore, the "implications of this unpreparedness may mean a reduction in intercultural competence" which in turn will impact cultural adjustment to the host country (Gopal's 2011 research as cited in Cai and Hall, 2016, p. 250). The researchers hold that the same may be true for the children of visiting scholars who accompany their parent(s) abroad. Thus, in order to facilitate a potential successful cultural adjustment to the host country, it is essential that visiting scholars and their sojourning family members learn as much about their new country as possible, the language that is spoken in it, all aspects of its culture, be open to new experiences, and gain some level of cultural competence of the host country, as suggested by Goldstein and Keller (2015).

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Higher-Order Accurate Finite Volume Discretization of the Three-Dimensional Poisson Equation Based on An Equation Error Method

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Abstract

Efficient higher-order accurate finite volume schemes are developed for the threedimensional Poisson's equation based on optimizations of an equation error expansion on local control volumes. A weighted quadrature of local compact fluxes and the flux integral form of the equation are utilized to formulate the local equation error expansions. Efficient quadrature weights for the schemes are then determined through a minimization of the error expansion for higher-order accurate discretizations of the equation. Consequently, the leading numerical viscosity coefficients are more accurately and completely determined to optimize the weight parameters for uniform higher-order convergence suitable for effective numerical modeling of physical phenomena. Effectiveness of the schemes are evaluated through the solution of the associated eigenvalue problem. Numerical results and analysis of the schemes demonstrate the effectiveness of the methodology.

Key words. Finite volume, local control volume, equation error expansion, uniform higherorder accurate convergence, local residual error, three-dimensional Poisson's equation, local compact fluxes, flux integral formulation

1. Introduction

The problems of interest in this work have been extensively investigated and we describe some of the relevant research. Higher order compact schemes for elliptic equations have been well-investigated, [5,23,25–28], since they achieve high-order accuracies without significant increases in the bandwidths of the coefficient matrices. In [19,25,27], and other application problems [6,17,31], the univariate Taylor series expansion is used to derive the finite difference approximations of individual terms of the differential equation and then coupled to obtain the schemes for multiple spatial dimensions. Subsequently, truncation errors are formulated to assess the accuracies of the schemes.

In [12,13], the multivariate Taylor expansion is used in developing higher-order finite volume schemes for elliptic equations in two spatial dimensions. First, local approximations for the unknown and the source are utilized to formulate an equation error expansion for the integral form of the equation. Generalized weighted quadratures of the local approximations are utilized for the equation error expansions based on flux integral formulations of the equation in order to capture all local compact fluxes and preserve operator

properties of the equation within the computational domain. The weight parameters are subsequently determined to minimize this wellbalanced error by eliminating the leading terms of the error. As a result, the leading coefficients of the resulting residuals which are the numerical viscosity coefficients are consequently more accurately and completely determined for the computational domain. These viscosity coefficients which describe the growth rates of local residual errors are then optimized by right choices of quadrature weights for the schemes to ensure uniformly diminishing residual errors. In [11], the approach was extended to develop a space-time finite volume differencing framework for effective higher-order accurate discretizations for parabolic equations.

In this paper, we utilize the local equation error expansion approach [11–13] to develop higher-order accurate discretizations for the three-dimensional Poisson's equation based on approximations of the flux integral formulations of the equation.

This ensures that the resulting residual errors are more accurately and completely determined for optimal quadrature weights for the discrete equations and further guarantee uniformly converging residual errors. That is, the focus is on the efficient representation of both the solution and the source term in the discrete representations of the equations. Our work in [11,12] shows that the rates of higher-order accurate convergence of the solution depends on efficient discretization of the source term in the discrete representation of the equation. While the 19-point stencil and the 27point stencil may be used for the solution [14,25,27], the associated stencils to be used for the source term should be emphasized as either the 7-point stencil or the 19-point stencil or the 27-point stencil. By using the equation error expansion which combines all local compact fluxes of the solution and their corresponding source term approximations in describing the resulting residual errors, the errors associated with all the various stencils for the source term may be optimally assessed. The weighted quadrature descriptions express the approximation of the divergence of the flow about each point within the computational domain and offers the right framework to allow for effective local flux improvements to ensure more uniform higher-order accuracies. Hence, there is effective representation of fluxes to neighboring grid points which ensures conservation of flow within the computational domain.

The equation error expansions allow for flexible configurations of local grid-point clouds [7,10,16] to be adopted as desired in order to effectively approximate fluxes in all compact directions of neighboring grid points needed to account for high frequencies in data distributions [15,30]. The structured distribution of grid points [1] ensures that accuracy estimates of the local residual error can be guaranteed. Thus, a local equation error [2] is formulated for the integral formulation of the equation on the control volume instead of just the coordinate directions as in traditional finite difference formulations [19,25]. This error is then locally constrained by the derivatives of the equation through the Cauchy-Kovalevskaya procedure [20] and then minimized by eliminating the leading terms iteratively to determine the weights to approximate the equation. These weights are further optimized to control the growth of residual errors and ensure uniformly diminishing computational errors and robust higher-order accurate convergence of the schemes.

The paper is organized as follows: In Section 2, we present the discretization framework of the method for a general elliptic equation in flux divergence form in ^{2}. In Section 3, we apply the method to develop new efficient higher-order schemes for the three-dimensional Poisson equation. We discuss quadrature-weight

optimizations of the residual errors for consistent fourth-order convergence for the resulting schemes in Section 4. In Section 5, we apply the resulting schemes to discuss the solution of the associated eigenvalue problem for the unit cube to demonstrate the efficiency of the numerical schemes. Numerical errors for the eigenvalue problem associated with different local stencil supports for the discretizations are demonstrated in Section 6. Sixth-order accurate discretizations for the three-dimensional Poisson equation is discussed in Section 7 and conclusions are presented in Section 8.

2. Finite Volume Differencing Discretization Framework

We describe the finite volume differencing discretization method for the elliptic boundary value problem

$$-\nabla \cdot (\kappa \nabla u) = q, \quad \text{in} \in \Omega \tag{2.1}$$

$$u = g, \quad \text{on} \in \Gamma \tag{2.2}$$

where Ω is a bounded domain in ^{2} or ^{3} with a smooth boundary Γ. We assume that $\kappa \in L^{\infty}(\Omega)$ is positive and the source function $q \in L^2(\Omega)$.

To develop a higher-order accurate discretization for (2.1) with a robust computational convergence, the discretization framework must effectively be able to represent all local fluxes to as many neighboring grid points as possible within the computational domain. That is, the framework must be conservative of all local compact fluxes [4] required for consistent and robust higher-order accuracies. We therefore formulate the equation (2.1) over local control volumes which can support all possible local fluxes to neighboring mesh points rather than independently in univariate coordinate directions [24] as in traditional finite difference formulations.

We first write the integral formulation of the equation (2.1) as

$$-\int_{\Omega} \nabla \cdot \kappa \nabla u \, dv = \int_{\Omega} q \, dv \tag{2.3}$$

where $dv = dxdy$ in ^{2} or $dv = dxdydz$ in ^{3}. By the divergence theorem, the equation (2.3) is rewritten into the flux integral balance form as

$$-\int_{\partial\Omega} \kappa \nabla u \cdot \nu \, dS = \int_{\Omega} q \, dv \tag{2.4}$$

where v is the unit outward normal to the boundary S of the domain Ω.

Now, consider the domain Ω partitioned into control volumes where each control volume is identified by its centroid mesh point and a distribution of neighboring mesh points. A uniform distribution of grid points is utilized for this work but the approach is applicable for a non-uniform distribution as well. A combination of uniform distribution for regular grid points and non-uniform distribution for irregular grid-points may be adopted [6]. The grid-point clouds for neighboring control volumes overlap [29] to create interlocking configurations which help to capture and track local fluxes effectively on the computational domain necessary for higher level of conservation and robust higher-order computational convergence.

We thus describe (2.4) about the centroid of each control volume $\mathbf{Q}_h$ by

$$-\int_{\partial \mathbf{Q}_h} \kappa \nabla u \cdot \nu_h \, dS_h = \int_{\mathbf{Q}_h} q \, dv \tag{2.5}$$

where v_h is the unit outward normal vector to S_h which is the boundary of $\mathbf{Q}_h$. The equation (2.5) represents the conservation of u about the centroid grid point of the control volume such that variations in the local source term distribution within the control volume are compensated for by the radial fluxes through the boundary S_h [9]. That is, the distribution of u within the control volume $\mathbf{Q}_h$ is completely determined by the sum of all diffusive radial fluxes about the centroid and the corresponding source term distribution. Hence the resulting equation error $E(u)$, about the centroid grid point is given by

$$E(u) = -\int_{\partial \mathbf{Q}_h} \kappa \nabla u \cdot \nu_h \, dS_h - \int_{\mathbf{Q}_h} q \, dv \; = 0 \quad , \qquad (2.6)$$

where $\mathbf{Q}_h$, a typical control volume in ^{2} with a centroid $X_0(x_m,y_n)$, is described as $\mathbf{Q}_h = [x_m-h,x_m+h]\times[y_n-h,y_n+h]$ and illustrated by Figure 2.1. In illustrating the control volume $\mathbf{Q}_h$ with centroid X_0 by a finite cloud of quadrature points $X_1(x_m +$

$$h, y_n),\ X_2(x_m + h, y_n + h),\ X_3(x_m, y_n + h),\ X_4(x_m - h, y_n + h),\ X_5(x_m - h, y_n$$

^{3}),

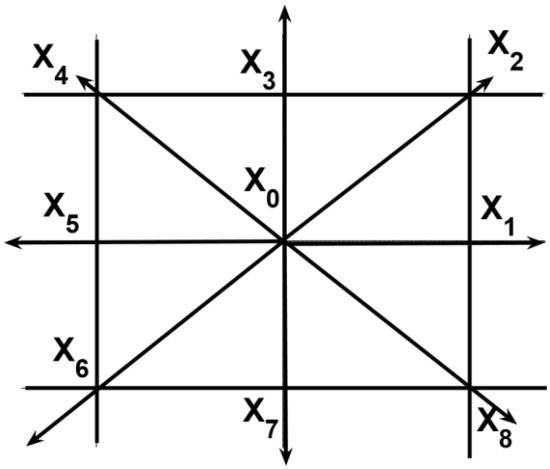

Fig. 2.1. *Local Control Volume,* $\mathbf{Q}h$ *in* ^{2}*, illustrating local compact fluxes to neighboring quadrature points within the computational domain with* $X_0(xm,yn)$ *as the centroid*

$X_6(x_m - h,y_n - h)$, $X_7(x_m,y_n - h)$, and $X_8(x_m + h,y_n = h)$, as in Figure 2.1, $\mathbf{Q}_h$ overlaps with control volumes centered on all these neighboring quadrature points.

In utilizing a finite number of quadrature representation points on the computational domain to approximate the local equation error, the discrete representation of (2.6) is therefore nonzero. In fact, we approximate the local diffusive flux about each centroid grid point (x_m,y_n) by a generalized weighted quadrature of the radial fluxes to the neighboring cloud of quadrature points by

$$\int_{\partial \mathbf{Q}_h} \kappa(u) \nabla u \cdot \nu_h \, dS_h \approx \sum_{\partial \mathbf{Q}_h} \kappa(u_0) \nabla u \cdot \nu_h \approx \kappa(u_0) \sum_{i=1}^{n_i} w_i (u_i - u_0 \qquad) \qquad (2.7)$$

where n_i is number of quadrature points, w_i is the collocation weight for the local directional flux $\nabla u \cdot v_{hi} = (u_i - u_0)$ along the radial direction v_{hi} toward location of u_i. Based on the adopted set of compact quadrature points, the quadrature approximation of (2.4) about the centroid becomes

$$-\kappa(u_0) \sum_{\partial \mathbf{Q}_h} w_i \ (u_i - u_0) = \sum_{\mathbf{Q}_h} v_i q_i \quad , \qquad (2.8)$$

where $\kappa(u_0)$ is an averaging value of $\kappa(u)$ about the centroid. The resulting residual is described as

$$E_{Qh}(u) = -\kappa(u_0)\sum_{\partial \mathbf{Q}_h} w_i\ (u_i - u_0) - \sum_{\mathbf{Q}_h} v_i q_i, /= 0 \qquad (2.9)$$

where the weights are constrained for a consistent numerical approximations such that

$$\sum_{\partial \mathbf{Q}h} w_i = 0, \quad \sum_{\mathbf{Q}h} v_i = 1. \qquad (2.10)$$

Clearly, the framework as described in (2.8) allows for regular and non-regular distribution of quadrature points locally about each centroid adaptively.

For a more accurate modeling of the local equation error (2.9) using a generalized weighted quadrature description in [2] for instance, we adopt a natural local multivariate Taylor expansion for u about each centroid (x_0,y_0) by

$$\phi(x_0+x, y_0+y) = \sum_{m=0}^{\infty}\sum_{i+j=m} \frac{C(m,i)}{m!}\frac{\partial^m \phi}{\partial x^i \partial y^j}(x_0,y_0)x^i y^j \qquad (2.11)$$

where φ is sufficiently smooth and locally defined everywhere such that

$$\varphi(x_0,y_0) = u(x_0,y_0)$$

$$\frac{\partial^m \varphi}{\partial xi \partial yj}(x0,y0) = \frac{\partial^m u}{\partial xi \partial yj}(x0,y0).$$

Consequently, we define the local source term expansion by

$$f(x_0+x, y_0+y) = -\Delta_\kappa \left(\sum_{m=0}^{\infty}\sum_{i+j=m} \frac{C(m,i)}{m!}\frac{\partial^m \phi}{\partial x^i \partial y^j}(x_0,y_0)x^i y^j \right) \qquad (2.12)$$

where Δ_κ is the local differential operator description of (2.1) with unique characteristics of the equation [21] such that

$$q(x_0,y_0) = f(x_0,y_0) = \triangle_\kappa \phi|_{(x_0,y_0)} := (\nabla\cdot(\kappa\nabla\phi))|_{(x_0,y_0)} = \kappa\Delta\phi|_{(x_0,y_0)}. \qquad (2.13)$$

In this way, *any* grid functions of φ and the source term f about each centroid may be determined and utilized to describe the approximations the integral fluxes in (2.4) in the form of (2.8). Thus, the grid point spacings may not necessarily need to be uniform and can be adaptively determined locally. As a result, *any* desired quadrature points about the centroid may be utilized or included in the approximation of the flux integrals to discretize (2.4) locally. The radial fluxes towards the neighboring quadrature points describe their relative dependencies locally on the total flux within the computational domain and therefore weighted accordingly.

To enable effective higher-order accuracies, the Cauchy-Kovalevskayaprocedure [20] is applied to replace higher order derivatives of the local solution expansion φ in (2.11) and (2.12) by lower-order derivatives of the local source term f so that higher-order rates of change in u can be efficiently explained by local source term variations. Thus, we replace coefficients such φ_{xxxx},φ_{xxxy}, φ_{xyyy}, etc in (2.11) and (2.13) by φ_{xxyy}, etc in order to more accurately represent local directional fluxes according to the physics behind (2.1) in the local expansions. Thus, the source term derivatives f_x, f_y, f_{yy}, f_{xx}, etc are introduced into (2.11) through higher-order derivatives of the equation (2.13) given as

$$
\begin{aligned}
-\kappa(\phi_{xx}+\phi_{yy}) &= f,\\
-\kappa(\phi_{xxx}+\phi_{xyy}) &= f_x,\\
-\kappa(\phi_{xxy}+\phi_{yyy}) &= f_y,\\
-\kappa(\phi_{xxxy}+\phi_{xyyy}) &= f_{xy},\\
-\kappa(\phi_{xxxx}+\phi_{xxyy}) &= f_{xx},\\
-\kappa(\phi_{xxyy}+\phi_{yyyy}) &= f_{yy}, \text{ etc}
\end{aligned}
\qquad 5 \qquad .
$$

As indicated by (2.7), the local diffusive flux about each centroid mesh point (x_0,y_0) within the computational domain is described by a generalized weighted quadrature of all local compact fluxes by

$$\int_{\partial \mathbf{Q}_h} \kappa \nabla\phi \cdot \nu_h \, dS_h \approx \kappa_{\mathbf{Q}_h} \sum_{\partial \mathbf{Q}_h} \nabla\phi \cdot \nu_h \approx \kappa_{\mathbf{Q}_h} \sum_{i=1}^{n_i} w_i(\phi_i - \phi_0 \qquad) \qquad (2.14)$$

where n_i is the desired number of quadrature points, and w_i is the quadrature weight for the local directional flux ($\varphi_i - \varphi_0$). The number of quadrature points forming the desired local distribution is part of the available degrees of freedom, which may be increased to improve local accuracy by incorporating sub-grid-scale points and nonlocal fluxes [3].

Thus, the local equation error expansion E_{Qh} about each centroid grid point is described as the differencing of the weighted quadrature approximations of the flux integrals by

$$\mathrm{E}Qh = \quad -\kappa_{\mathbf{Q}_h} \sum_{\partial \mathbf{Q}_h} w_i(\phi_i - \phi_0) - \quad \sum v_i f_i, \qquad (2.15)$$

$$\mathbf{Q}_h$$

where the weights are constrained by

$$\sum_{i=1}^{8} w_i = 0, \quad \sum_{i=0}^{8} v_i = 1 \qquad (2.16)$$

such that the differential and integral operator properties of the equations are preserved about each centroid. This error expansion measures the sum of the discrepancies of the separate possible approximations flux integrals using subsets of the quadrature points as in traditional finite difference approximations of (2.1). Thus, the formulation (2.4) offers a more complete accounting of local fluxes than traditional finite difference approximations which is a parameterized version of this framework.

To obtain the specifics the discretization for (2.1), the discrete minimax approach is utilized to determine the quadrature weights to annihilate the leading terms of the error expansion. That is, the weights w_i and v_i are determined to annihilate the leading terms of the multivariate error expansion of (2.5) and to further regulate the growth of the residual error through efficient collocations of the local source terms f_i and the solutions φ_i. The eventual order p of the approximation depends on the degrees of freedom available to discretize the equation (2.4) locally.

One advantage here is that for various innovative ways [22,30] to incorporate local micro scale properties into the numerical model, our comprehensive approach is naturally efficient in determining the right sampling and collocations of the source required for effective and robust higher-order accuracy.

3. Finite Volume Discretization for Poisson's Equation in 3D

We formulate the equation error expansion (2.9) about each grid point using local compact cloud of 27 grid points within the three-dimensional computational domain. The corresponding control volume Q_h, for a uniformly partitioned computational domain is illustrated in Figure 3.1 where the centroid grid-point function φ_0, is surrounded by 26 mesh points distributed at three radial distances of $h,\ \sqrt{2}h$ and$\sqrt{3}h$ from the centroid.

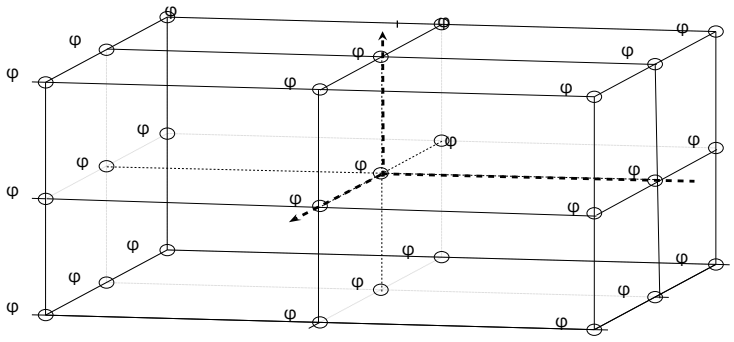

Fig. 3.1. *A compact cloud of neighboring grid-point distribution about each Centroid*

As discussed above, we use the multivariate Taylor expansion $\varphi(x_0+\alpha, y_0+\tau, z_0+\nu)$ defined in the form of (2.11) for the local expansion of the solution about each centroid. In a likewise manner, the local source term is formulated on the local stencil by a corresponding multivariate expansion as described by $3D$ versions of (2.11), (2.12) and (2.13). Thus, the compact stencil grid point approximations are well defined for φ_i and their corresponding source terms f_i everywhere about the centroid.

For a regular uniform discretization of size h, we define and evaluate the local compact cloud of grid-point approximations of φ_i about the centroid by

$$\begin{array}{llll}
\phi_0=\phi(0,0,0), & \phi_1=\phi(h,0,0), & \phi_2=\phi(0,h,0), & \phi_3=\phi(-h,0,0)\\
\phi_4=\phi(0,-h,0), & \phi_5=\phi(0,0,h), & \phi_6=\phi(0,0,-h), & \phi_7=\phi(h,h,0),\\
\phi_8=\phi(-h,h,0), & \phi_9=\phi(-h,-h,0), & \phi_{10}=\phi(h,-h,0), & \phi_{11}=\phi(h,0,h)\\
\phi_{12}=\phi(0,h,h) & \phi_{13}=\phi(-h,0,h) & \phi_{14}=\phi(0,-h,h), & \phi_{15}=\phi(h,0,-h)\\
\phi_{16}=\phi(0,h,-h) & \phi_{17}=\phi(-h,0,-h) & \phi_{18}=\phi(0,-h,-h), & \phi_{19}=\phi(h,h,h)\\
\phi_{20}=\phi(-h,h,h) & \phi_{21}=\phi(-h,-h,h) & \phi_{22}=\phi(h,-h,h) & \phi_{23}=\phi(h,h,-h)\\
\phi_{24}=\phi(-h,h,-h) & \phi_{25}=\phi(-h,-h,-h) & \phi_{26}=\phi(h,-h,-h) &
\end{array}$$

as well as the source term evaluations $\{f_i\}i=0,2,\ldots,26$. The equation error expansion about the centroid is then constituted as

$$E(\phi_0)=-\kappa_{\phi_0}\left\{\sum_{i=1}^{6}w_1(\phi_i-\phi_0)+\sum_{i=7}^{18}w_7(\phi_i-\phi_0)+\sum_{i=19}^{26}w_{19}(\phi_i-\phi_0)\right\} \quad (3.1)$$
$$-\left\{\beta_1\sum_{i=1}^{6}f_i+\beta_7\sum_{i=7}^{18}f_i+\beta_{19}\sum_{i=19}^{26}f_i+(1-6\beta_1-12\beta_7-8\beta_{19})f_0\right\}$$

where equal quadrature weights are adopted for grid points at equal radial distances from the centroid. By substituting $\{\varphi_i\}i=0,2,\ldots,26$ and $\{f_i\}i=0,2,\ldots,26$ into threedimensional version of (2.15), the terms of the error expansion of (3.2) are assembled in the form

$$E(\phi_0) \approx \kappa U_2 \left\{ \frac{\partial^2 \phi}{\partial x^2} + \frac{\partial^2 \phi}{\partial y^2} + \frac{\partial^2 \phi}{\partial z^2} \right\} + F_2 \left\{ \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} + \frac{\partial^2 f}{\partial z^2} \right\} h^2$$
$$+\kappa U_4 \left\{ \frac{\partial^4 \phi}{\partial x^2 \partial y^2} + \frac{\partial^4 \phi}{\partial x^2 \partial z^2} + \frac{\partial^4 \phi}{\partial y^2 \partial z^2} \right\} h^2 + O(h^4) \quad (3.2)$$

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where

$U_2 = 1 - w_1 - 4w_7 - 4w_{19}$

$$F2 = \beta 1 + 4\beta 7 + 4\beta 19 - \frac{1}{12} w1 - \frac{1}{3} w7 - \frac{1}{3} w19$$

$$U4 = \frac{1}{6} w1 - \frac{1}{3} w7 - \frac{4}{3} w19.$$

By annihilating the leading coefficients U_2, F_2 and U_4 of the error (3.2), the quadrature weights for the stiffness matrix **H** of the discretization are transformed as functions of w_{19} by

$$w0 = \frac{4}{2} + {}_h 2w19 \; {}_h \frac{8}{}$$

$$\frac{1}{} \quad \frac{4}{} \quad w1 = -3h2 - {}_h 2w19$$

$$1 \quad 2 \; w_7 = -2 + {}_h 2w_{19} \quad (3.3) \quad \frac{}{} \quad \frac{}{}$$

$$6h$$

where w_0 is the weight of centroid value φ_0. Consequently, the quadrature weights for the mass matrix **Q** are transformed as functions of β_7 and β_{19} by

$$\beta_0 = \frac{1}{2} + 12\beta_7 + 16\beta_{19}$$

$$\beta_1 = \frac{1}{12} - 4\beta_7 - 4\beta_{19} \quad (3.4)$$

and the leading terms of the local residual error $R_{\varphi 0}$, are transformed as

$$R_{\phi_0} \approx \left\{ \frac{1}{240} \left(\frac{\partial^4 f}{\partial x^4} + \frac{\partial^4 f}{\partial y^4} + \frac{\partial^4 f}{\partial z^4} \right) + \kappa \left(\frac{1}{30} - w_{19} \right) \frac{\partial^6 u}{\partial x^2 \partial y^2 \partial z^2} \right\} h^4$$
$$+ \left\{ \left(\beta_7 + 2\beta_{19} - \frac{1}{90} \right) \left(\frac{\partial^4 f}{\partial x^2 \partial y^2} + \frac{\partial^4 f}{\partial x^2 \partial y^2} + \frac{\partial^4 f}{\partial x^2 \partial z^2} \right) \right\} h^4$$
$$+ \left\{ \frac{11}{60480} \left(\frac{\partial^6 f}{\partial x^6} + \frac{\partial^6 f}{\partial y^6} + \frac{\partial^6 f}{\partial z^6} \right) + L_6 \left(\frac{\partial^6 f}{\partial x^2 \partial z^4} + \cdots + \frac{\partial^6 f}{\partial y^2 \partial z^4} \right) \right\} h^6$$
$$+\kappa L_7 \frac{\partial^6 f}{\partial x^2 \partial y^2 \partial z^2} h^6 - \frac{\kappa}{3024} \left\{ \frac{\partial^8 u}{\partial x^4 \partial y^4} + \cdots + \frac{\partial^8 u}{\partial y^4 \partial z^4} \right\} h^6 + C_6 h^8 \quad (3.5)$$

where

$$L6 = \beta 7 + \beta 19 - \frac{1}{12} \frac{1}{6} \frac{5}{12096}$$

$$L7 = \frac{5}{6048} - \frac{1}{12} w19 + \beta 19.$$

As indicated in [13], diagonal dominance of **H** requires W_{19} to be chosen to satisfy

$$|4 + 8w_{19}| \geq 6| - \frac{1}{3} - 4w_{19}| + 12|2w_{19} - \frac{1}{6}| + 8|w_{19}| \quad (3.6)$$

for which the solution is found to be

$$0 \leq w_{19} \leq \frac{1}{12}. \quad (3.7)$$

Clearly, there are several possible ways to choose $\{w_7, w_{19}, \beta_7, \beta_{19}\}$ for a fourthorder accuracy. In the next section, we discuss the optimization of such choices for higher-order convergence robustness of the discretization.

4. Residual Error Optimization for Robust Higher-order Accurate Convergence

For a uniform distribution of quadrature grid points as illustrated in Figure 3.1, higher-order accurate computational performances of the resulting schemes depend on the structure and convergence properties of the local residual error. That is, analysis of computational performances are focused on the asymptotic nature of the associated local residual errors for the equation error expansions which are of the form

$$R_{\phi_0} \approx \sum_{i,j,k}^{i+j+k=3} E_i \frac{\partial^6 \phi}{\partial x^{2i} \partial y^{2j} \partial z^{2k}} h^4 + \sum_{i,j,k}^{i+j+k=4} F_i \frac{\partial^8 \phi}{\partial x^{2i} \partial y^{2j} \partial z^{2k}} h^6 + O(h^8) \quad (4.1)$$

where the leading coefficients E_i and F_i are functions of the quadrature weights as described in (3.5). Thus, with the introduction of higher-order derivatives of f, the residual of the equation error expansion is reconstituted to describe errors in approximating the local manifold of the solution along the directions of local quadrature points.

Now, the point-wise equation error residuals for the Poisson equation and its higher-order derivatives are of the form

$$L(\varphi_0) = \varphi_{xx} + \varphi_{yy} + \varphi_{zz} + f = 0$$

$$\frac{\partial^p}{\partial x^i \partial y^j \partial z^k} L(\varphi 0) = \frac{\partial^p}{\partial x^i \partial y^j \partial z^k} \{\varphi xx + \varphi yy + \varphi zz + f\} = 0 \quad (4.2)$$

where $p = 1,2,3,\cdots$ and $i + j + k = p$. Notice that the coefficients of higher-order derivatives of φ and f have same signs. For the resulting discretization to produce robust higher-order computational convergence rates, the computational errors must diminish monotonically. After incorporating higher-order derivatives of the equation, the residual error terms assume the form of (4.2). Therefore, robust higher-order computational convergence requires that the coefficients of the higher-order derivatives of both φ and f within the leading terms of the residual error (4.1) maintain similar signs as described in (4.2). Thus, the weights β_7, β_{19} and w_{19} as in the leading term of the residual error expansion (3.5) should be chosen such that

$$\beta_7 + 2\beta_{19} - \frac{1}{90} \geq 0, \text{ and } \frac{1}{30} - w_{19} \geq 0 \quad (4.3)$$

to render the leading term of the residual error decreasing monotonically as resolution is refined.

5. Laplacian Eigenvalue Approximations

To computationally evaluate the higher-order accurate convergence of the resulting schemes, consider the associated eigenvalue problem for the three-dimensional Laplacian

$$-\Delta u = \lambda u, \quad \text{in} \in \Omega \tag{5.1}$$

$$u = 0, \quad \text{on} \in \Gamma \tag{5.2}$$

where Ω is the unit cube [0 1] × [0 1] × [0 1]. As discussed above, the equation error for (5.1) about the centroid of each control volume $\mathbf{Q}_h \in \Omega$ as described in (2.6) is

$$R(u) = -\int_{\partial \mathbf{Q}_h} \nabla u \cdot \nu_h \, dS_h - \lambda \int_{\mathbf{Q}_h} u \, dv \; = 0 \tag{5.3}$$

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The finite dimensional representation of (5.3) by utilizing the local uniform cloud of quadrature points on the control volume shown in Figure 3.1 may be described as

$$\mathbf{H}\Phi - \Lambda\mathbf{Q}\Phi = \mathbf{E}R_{\varphi 0} \tag{5.4}$$

where Φ is a column vector of the discrete representation of the eigenfunctions on Ω which are locally supported by the quadrature points on the control volumes and Λ as the matrix of associated eigenvalue estimates. The mass and stiffness for the discretizations are **Q** and **H** respectively, and **E** is a column vector of ones. As described by the discrete approximation (5.4), the robustness of the resulting numerical schemes for higher-order accuracy depends on the convergence properties of the local residual error $R_{\varphi 0}$ in convergence analyses. The eigenvalue estimates, Λ and the associated eigenfunctions Φ are a function of the geometry of the domain and the boundary conditions [8]. Therefore, the accuracy of the estimates Φ and Λ are a direct reflection of the level of effectiveness of the discretization method in sufficiently approximating the equation on the geometry of the domain [18]. Thus, the effectiveness of the discretization for higher-order accuracies may be evaluated through the convergence properties of the local residual error R_{Q0} as described in (3.5).

The parameters w_{19}, β_7, and β_{19} are free for a fourth-order accuracy and so various strategies may be adopted to further optimize the discretization for convergence robustness. Since the local residual error R_{Q0} serves as the local source term for the discrete error equation associated with the discretization, our strategy for robustness is to effectively ensure that R_{Q0} is more uniformly diminishing by choosing the parameters to avoid fluctuations about zero. The computational profiles of various choices of w_{19}, β_7, and β_{19} for higher-order accurate convergence are discussed for the solution of (5.4) by the *eigs* function in *Matlab.*

6. Numerical Errors for Different Local Stencil Supports

In this Section, we discuss numerical results for the eigenvalue estimates associated with the different choices of the local computational supports for the stiffness and mass matrix pair in the discrete equation (5.4). That is, we examine the computations errors in estimating the eigenvalues of the unit cube associated with the possible choices of the parameters w_{19}, β_7, and β_{19} in (5.4).

6.1. Nineteen-by-Seven-Point Local Stencil Support for H × Q. First, the traditional finite difference scheme [19,25,27], is recovered with $w_{19} = 0$, $\beta_7 = 0$, and $\beta_{19} = 0$ in (3.5) and uses a 19×7 point local support for **H**×**Q** and the associated local residual error is given as

$$\begin{aligned} R_{\phi_0} \approx & \left\{ \frac{1}{240}\left(\frac{\partial^4 f}{\partial x^4}+\frac{\partial^4 f}{\partial y^4}+\frac{\partial^4 f}{\partial z^4}\right)+\frac{\kappa}{30}\frac{\partial^6 u}{\partial x^2\partial y^2\partial z^2}\right\} h^4 \\ & -\frac{1}{90}\left(\frac{\partial^4 f}{\partial x^2\partial y^2}+\frac{\partial^4 f}{\partial x^2\partial y^2}+\frac{\partial^4 f}{\partial x^2\partial z^2}\right) h^4 \\ & +\left\{ \frac{11}{60480}\left(\frac{\partial^6 f}{\partial x^6}+\frac{\partial^6 f}{\partial y^6}+\frac{\partial^6 f}{\partial z^6}\right)-\frac{5}{12096}\left(\frac{\partial^6 f}{\partial x^2\partial z^4}+\cdots+\frac{\partial^6 f}{\partial y^2\partial z^4}\right)\right\} h^6 \\ & +\frac{5\kappa}{6048}\frac{\partial^6 f}{\partial x^2\partial y^2\partial z^2}h^6-\frac{\kappa}{3024}\left\{\frac{\partial^8 u}{\partial x^4\partial y^4}+\cdots+\frac{\partial^8 u}{\partial y^4\partial z^4}\right\} h^6+C_6h^8. \qquad (6.1) \end{aligned}$$

Clearly, condition (4.3) fails with both $O(h^4)$ and $O(h^6)$ terms having both positive and negative signs. The computational error profile illustrated by Figure 6.1 shows considerable inconsistent accuracy performances for the eigenvalues due to nonsystematic cancelations of error terms for all eigenfunctions. Furthermore, since the local support for **Q** is a 7-point stencil while that of **H** is a 19−point stencil, some eigenfunctions are poorly and inconsistently represented. Hence the differing shapes of the eigenfunctions along different directions affect the accuracies of their approximations differently.

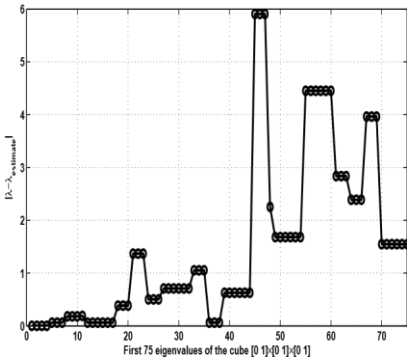


Fig. 6.1.
Computational errorsfirst the 75 eigenvalues of the unit cube$|\lambda - \lambda_{estimate}|$ for
with 19 × 7 point local support, illustrated in Figure 6.1.

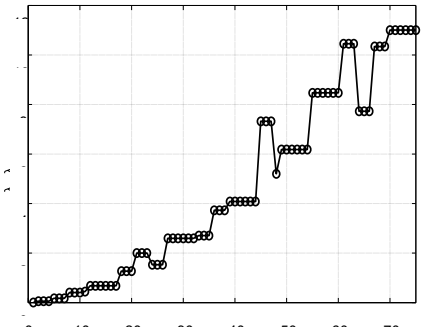


Fig. 6.2.
Computational errors $|\lambda - \lambda_{estimate}|$ for first the 75 eigenvalues of unit the cube with 19 19 point local support,

6.2. Nineteen-by-Nineteen-Point Local Stencil Support for H × Q. On the other hand, in utilizing a 19−point local support for both the mass matrix **Q** and the stiffness matrix **H** by choosing $w_{19} = 0$, $\beta_7 \neq 0$, and $\beta_{19} = 0$ in (3.5), seems geometrically logical. A direct obvious choice of $\beta_7 = \frac{1}{90}$ from (5.4) shows a more uniform convergence profile as shown in Figure 6.2 than with $\beta_7 = 0$

First 75 eigenvalues of the cube [0 1]×[0 1]×[0 1]

$w_{19} = \ _7 = \ _{19} = 0$ for $= \frac{1}{10}$ × $w_{19} = \beta_{19} = 0$, $\beta_7 = \frac{1}{90}$ $h = \frac{1}{10}$

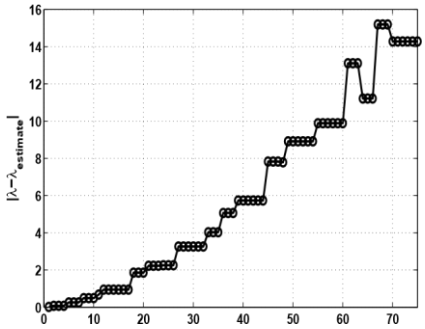
β β $h$for

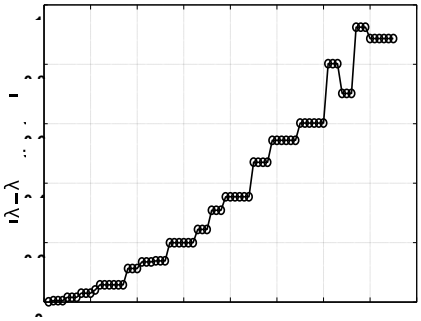
The computational errors for the eigenvalues as displayed in Figure 6.1 are clearly lower than those in Figure 6.2 for the 7−point and 19−point stencil mass matrices respectively. However, in Figure 6.2, the errors grow more uniform with the level of complexity of eigenfunctions demonstrating a more robust higher-order convergence and consistent accuracies. That is, the 19-point stencil mass matrix **Q** with

$\beta_7 = \frac{1}{90}$has a leading error expansion term with same signs for the higher-order derivatives as described in (4.2) ensuring a monotonic convergence than for the 7−point stencil mass matrix with $\beta_7 = 0$.

Furthermore, the mass matrix **Q** with $\beta_7 = \frac{3}{200}$ provides an improved uniform fourth-order accuracies than with$\beta_7 = \frac{1}{90}$ as demonstrated between Figures 6.2 and 6.3. With $\beta_7 = \frac{1}{90}$, the mixed partial derivatives of the source term *f* is eliminated from the $O(h^4)$ term and the size of the leading error term gets polluted by $O(h^6)$ term for some eigenfunctions.

A convergence analysis through resolution refinement for the 19−point stencil mass matrix **Q** with$\beta_7 = \frac{3}{200}$ is shown from Figure 6.3 with h = 1/10 to Figure 6.4 with h = 1/20 which fails to show much local improvements in the error profile. Thus, the 19−point stencil for both the mass and stiffness matrices in 3*D* is not sufficient and effective enough in generating local accuracy improvements as resolution is refined.





First 75 eigenvalues of the cube [0 1]×[0 1]×[0 1]First 75 eigenvalues of the cube [0 1]×[0 1]×[0 1]

Fig. 6.3. Computational errors$|\lambda - \lambda_{estimate}|$ for unit the cube first the 75 eigenvalues of unit the cube with 19 × 19 point local support, $w_{19} = 0$, with 19 × 19 point local support, $w_{19} = 0$, $\beta_7 = \frac{1.35}{90} = \frac{3}{200}$, $\beta_{19} = 0$ with $h = \frac{1}{10}$

Fig. 6.4. Computational errors $|\lambda - \lambda_{estimate}|$ for first the 75 eigenvalues of $\beta_7 = \frac{1.35}{90} = \frac{3}{200}$, $\beta_{19} = 0$ with $h = \frac{1}{20}$

6.3. Twenty-Seven Point Stencil. Next, we examine the case for a 27−point stencil local support for the discretization. Since the parameters w_{19}, β_7, and β_{19} are free for a fourth-order accuracy as indicated by the residual error (3.5), our strategy for robustness and consistent higher-order accurate convergence is to ensure that the residual error is uniformly diminishing by reducing the size and fluctuations of the residual error as much as possible as resolution is refined. Therefore, we exercise the choices for w_{19}, β_7, and β_{19} to control leading coefficients in both the $O(h^4)$ and $O(h^6)$ terms to minimize associated local error pollution. First, we utilize w_{19} to eliminate $\partial x2^{\partial}\partial y^{6f}{}_2\partial z_2$ in the ^{6}) term and then utilize β_{19} to eliminate $_{\partial x}2^{\partial}{}_{\partial y}{}^{6u}{}_{2\partial z}2$ term in $O(h^4)$ $O(h$ term such that

$$w_0 = -6w_1 - 12w_7 - 8w_{19} = -\frac{64}{15h2}$$

$$w_1 = -(1 + 4w_7 + 4w_{19}) = \frac{7}{15h_2}$$

$$w_7 = -(\frac{1}{6} + 2w_{19}) = \frac{1}{10h_2}$$

$$w19 = -12\beta 19 - \frac{5}{504} = \frac{1}{30h} \qquad (6.2)$$

$$\frac{502}{945}$$

$\beta_0 = 1 - 6\beta_1 - 12\beta_7$ $\quad -8\beta_{19} = \frac{}{} + 12\beta_7$

which transforms $\frac{1}{12}$ the error as $\frac{571}{7560}$

$$\beta_1 = \frac{}{} - 4\beta_7 - 4\beta_{19} = \frac{}{} - 4\beta_7$$

$$\beta_{..} = \frac{59}{30240} \qquad (6.3)$$

$$\begin{aligned} R_{\phi_0} \approx & \left\{ \frac{1}{240}\left(\frac{\partial^4 f}{\partial x^4} + \frac{\partial^4 f}{\partial y^4} + \frac{\partial^4 f}{\partial z^4}\right) + (\beta_7 - \frac{109}{15120})\left(\frac{\partial^4 f}{\partial x^2 \partial y^2} + \cdots + \frac{\partial^4 f}{\partial x^2 \partial z^2}\right)\right\} h^4 \\ & + \left\{ \frac{11}{60480}\left(\frac{\partial^6 f}{\partial x^6} + \frac{\partial^6 f}{\partial y^6} + \frac{\partial^6 f}{\partial z^6}\right) - \frac{\kappa}{3024}\left(\frac{\partial^8 u}{\partial x^4 \partial y^4} + \cdots + \frac{\partial^8 u}{\partial y^4 \partial z^4}\right)\right\} h^6 \\ & + \left(\frac{\beta_7}{12} - \frac{1}{11340}\right)\left(\frac{\partial^6 f}{\partial x^2 \partial z^4} + \cdots + \frac{\partial^6 f}{\partial y^2 \partial z^4}\right) h^6 + C_0^6(x_0, y_0, z_0) h^8. \end{aligned} \qquad (6.4)$$

For a higher-order accurate method, the objective here is to achieve a robust discretization scheme by ensuring stability and steady higher-order accurate convergence. For stability, β_7 should be selected to ensure diagonal dominance of the mass matrix **Q** such that

$$\left| \quad 6 \left| \frac{}{7560} - 4 \quad {}_{19} \right| + 12 \quad {}_7 | + 8 \right| \left| \frac{502}{954} + 12\beta_7 \right| \geq \left| \frac{571}{} \quad \beta \right| \beta \quad \left| \frac{59}{30240} \right|, \qquad (6.5)$$

the solution is determined as

$$0 \leq \beta_7 \leq \frac{1831}{45360}. \qquad (6.6)$$

For a steady and a robust higher-order accurate convergence, the choice of β_7 should be made to render the error (6.4) uniformly diminishing with same signs for the source term derivatives in the $O(h^4)$ term such that

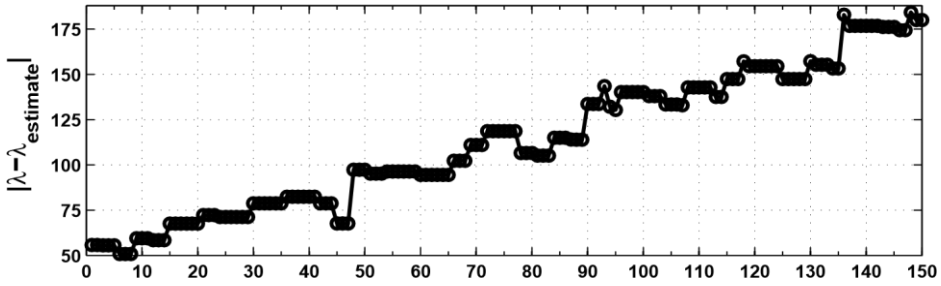
$$\beta_7 \geq \frac{109}{15120} = \frac{327}{45360} \qquad (6.7)$$

which leads to a 27−point compact discretization for the equations.

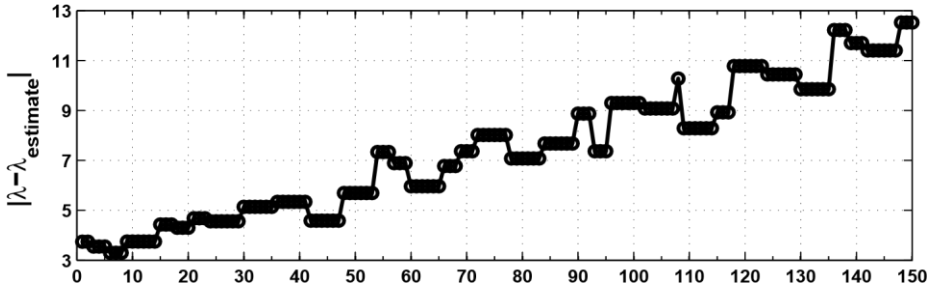
In terms of local support, the 27−point compact stencil for both the mass and stiffness matrices provides for a complete representation of the eigenfunctions as demonstrated in a comparison of error convergence profiles in Figures 6.5 and 6.6.

As evident from Figure 6.5, resolution refinement fails to improve on local accuracies for larger eigenvalues with the 19 × 19 discretization. On the other hand, the 27 × 27 discretization shows much improvement in local accuracy as illustrated in in Figure 6.6.

Clearly, the 27−point compact local support for both the stiffness and mass matrices provide for a uniform higher-order accurate convergence rates for the eigenvalue calculations as well as consistent local improvements in accuracies as resolution is refined which is suitable for effective numerical modeling of physical phenomena.



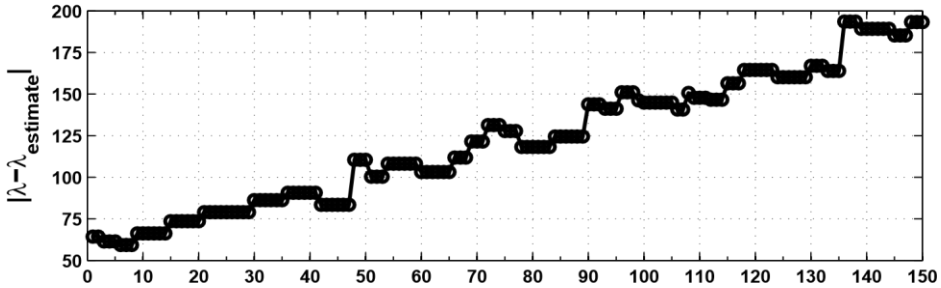
150th to 300th eigenvalues of the cube [0 1]×[0 1]×[0 1]



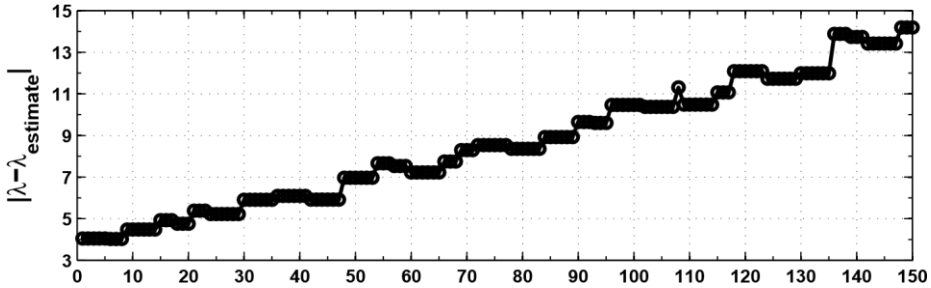
150th to 300th eigenvalues of the cube [0 1]×[0 1]×[0 1]

Fig. 6.5.

Computational errors $|\lambda - \lambda_{estimate}|$ for the 150*th* to 300*th* eigenvalues of unit the cube with 19 × 19 point local support,$w_{19} = \beta_{19} = 0$, $\beta_7 = \frac{1.35}{90} = \frac{3}{200}$, with $h = \frac{1}{10}$and $h = \frac{1}{20}$ for the top and bottom graphs respectively.



150th to 300th eigenvalues of the cube [0 1]×[0 1]×[0 1]



150th to 300th eigenvalues of the cube [0 1]×[0 1]×[0 1]

Fig. 6.6.

Computational errors $|\lambda - \lambda_{estimate}|$ for the 150*th* to 300*th* eigenvalues of unit the cube with 27 × 27 point local support,$w_{19} = \frac{1}{30}$, $\beta_7 = 2.3 * \frac{327}{45360} = \frac{2507}{151200}$, $\beta_{19} = \frac{59}{45360}$ with $h = \frac{1}{10}$ and $h = \frac{1}{20}$ for the top and bottom graphs respectively.

7. Sixth-Order Accuracy

Since the $O(h^4)$ term in the local residual error only involves derivatives of the source term, the right sampling of the numerical source term at sub-grid scale points on the computational stencil may be utilized to achieve sixthorder accuracy. If the fourth-order derivatives of the source term are readily available then the sixth-order accuracy may be achieved by determining β_7 to annihilate the $O(h^4)$ term in the residual error by

$$\beta_7 = \frac{109}{15120} - \frac{1}{240}\left(\frac{f_{xxxx} + f_{yyyy} + f_{zzzz}}{f_{xxyy} + f_{xxzz} + f_{yyzz}}\right). \qquad (7.1)$$

On the other hand, since

$$\mathbf{F}^{Q_h} = 18f_0 - 4f_{\frac{1}{2}} + f_{1-6} \approx \frac{f_{xxxx} + f_{yyyy} + f_{zzzz}}{240}h^4$$

$$fxxxxxx + fyyyyyy + fzzzzzz\,^6 + \frac{}{+h} \quad O(h^8) \qquad (7.2)$$

$$5760$$

where

$$f_{1-6} := \underset{h}{f_1} + \underset{h}{f_2} + \underset{h}{f_3} + \underset{h}{f_4} + \underset{h}{f_5} + \underset{h}{f_6}, \quad f_{7-18} := \underset{h}{f_7} \cdots \underset{h}{f_{18}}, \text{and}$$

$$f_{\frac{1}{2}} := f(\tfrac{}{2},0,0) + f(-\tfrac{}{2},0,0) + f(0,\tfrac{}{2},0) + f(0,-\tfrac{}{2},0) + f(0,0,\frac{h}{2}) + f(0,0,-\frac{h}{2}),$$

sixth-order convergence can be achieved by first choosing

$$\beta_7 = \frac{109}{15120} \qquad (7.3)$$

and then adding (7.2) to the discretization such that

$$R_{\phi_0} \approx \left\{\frac{-1}{120960}\left(\frac{\partial^6 f}{\partial x^6} + \frac{\partial^6 f}{\partial y^6} + \frac{\partial^6 f}{\partial z^6}\right) + \frac{\kappa}{3024}\left(\frac{\partial^8 u}{\partial x^4 \partial y^4} + \cdots + \frac{\partial^8 u}{\partial y^4 \partial z^4}\right)\right\}h^6$$
$$-\frac{31}{60480}\left(\frac{\partial^6 f}{\partial x^2 \partial z^4} + \cdots + \frac{\partial^6 f}{\partial y^2 \partial z^4}\right)h^6 + C_0^6(x_0, y_0, z_0)h^8. \qquad (7.4)$$

Thus, the sixth-order discrete representation of the equations may be described as

$$\mathbf{H}\Phi = \mathbf{Q}F - F_{Qh}, \qquad (7.5)$$

where the stiffness matrix **H** is composed by (6.2) and the mass matrix is composed by (6.3) with $\beta_7 = \frac{109}{15120}$ and F_{Qh} given in (7.2). Similar sixth-order computational experiments have been demonstrated in [13].

8. Conclusion

We have demonstrated the effectiveness of the finite volume discretization approach in developing efficient higher-order accurate schemes for the three-dimensional Poisson's equation based on the equation error method. Using a more balanced integral form of the equation to formulate the local error expansion provides for an efficient framework for a more complete local flux modeling on the computational domain that ensures local accuracies as well as uniform higher-order accurate convergence of the resulting schemes. In particular, using the 27−point stencil local support for both the mass and stiffness matrices in the discrete equation achieves robust higher-order accurate convergence, and very suitable for large scale eigenvalue problem in 3D due to local accuracy improvements for finer resolutions. Though, both the 19−

point and 27−point local supports yield fourth-order accurate schemes, the 27−point support yields a much better local accuracy as demonstrated through the eigenvalue estimates.

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An Overview of Moderating Effect of Familiarity on Tourism Resources and Future Behavioural Intentions: A Study on Domestic Tourists Visiting Ningxia, China

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ABSTRACT

Tourism resources is one of the most important destination attributes which helps to create an image for the destination and attract the tourists. This study aims to investigate how the domestic tourists visiting Ningxia evaluates Ningxia's destination attributes (Tourism Resources) and how their evaluation future behavioural intentions, that is, their intention to recommend and to revisit Ningxia. The study will also investigate how destination familiarity moderates the relationship of destination attributes evaluations and future behavioural intentions. In the current study, the researchers reviewed the literatures in order to explore domestic tourists' travelling behaviour, experiences, and some extensive discussions on their satisfaction level. The researchers have conducted a general search for tourists' behaviour, and more specifically on moderating role destination familiarity on future behavioural intentions. This study made the contribution towards body of knowledge by reviewing previous literatures related to the evaluation of destination attributes. The study revealed that, when tourists choose a place to visit, they are attracted by destination attributes, more specifically by tourism related resources in the destination.

Keywords: Destination Attributes, Tourism Resources, Destination Familiarity, Future Behavioural Intentions, Domestic Tourists, Ningxia China

Introduction

Tourism is considered as an economic driver for present and future generations for many countries for its socio-economic contribution (Mahadevan, Amir, & Nugroho, 2017). According to UNWTO (2017), 2016 was an outstanding year for tourism in terms of economic contribution to the world. In Africa and Asia Pacific region, international tourist arrivals had increased for the 7th consecutive year to reach 1.235 billion (a growth of 4% over 2015) with the strongest growth recorded (UNWTO, 2017).

Tourism industry is said to be highly dependent on natural resources, due to that the tourism industry is vulnerable to natural disaster (Jiang & Ritchie, 2017). Besides the natural disaster, the tourism industry in some countries face challenging moments from some man-made disasters which lead to the decline in international tourist arrivals (Ritchie, Crotts, Zehrer, & Volsky, 2014; Horner & Swarbrooke, 2016), such as communication crises (Luo & Zhai, 2017), economic crisis (Eugenio-Martin & Campos-Soria, 2014), and geopolitical tensions (Avraham, 2015). On these circumstances, domestic tourism plays a significant role by sustaining services and jobs, compensating the loss of inbound tourism and reducing the disparity amongst regions' development (Yang, Wang, & Chen, 2011; Hosie & Pforr, 2016). Domestic tourism is also the key to national integration (Nair & Ramachandran, 2016), besides redistributing wealth within the country, stimulate domestic demands and employment, and counter the seasonal nature of international tourism (Rogerson & Visser, 2011; Okello, Kenana, & Kieti, 2012). Because of this, most governments are now promoting domestic tourism (Patwary & Hamimi, 2016; Molokomme, Tsoanamatsie, Karuaihe, Mashile, & Nhemachena, 2016).

In aligning with other countries, tourism is becoming an important part of Chinese residents' life, especially for those living in the well-developed regions such as in the south and in the east of China (Zhang, Guillet, & Gao, 2012). Level of tourism development was the combination of several factors, such as; the level of economic development, resources and location, infrastructures and tourism policies (Qian, Wang, & Wu, 2012). As shown in Figure 1, in 2017, Chinese tourists made 2.8 billion trips within the country compared to 136.5 million outbound trips. The trend reflects in tourist spending, as total outbound tourist expenditure stood at $220.6 bn, whereas domestic tourist expenditure registered $679.1bn in 2017.

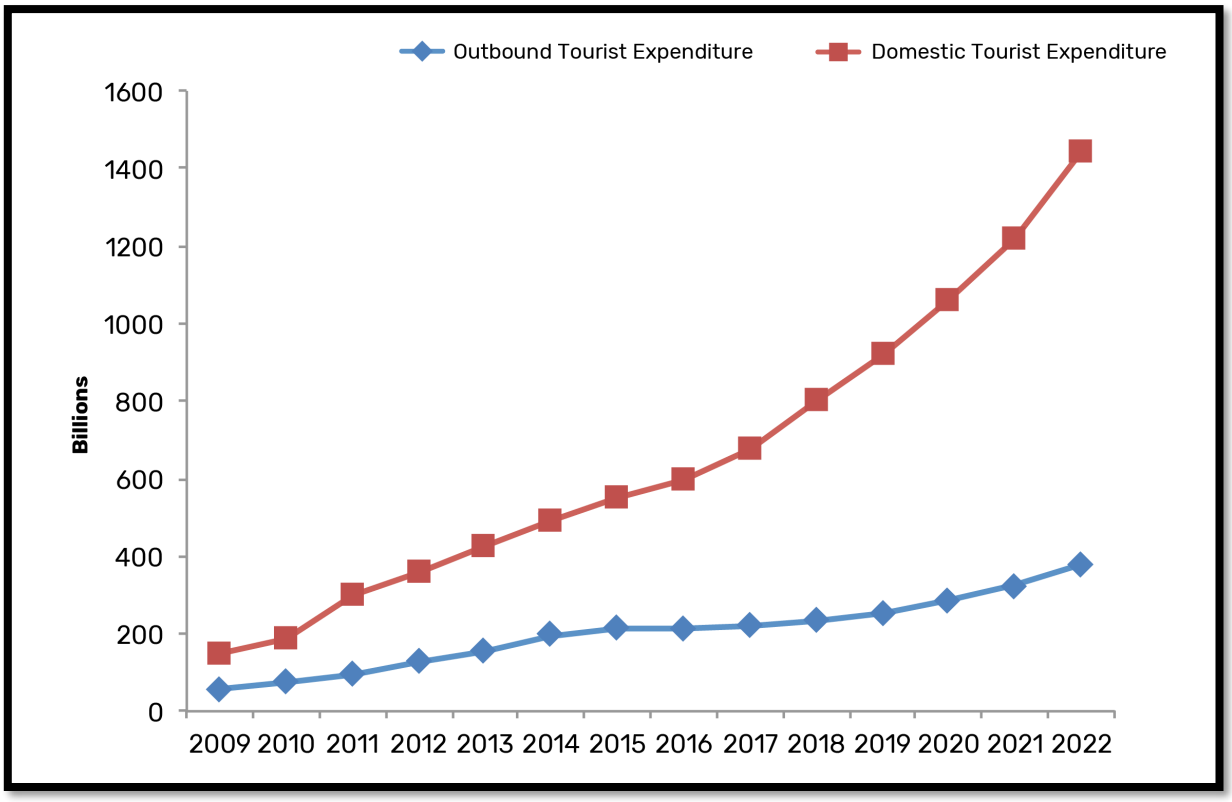

Figure 1: Domestic and Outbound Tourists Expenditures in China (USD); (Source: Global Data, 2018)

The regional unbalance appeared on the development of China which seems sophisticated, although there was a significant gap among the provinces (Goh, Li, & Zhang, 2015). Overall, the level of tourism development in the north-west inland part of China is much lower than the south-east coastal part of China (Luo, Qiu, & Lam, 2016). China's tourism policies have accelerated an unbalanced interregional development through providing less supports for inland regions instead of arranging support for the coastal international tourism industry (Bao & Ma, 2011; Luo, Qiu, & Lam, 2016). This is true for Ningxia Hui Autonomous Region, one of the inland provinces lying in the north-west part of China. Ningxia is known for its beautiful natural landscape and numerous historical sites, and home to the largest concentration of Hui people - a predominantly Muslim minority ethnic group (Gladney, 1998).

This study aims to investigate how the domestic tourists visiting Ningxia evaluates Ningxia's destination attributes (tourism resources) and how their evaluation effect their future behavioural intentions, that is, their intention to recommend and to revisit Ningxia. The study will also investigate how destination familiarity moderates the relationship of destination attributes evaluations and future behavioural intentions.

Literature Review

Tourism Resources

According to Nadeau, Heslop, O'Reilly, & Luk, (2008), destinations refer to the locations such as countries, regions, and cities visited by tourists which have multiple attributes (such as climate conditions, natural and historical values, accessibility) that distinguish them from the other destinations (Sirakaya, McLellan, & Uysal, 1996). Destinations consists of several attributes that significantly affect visitors at different stages. For example, a favourable image of a destination formed by a combination of the destination's attributes which are beautiful landscape, shopping opportunities for tourists, cultural exchange, infrastructure, safety, and activities. These attributes significantly affect tourists' destination choices (Kim, Hallab, et al., 2012).

Tourism resources have been considered as one of the important destination attributes which helps to create an image and attract more tourists on the destination. Herington, Merrilees, and Wilkins (2013), identified six main components of destination attractiveness features through literature: (1) actual attractions are comprised of the natural scenery and climate, and human-made attractions i.e. architectural attractions, historical attractions, cultural event, sporting event, and theme parks; (2) service includes food and accommodation; (3) facilities are accessibility, infrastructure, shopping, transport; (4) reputation includes the overall picture of the destination, attitudes to tourists and tourism; (5) social component is considered how locals look after the destination; and (6) economic is whether the attractiveness of the destination is worth for money spent for the holiday. Based on the above discussion, the hypothesis formulated as below:

Hypothesis 1: *Evaluation of tourism resources in the destination influences the future intentions of domestic tourists visiting Ningxia.*

Destination Familiarity

Destination familiarity refers to the visual or mental impression of a destination or tourist experience and can stimulate travel intention to visit those places (Milman & Pizam, 1995). According to Tan & Chang, (2016), the familiarity has been defined as knowledge about the places, including travel knowledge and information sources, are now extensively accepted influences on destinations attributes. Consumers familiarity with a product or services have been extensively used in product categories (Alba & Hutchinson, 1987) and consumer decision making (Bettman & Park, 1980). Maestro, Munoz-Gallego, and Requejo (2007) pointed that travel destination familiarity plays a vital role in the process of evaluating the information related to the destination. Perceptions of service quality, personality, or satisfaction can affect the evaluated process of destination familiarity, thus, determine the customer's attitude and intention to travel to that destination (Horng, Liu, Chou, & Tsai, 2012).

In this context, destination familiarity has a significant moderating role between destination attributes (tourism resources) and future behavioural intentions. Studies have shown that familiarity has important effects on the destination searching behaviour of tourists (Baloglu, 2001). When tourists are about to select either familiar or unfamiliar destinations, at very first stage, they search memories and previous experiences for familiar information to guide their decision. Tourist familiarity with a travel destination leads them to direct acquisition of available information from their memory. Therefore, tourist experiences and memories could thrive the destination selection process. As stated by Sharifpour et al. (2014), destination familiarity can be conceptualized based on the combination of these aspects, which are awareness, knowledge, experience and expertise. Moreover, the operationalization of familiarity has been inconsistent and blurred by the different definitions of familiarity. Nonetheless, the existing literature regarding familiarity and its related concepts attempted to develop a model for investigating the interdependency between different types of familiarity (Tan & Wu, 2015). Based on the above discussion, the hypothesis formulated as below:

Hypothesis 2: *Familiarity in a destination moderates the relationship between tourism resources evaluations and future behavioural intentions of domestic tourists visiting Ningxia.*

Future Behavioural Intentions

The evaluation of post consumption is a complex process as it involves the measurements of a number of constructs (Weaver, 2012). The consequences of an evaluation are often described in term of tourists' perception of quality, value and satisfaction. However, the result of visit evaluation is more beneficial if it is examined beyond these consequences such as recommendation and revisit (Phillips, Wolfe, Hodur, & Leistritz, 2013). Thus, repurchase intention and willingness to recommend to others are well-established measurements for consumers' future behaviours. Tourism literature has proven that tourists with higher levels of satisfaction are more inclined to visit the destination again, willing to give more positive word-of-mouth (WOM) and to recommend the destination to others (Kuo, Chang, Cheng & Lin, 2016). For instance, satisfied tourists may visit a place and recommend it to others, or they might have a favourable belief about that place (Ranjbarian & Pool, 2015).

On the other hand, an unsatisfied tourist may not revisit the place and will not recommend it to others. The dissatisfied tourist may have negative ideas about the destination and thus impair its market reputation (Patwary & Rashid, 2016; Reisinger & Turner, 2003). Additionally, it always benefits the destination if visitors went home feeling satisfied and spread good word-of-mouth, recommend and encourage others to visit the destination (Patwary & Rashid, 2016). Such positive actions would generate a continuous flow of visitors to the destination and consequently help towards sustainability (Martin, O'neill, Hubbard, & Palmer, 2008). Therefore, anticipating tourist future intentions would be a good way to instrument a destination's future direction.

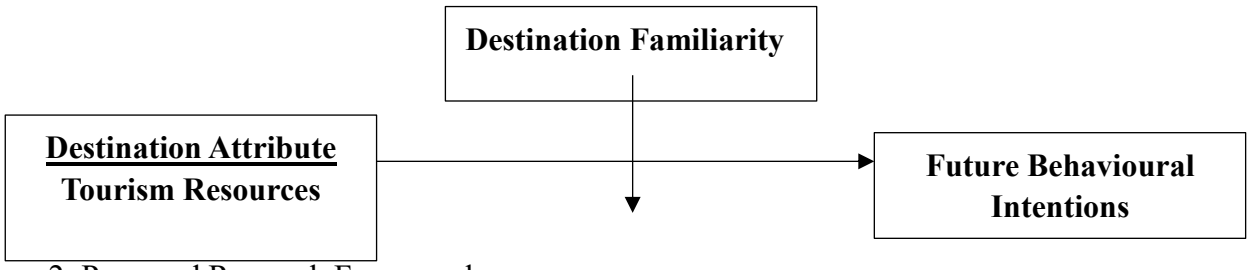

Figure 2: Proposed Research Framework

Methodology

In current study, the researchers relied on existing literature to explore domestic tourists' behaviour, experiences, and some extensive discussions on their satisfaction level. This review study examined the perspective of tourists experience in terms of destination attributes, destination familiarity and future behavioural intentions based on existing literature. Throughout the study, the researchers have conducted a general search for tourists' behavior, and stepwise more specifically on how destination familiarity moderate the relationship on future behavioural intentions. Researchers gathered the information by searching in different online database sources such as Google Scholars, Springer Link, Research Gate, Wiley, Science Direct, Taylor and Francis, JSTOR, Emerald, Scopus, Repository of Universiti Utara Malaysia Library, WorldCAT, and EBSCO HOST etc. During the searching of articles, the researchers have tried to figure out the most relevant articles, conference proceedings, books, published dissertations in order to provide an extensive review of the topic and as well as to provide legitimate suggestions for future study. The review has been examined on the basis of research objectives, methods and findings of the study in accordance with previous empirical and conceptual studies on that particular subject area.

Conclusion and Recommendations for Future Study

China is the largest domestic and outbound travel market in the world and even though international visitors from China are a force too big to ignore, domestic traffic is far outstripping outbound traffic in the country. As a result, a growing number of players are seeking to effectively tap into this market. It is the right time for authorities to look after the development of domestic tourism in China when outbound tourism causes rapid outsource of the money from China. This study contributes to the body of knowledge by review previous literatures related to the evaluation of destination attributes. The study revealed that, while tourists choosing a place to visit, they are attracted on destination attributes, more specifically on tourism related

resources in the destination. In order to increase the repeat domestic visitors, the authorities must consider increasing natural and artificial tourism resources in the destination. When tourists are about to select the destination for next visit, tourists consider their familiarity, memories and experiences related to any particular destination. As a result, tourists familiarity and previous experiences with a travel destination lead them to obtain available information from their memory. Furthermore, by understanding the domestic tourists' travel experience and satisfactions, tourism stakeholders and Ningxia Tourism Bureau will be able to better comprehend what different people want from their visit in Ningxia. The future studies in this area should explore more on empirical investigation rather merely focusing on the basis of literature review. While measuring destination attributes, besides tourism resources, there are other aspects of destination attributes (e.g. tourism amenities, tourism supporting factors, service experience, travel environment).

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The nonverbal behavior of football players: A sociological and psychological study

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Introduction

The relationship among the body, soul and society is not new, but an old relationship as the humanity itself. There are many studies dealt with the body in relation to various sciences, including psychology, sociology and anthropology.

In the modern era, the interest in the sociology and physiology of the body has become a research trend that includes many fields such as communication sciences, folklore and arts. The body has important, expressive and fundamental connotations in expression and nonverbal communication with others, including various movements and gestures as well as the tattoos drawn on different body parts. These have various psychological, cultural and social implications.

Thus, the body represents the other ego of the individual through which he expresses his individual and societal components, and implications that reflect the social and cultural context.

The football game is one of the most popular in the world, followed by many people from different social classes as well as different ages and nationalities. This game has a large audience not only watching the matches, but also follow the movements and emotions of the player and is affected by them as well as follow the details of their personal lives.

Research problem

As football players have such great influence, the idea of this study is to focus on the nonverbal cues specially movements and gestures of the body. In addition to tattoos drawn on different body parts of football players and hairstyles adopted by them.

This research intends to interpret and analyze this phenomenon from the psychological perspective and its relation to the cultural background and social affiliation of the players.

Objectives

The main goal of this study is to clarify the relationship between the nonverbal behavior of football players, and their social status and cultural background. This goal is subdivided into the following objectives:

1- Interpreting the nonverbal behavior, body movement and gestures of the football player form psychological perspective.
2- Explaining the relationship between the body movements and the social and cultural background of the football player

3 - Clarifying the psychological and social meaning of tattoos and hairstyle of football players.

Research Questions

The study seeks to answer the following questions:

1- What are the psychological meaning of some movements and gestures of the body of football players?
2- Is there a relationship between the movements of the body of the football player and the cultural and social background to which he belongs?
3- Is there a relationship between the drawings and tattoos used by football players and their emotional state?

Methodology

Methodological Approach

This study is based on the descriptive method, which is considered one of the most appropriate methodological approach for this type of study. It can clarify the multiple relationships between the body movements of the football player and the outside world, as well as contribute to the interpretation and analysis of it in term of psychological, cultural and social affiliations.

Sample Design

This study is based on the objective sample, by presenting different models of the bodies of football players in European Leagues, and other players in national or regional teams.

Data Collection

Data collection is limited to one tool represented by the content analysis. The study is based on analysis of the body signs of the football player through pictures and videos.

Literature review

Important research in the field of the body and its social and cultural use (Shilling, 2003). The importance of this study for this research is that it presented a fascinating theoretical view of the body in the conception of classical and modern sociologists(Shilling, 2003)

On the other hand, Chris was able to provide her with the body's responses to social and cultural factors for the individual and the community, because such responses are the movement and change of social systems.(sShlling,2003)

In general, Shillinger's study was able to theoretically employ the body in sociological studies.

In order to address the social connotations and meanings of the body within the context of social and cultural context, the research must be based on the precise identification of concepts such as culture, society and group. The most reliable reference is the book by Maurice Godelier entitled Society, group and Culture. Which makes all groups assert themselves as distinct assemblages, Gödelier's idea of distinct groups and their social relations can be used in body signs in football players, expected to be a reflection of the meaning

of community and cultural committed by football player through social and individual ego. (Godelier, 2015)

Psychology is defined as the scientific study of the mind and behavior (Gray, 1991), the study of nonverbal behavior has a distinguished place in the history of science.

Nonverbal behavior refers to all the messages that is coded in words (Eisenberg & Smith, 1971), which contain facial expressions, body signs, hand gestures, eye contact, voice tone and interpersonal distance, (Meuse, 1987; Besson et al., 2004).

From a social psychology perspective, one of the most interesting aspect of nonverbal behavior is that it is rarely totally unregulated in social interactions. A lot of people more try to control their nonverbal expression behavior. They also always try to interpret the nonverbal behaviors shown by others that they communicate with in order to understand those behaviors (Izard, 1994)

Understanding and interpretation of nonverbal cues in communication has been a very important topic to researchers in different fields for many years.

Some early thoughts about nonverbal communication come from Charles Darwin (1872) who published his famous book about expression of the emotions in man and animals. Consistent with facial expressions are the actions that complete and assert behavioral responses, these expressions are happened in integration with other bodily movements. Darwin pointed that these bodily movements are helpful and used to transfer emotions.

Many scientists studied the evaluation of nonverbal behaviors, they thought that nonverbal behavior have developed with the purpose of facilitate and enable animals to communicate emotional information with one another (Tracy & Robins, 2008; Darwin, 1872; Ekman, 2003).

Moreover, Evolutionists suggest that social animals have the ability to produce and identify certain non-verbal behaviors; they express them in practical way to facilitate communication and transmission of an important information.

Social Schema theory and nonverbal behavior

Social schema theory considered one of the most significant theory in social psychology, which has played an important role in understanding and interpret nonverbal behavior.

The main principle of schema-driven theories is that for reasons of effectiveness, people use cues (e.g., physical appearance, posture, gesture, and clothing) from early instances of social interaction to classify a person into a certain type (Fiske & Taylor, 1991).

The main concept of the theory is " person Schema " which is defined as "an individual's knowledge of attributes of a specific type of person and the relationships among these attributes, the person schemes include all the evaluations and judgments of the characteristics of the type of person. In addition, the social schema suggest that when people see or think about someone ,a mental person schema is activated, and try to link between person's characteristics Which in turn leads to adopt behavioral , emotional and cognitive reactions or outcomes according to the conception that developed (Montepare & Dobish, 2003).

Furthermore ,the schema theory suggest that the mere exposure to an image of a person can led to activate the person schema and made some evaluation and judgment that trigging generalization effects that go beyond the information that is actually available. (Harker & Keltner, 2001; Knutson, 1996)
For example, Greenlees et al. (2008) showed in their study that the combination of 90% gaze and red uniform triggered a "good" person (i.e., soccer player) schema, while the 10% gaze and white uniform triggered a "bad" penalty taker schema (Greenlees, etal, 2008)

Previous studies

Many previous researches focused on investigating the non-verbal behavior in sport, and examining the relationship between facial expression and body gestures.
For example, Kerr, Wilson, Nakamura and Sudo (2005) examined the emotional reactions of winning and losing teams at two professional soccer matches. They found that the winning soccer club experienced pleasurable emotions during the match while the losing soccer club experienced increases in unpleasant emotions.
This agrees with the results of Wann, et al (1994) who examined the reactions of winning and losing of a university basketball match, he also state that there are positive or pleasant emotions that associated with winning team and negative or unpleasant emotions associated with losing team.
In the study of Troisi and Moles (1999), they developed a coding scheme (Ethological Coding System for Interviews-ECSI) for measuring nonverbal behavior of soccer players who were interviewed after a soccer match. They found that soccer player may exhibit such nonverbal behaviors as looking away, hand to face, eyebrow movement, smile and shoulder movement (Troisi & Moles, 1999).
Soccer players show different emotions after a match and the range of nonverbal behavior varies among the players due to the different in social and psychological context. Therefore, the present study try to investigate nonverbal behaviors of some players and interpret it through its psychological and social context.

Psychological Interpretation of Nonverbal behavior of some famous players:

The ability to work out what is really happening with a person is not easy, but simple. It is about matching what you see and hear in the environment in which it all happens and drawing credible conclusions. Most people, however, only see the things they think they are seeing.
In this paper, we have chosen two of famous football player and analyzed their nonverbal behavior in critical situation as shown below:

Lionel Messi

The famous Barcelona football player Lionel Andrés Messi in an often misunderstood nonverbal display - that of the "Lateral Lip Purse". A lateral lip purse is a sign of an open decision making process. In difference to the forward lip purse when the lips are pursed to one side, it sends an honest, open and non-secretive

emotional attitude. A lateral lip purse is very commonly seen in shops when a person is deciding between two brands.

Furthermore, Messi's expression here is seen in the configuration of his eyebrows - as they are drawn together and lowered. Lionel is a few seconds into his negative judgment of what he sees is transpiring - and what he believes should have occurred. He is still open about this judgement however - that is a very important distinction (Appendix A).

Cristiano Ronaldo

The famous Real Madrid football player Cristiano Ronaldo

1- Words beyond body language

This photo (Appendix B) was taken after he scored the winning goal against Ghana. It shows the body language of Ronaldo in very critical moment, because he is displaying inconsistent nonverbal behavior.

In spite of higher clapping his hand in a very conscious of symbol agreement, it could be seen that his mouth and mid-face are conveying two negative emotions - primarily that of regret and to a somewhat lesser degree disgust. These facial components occur according to subconscious driven.

Whenever there is a difference between conscious and subconscious directed nonverbal signal - it is the subconscious one - which represent the person's real emotions.

2- Real laughing real emotion

This photo (Appendix C) was taken for Ronaldo after his double scoring and becoming the first player ever to reach 100 European goals in 2015.

It shows moments of truthful laughter, in addition to smiling during excitement and deep pleasure; there is a facial expression component that is not often noted.

The sincere smile of Cristiano Ronaldo can be noticed. It begins with eyes (e.g. with partial eyelid closure) follow by retracting (pulling it back) of his jaw. It was surprising to find how performing these two nonverbal configurations (in this specific order) will jump-start happiness.

Expression of cultural affiliation through dance

From the anthropological perspective, dance can be defined as a cultural practice and as a social ritual (Radcliffe-Brown 1994), whereby dance is seen as a means of aesthetic pleasure and a means for creating ties and specific structure in the community.

Dance researches gives a better understanding of how social characteristics are signaled and formed through bodily movement. Dance transfer complex cultural codes, and the studies of dance history interpret and analysis the practice and the reception of body movements in the context of ethnic and national identities, problems, events and ideologies beyond the field of dance as art..

Franz Boas (1858-1942), the 'Father of American Anthropology was the first the anthropologists who suggested that a study and understanding of movement and dance might actually lead to critical analysis of the structure of a society along with providing new insights into understanding other parts of culture. In the

1920s started to examine dance and responses to it in terms of one's own culture instead of understanding it as a universal language.

Dance as a specific language is a socially historical phenomenon, dependent on the space and time in which it exists, which is mean that Dance is a learned cultural practice.

Many researchers see that societies produce dances and that dance is actually a 'metaphysics of culture', because a culture of specific society is embodied in the forms of material and physical culture (Polhemus, 1993)

African football players show most of these expressions. They often express the joy of winning or aiming in group or individual dances inspired by the local culture, from collective dances, for example the palm wine dance at the Sierra Leonean players, The rapid movement in wars, also the Situfo dance performed by Ivory Coast players inspired by the movement of animals and is the favorite of the tribes.

Mali Country player also dance on Griot music, which is a profession of cultural importance because those who perform it were walking around. They transmit news and events, and they are the custodians of the oral history of the tribe.

One of the movements of the dancing body is also the dance of the harvest by the Democratic Congo players; it gives cultural meanings, as the harvest is considered an important celebration an in society. It is the movements of the body when the football player, which returns to pride in the local culture, played by Real Madrid player "Sergio Ramos" in the celebrations of victory related to the movements of bullfights.

One of the most popular dances of football players with a cultural dimension and an expression of adherence to history, the reggae music performed by Jamaican players, was associated with anti-slavery and belonging to African.

It is important to say that the dance body movements in football emphasize the rights of indigenous peoples: (see arts. 8 and 11 of the Declaration on the Rights of Indigenous Peoples, 2007)

1 - Not to be subjected to forced assimilation and destruction of their culture.

2- Emphasis on ethnic identity.

3- To exercise the right to revive the traditions and customs of their peoples.

On the other hand, each of dances done by football players do not have any cultural meanings, but are done for simulations, for example, dab dance.

Sometimes one may find the simulation of some dances when the football player rejected from the community, for example the penguin dance done by the players of the Union team in Saudi Arabia when celebrating the goal.

Tattoo in Football

Most tattoos are an expression of the social and personal actions and behavior of a football player, especially celebrities, or the tattoos may express cultural dimensions and community concerns that the player wants to express or that Tattoos are no more than a match for the fashion. Tattooing is a state of communication between the player and the community. In many cases, tattooing may be a socially symbolic position. However, the data and information collected for the research showed that most of the

football players are dancing is an expression of emotional states either towards other societies or towards the other cultures.

Some Illustrative examples

Tattoo as an indicator of emotional behavior

Some of the players' drawings are an expression of emotional states indicating their feelings towards others that are: family, wife and children.

For Example, On Zlatan Ibrahimović's right wrist, there are numbers called as the "Zlatan Ibrahimović code". Actually, they refer to the birthdates of the male members in his family. He is also writing names of some children in charity organization to send a message of sympathy to disadvantaged children around the world. Tattoo of Real Madrid player Sergio Ramos refers to his sympathy for the victims of terrorist crimes and others pointed to the fruits of the Real Madrid Championships.

Icardi the Inter Milan player is drawing on his body image of his sons as a message of love to them. Also Dany ALevas Paris Saint-Germain player drawing image of his wife to express his love for her. Gabriel Jesus Manchester City player, drew a tattoo of his mother's image as an expression of his love to her. Chilean Vidal also drew a picture of his son in solidarity with his diabetes.

Tattoo as an inductor to cultural affiliation

Many football players drawing on body shows their cultural affiliation, for example, the Colombian player Falcao, who design a picture of a Red Indian holding a stock to indicate his belonging to the culture of red Indians. Zlatan Ibrahimović draw on his right side, a red dragon. This dragon stands to brag out his warrior personality. In addition, it is believed to have emerged from Japanese culture. Dragons otherwise are a good omen too, as they stand for endurance, stability, and determination.

In addition, a number of African players put on their body's drawings of predatory animals to indicate their belonging to the forest that represents the continent of Africa.

Hairstyles of football player

Cutting and decorating the hair of football players are four physical states reflecting the use of the body.

The first is commercial, advertising and marketing example of the English player David Beckham and later it was noted at Messi and Neymar.

Second: the state of expression community, cultural and historical example of the hairstyle of Napoli player Merle Hamsik. Some players decorate their body through hair haircut to admire certain historical situations such as the player Rome team Maiconon characterizes hair haircut in a helmet fashion Roman soldiers.

The third is a steady emotional and emotional state of mind. An example of this is the hairstyle of the Italian players Estefan Sharaoui, Guyan Asimawa and Abumayang.

The fourth is a physical and emotional state that can be modified and changed. For example, the hairstyle of Giovanni Simone, the French player of Nice, Mario Politely, as well as the most famous soccer players such as Cristiano Ronaldo.

Conclusion:

In general, the research concluded that the football player was able to use the body in many cultural and societal situations and the structure of the different social relations. It also represents a transmitter and receiver of the social and cultural space in which the footballer lives.

These results can be summarized as follows:

1- Nonverbal cues and behaviors are due to a lot of psychological and social factors.
2- Individuals nonverbal behaviors and especially football player Is an expression of real emotional state
3- Nonverbal behavior could be understand especially if it not agree with what he says
4- Tattoo is an expression of psychological feeling
5- The use of dance as one of the body in football is a confirmation of the collective cultural and societal ego, especially when African football players and Latin America.
6- The body dance in football often have meanings related to the environment, geography and history.
7- Football players are used body to clarify the right to practice the traditions and customs of the people.
8- One of meanings for body in football is preserving the cultural heritage.
9- One of the body functions of in the football, (dance or tattoo or hairstyle) emphasis on ethnic.

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Appendix

Appendix A

Appendix B

Sistematization of Assistance in Nursing in a Post Anesthesic Recovering Unit, Experience Report

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Abstract

Aim: *to describe the process of implementation of the Sistematization of Nursing Assistance (SNA) in a Post Anesthesic Recovering Unit of a general hospital.* ***Methodology:*** *It concerns to an experience report that emerged from the acting as a nurse in the respective unit, allied to the insertion in the Post Graduation lato sensu course in Nursing in a Surgery Center, Anesthesic Recovering and Center of Sterilization material in a private university of the state of Rio Grande do Sul.* ***Results:*** *the implementation of the Sistematization of Nursing Assistance is a process that requires culture change from the old paradigm of practicing Nursing that, sometimes, is reluctant in registrating its actions. In this sense, the nurse performs an important role that goes from the expansion of the scientific knowledge, followed by educational actions directed to the nursing staff, until the implementation, monitoring and evaluation of the quality of the patient assistance, extended to the relatives.* ***Final considerations:*** *during the implementation of the sistematization of the nursing assistance several difficulties emerged from the nurses concerning the execution, knowledge and staff quantity. Besides that, it was evidenced that the use of information technologies can be used as a facilitator factor in the operalization of the daily actions of the nurse and, in this way, contribute to decrease possible errors and to obtain greater reliability to caring. It was evidenced gradual empowerment of the nurses during the implementation of the assistance, and this one, besides contributing to the expansion of quality and safety of the patients, increased their recognition by attended patients.*

Keywords: Nurse, sistematization of Nursing assistance, information technologies.

1. Introduction

The Unit of Post Anesthesic Recuperation (UPAR) is the place where the patient who had undergone a surgical anesthesic procedure keeps under monitoring and intensive care (NUNES; MATOS; MATIA, 2017). It has as a purpose to provide structural and functional conditions to attend the patient in Immediate Post Operative (IPO) until the recovering of the hemodynamic stabilization consciousness under the care of the nursing staff occurs (SOBECC, 2013).

The nursing that works for UPAR should be alert and prepared to prevent and detect early complications in post anesthesic surgical patients and, in this way, give immediate assistance. In this

context, the need of capacitation and trainings reverberates on the conditions of these professionals who are able to continuously evaluate the patient and contribute in the reduction of the risks related to this period of critical care of high complexity. And, in this way, keep themselves alert in order to identify and intervene in possible events that can compromise the safety of these patients (SOBECC, 2013).

The SOBECC (2013) highlights that the patients' complications in the IPO refer to the preoperative clinical conditions, to the type, time and extension of the surgery besides the anesthesic ans surgical complications that can occur. For Possari (2003), even after the end of the anesthesic surgical procedure, the patient still keeps prone to respiratory, circulatory and gastrointestinal complications. Concerning the probable complications to which the patient is exposed to, it is up to the nurse to plan policies and actions for his care.

The role of the nurse in the UPAR is essential for an integral and safe assistance to the patient in the IPO. For that, this professional needs to have knowledge, abilities and competences to promote post anesthesic and operative care to the patients that have undergone different kinds of surgical procedures. It is also up to him to lead and to capacitate his staff to supervise the developed activities, to manage the needs of the respective unit, aiming at functionality and also at the participation of the several adminsitrative demands concernig the planning and the management of the institution (SOBECC, 2013).

Furthermore, it is up to the nurse in the UPAR to coordenate and to implement the health assistance based on the individual's needs in the IPO. For that, it is necessary for the professional to seek for technical, scientific and humanistic improvement to promote personalized and efficient care for the patient. And this improvement consolidates the profession with the use of a scientific methodology of work, represented by the Nursing Process (NP) and, more specifically, by the Sistematization of the Nursing Assistance (SNA) (COFEN, 2009).

The SNA is regulated by the legislation that guides the professional performance of the nurse. According to the Resolution 358/2009 of the Federal Council of Nursing, the SNA organizes the professional work concerning the method, the staff and the instruments, in such a way to turn it capable for the operalization of the NP. The NP makes part of the process of the SNA and according to what is preconized on the same resolution, it is a duty of the nurses while practicing the care to do it in a methodical and systematical way in public or private health institutions (COFEN, 2009). The NP is defined as an instrument that guides the care and documents the practice in order to turn evident its effective accomplishment (BENEDET; GELBCKE; AMANTE; et al., 2016).

Implementing the SNA in nursing daily routine, brings more safety to the patients and their relatives, improves the quality and humanizes assistance, ensures the professional's autonomy, as it organizes the nursing work through the NP. The accomplishment of the NP gives visibility to the nurse's work with a positive impact in patient´s care in IPO (SOBECC, 2017). Equally, it consolidates the care resulting from the planning stages, execution, control and evaluation of the direct and indirect assistance actions to the patient (MATOS; FERRAZ; GUIMARÃES; et al., 2015).

Regarding the NP, Gaidzinski (2008) defines it as an instrument in shape of a 'systematized guide' for the development of a thinking style, which leads the professional to a clinical evaluation necessary to the definition of nursing care. It predicts that nursing asistance should be guided by the patient's evaluation,

and in this way the nurse can obtain data to list the nursing diagnostics. The NP contemplates five stages: historical background, diagnosis, prescription, implementation of care and evolution (SILVA; SOUZA; SILVA, 2016).

In surgical patient's care, as well as in other sectors that give assistance to the patients, it is essential the use of the SNA as the guide of care. In this sense, the application of the systematization of the perioperative nursing assistance (SPNA) was indicated by Castellanos and Jouclas in 1990. The authors report themselves to the integral, individual and continuous care in order to attend the patient´s needs. In this way, the SPNA constitutes itself in the supportive basis of the nursing care in the Surgical Center. (SOBECC, 2017).

The SOBECC (2017) describes in its recommended practices the objectives of the SPNA, among them the highlighted ones are: to promote the comprehension of the patient and relatives about the anesthesic surgical procedure; prediction and provision of human resources and materials used for the procedure; to reduce inherent risks of the use of equipment, materials of the surgical center and UPAR environment

In 1990, Castellanos and Jouclas have already described the use of NP in surgical patients and proposed the operability of SPNA in five moments: preoperative nursing visit; perioperative assistance planning; implementation of assistance, evaluation of the assistance through post operatives nursing visits and reformulation of assistance to be planned, according to obtained results and solution of situations not desired or the occurence of adverse events. Nowadays, the SOBECC recommends this operability.

Even though being a tool that facilitates improvements at the nurse's work in terms of visibility and improvement at the care given, studies point out several barriers in the execution of the SNA (BENEDET; GELBCKE; AMANTE; et al., 2016). Among some of them, we highlight insufficient professionals, nurse's overload of work, production of an incoherent SNA that makes the professional nurses's practice unfeasible; lack of knowledge, lack of engagement of professionals of the field in this process (SILVA; ALMEIDA; OLIVEIRA; et al., 2016). It is considered that these difficulties show how much the nurses need to work for the implementation of the SNA as a practice in the hospital environment as well as in the basic health care network.

Based on these considerations, combined with the importance of the SNA for a quality care of the patient during the Post Graduation Course *latu sensu*, I felt motivated to reflect on the use of the SNA as a tool for the nurse care. In this sense, we seek through this work to contextualize the experience of implementation of the SNA in a Post Anesthesic Recuperation Unit.

2. Methodology

It concerns to an experience report developed from the implementation of the SNA at the UPAR of a general hospital. We consider important to define an experience report that according to Cavalcante; Lima (2012) is a modality of research that seeks to reflect about one or several actions refering to a specific situation experienced at the professional field and relevant to the scientific community. The research starts from the premise that the practices can be improved through the description and analys of objective and direct observations (BORGHETI; VIEGAS; CAREGNATO, 2016).

The present work was developed during the year of 2017. To better situate the reader, the referred UPAR in question is established in a philantropic hospital of medium size located in the region of the northeast of the state of Rio Grande do Sul, a regional reference among others for the services of traumatology, neurosurgery, urology, obstetrics, general surgery and orthopedics.

The Unit counts with 12 hospital beds for immediate anesthesic recovery, a staff of eight nursing technicians that work from 7 a.m. to midnight and a nurse. It is a closed unit of limited access alocated at the same physical area of the local Surgery Center where the monthly average is of 650 surgeries.

3. Lived experience

In order to value the nursing practice in the institution and in relation to legal requirements, the need of the nurses to enrich and improve their practices come about. In this context, the desire of instituting the SNA in the refered institution emerged. A group of studies composed of 4 nurses was created motivated by the interest of learning and knowing about the application of the SNA as a guiding practice of care. These nurses worked in the several assistential fields by the premise that the SNA is a tool of the assistential process of the nurse and that contributes to amplify the quality of assistance to the patients (SOARES; RESCK; TERRA; CAMELO, 2015).

The NP in the referred institution in the period that preceded the creation of the group was done in a concise way and basically in the Intensive Care Units (ICUs). An interview with the patient and a relative made part of the moment of the admission in the ICU. Besides this, the nurse makes a physical anamnesis that subsidizes the writings of the health background of the patient. Sequentially, the main care actions to be implemented by the nursing staff were listed and all the registrations occured in a manual way and were attached to the medical records of the patient. At the Surgery Center and at the UPA, both the SPNA and the NP were informally developed and not documented. The organization of the surgeries rooms, of the surgical staff, prediction and provision of equipments, materials and hospital beds at the UPAR were systematically accomplished, however, without a *Check List* or protocol.

The nurses that integrated the group were aware of the need of the use of the scientific methodology to improve the assistance in the hospital as a whole. This statement reinforces Malagutti, Bonfim (2013) theories as they state that the SPNA goes beyond the patient´s satisfaction, stands out for the quality of the service and for the safety in the execution of care. In this way, the documentation of the SPNA at UPAR and the use of SNA got started.

The acquisition of an information system by the institution promoted the execution of the NP in an eletrocnic and virtual way attending the needs expressed by the nurses in order to facilitate the execution of the NP. In this sense, the technological evolution and the demands of the health field require from professionals the incorporation of new technologies that allow safety and reliability to the work processes (SOBECC, 2017). The use of high technologies and technological products in patient´s care integrates the constant evolution of the health field and it is the trend of the technological advances in nursing, to promote operational and strategical benefits in care practice. (REZENDE; SANTOS; MEDEIROS, 2016).

From the acquisition of the informatized system by the institution, the nurses felt motivated to expand their knowledge to subsidize them in the software construction. As for that they participated

effectively in several courses, lectures, and seminars in order to aggregate knowledge about the topic. Allied to this, technical visits in other institutions that contributed to get to know experiences of other professionals in different realities were accomplished. We evaluate as positive all the iniatives of the group in order to make possible the use of the tool in the information system of the institution and to facilitate the long way of parameterization of the system with the work processes. Against the complexity of the accomplishment of the nurse in the perioperative should constantly keep updated to evaluate the stages that integrate them (SOBECC, 2017). Concomitantly, the stage of feeding the system with pertinent information to the accomplishment of the NP in the different assistential units got started. The group members of the study group started to ask for the other nurses of the hospital that they equally enlarged their knowledge in order to subsidize them in the definition of the more adequate diagnosis of nursing for each field. In this field, Gaidzinski (2008) points out that the diagnosis of nursing constitutes itself in a tool that turns possible to make inferences from subjective information coming from patients and obtained from the nursing background. The author adds to it while stating that the nursing diagnosis consists in the comprehension and definition of clinical situations with the potential of being modified by the nursing actions.

The definitions of diagnosis that makes part of the sistematization of the assistance at UPAR were based on the legislation and in the reading of updated articles, refering to the topic and/or that approached the specific diagnostics to each kind of surgical procedure and/or mental conditions. The purpose of this selection constitutes in attributing nursing diagnostics that enable interventions and adequate results for the patient care in IPO (VIEIRA, OLIVEIRA, CARVALHO, 2016). And the use of standardized language to all nurses having as an international reference NANDA (SOBECC, 2017).

The data collection during the interview and patient´s anamnesis permits listing the problems in the process of health and disease. Taking this into consideration, they are important to signal their needs and to elaborate nursing diagnosis that will significantly contribute for caring (NANDA, 2015). So that the nursing diagnostics can be composed, the data collection and patient´s anamnesis contribute for the identification of patient´s problems aiming at effective actions of the nursing staff (DEBONE; SILVA; CÂNDIDO; et al., 2017). The grouping of background data will result in the choice of nursing diagnostics that better attend the needs of the patient and the family with interventions that culminate with expected results (COFEN, 2009).

After the information was compiled in the system with the stages of the NP, the other nurses were properly prepared and instrumentalized for the use of the tool. We've chosen the adult IUC as a pilot unit to test the software properly fed with nurses' information. After that small adjustments to the use of the NP occured in the other assistential units of the institution. At the UPAR, to start the use of the tool, patients submitted to procedures of big size and attended in the reffered unit were used as a criterion of accomplishment of the NP considering the insufficient quantity of nurses in the sector.

For that, the Federal Council of Nursing considers the implementation of the SNA and of the NP a tool of continuous improvement and safety for assistance and recommends it to be applied for all patients (COFEN, 2009).

The NP constitutes itself as scientific methodology of the nurse to organize the nursing assistance, from the interrelated and interdependent stages (BENEDET; GELBCKE; AMANTE; et al., 2016). The NP

was implemented by me and it starts by the reception of the patient at UPAR through the receiving of the work shift by the nursing staff of the surgical center and of the anesthetist. At this moment, information pertinent to care, monitoring and initial stabilization of the patient are conveyed. On this stage, the data collection and anamnesis take place, a moment in which the information of the patient´s previous medical background are reinforced. These information have already been verified in the preoperative interview such as preexisting diseases, alergies, emotional state, information about the patient´s general state. Besides these information, there are also the ones refering to the transoperative that include a kind of anesthesia, complications, updated clinical conditions of the IPO: pain, heart beat, respiratory frequency, high blood pressure and body temperature. NANDA (2015). The evaluation is reported as a continuous procedure of the NS and it is used for the data collection, validation of the selected diagnostics that helps on the choice of nursing actions to be prescribed.

These information obtained during the interview and data collection after being added to the software make possible to compile the nursing diagnostics that better relate to the patient's background and medical conditions. Having the list of the possible preselected diagnostics, the nurse selects and confirms the nursing diagnostics compatible to the assistance objective. In this context, the nurse identifies and evaluates the relevance of the data obtained and turns them into nursing actions to qualify the assistance and, in this way, improves the patient's health condition (NANDA, 2015). The author states that the nursing interventions based on the diagnostics add to the medical treatment in order to promote, recover and protect the patient's health (NANDA, 2015).

It is considered importante to highlight what NANDA points out in relation to the performance of the nurse as a good diagnostician. She reports the need this professional has of developing abilities and competences for that and emphazises the intellectual, interpersonal and technical knowledge, tolerance, ambiguity and the practice of reflection as important aspects for the practice of diagnosis (NANDA, 2015). A study in the School Hospital of João Pessoa in the state of Paraíba identified the diagnostics, results and nursing interventions in a post surgical unit between the years of 2011 and 2012 (VIEIRA; OLIVEIRA; CARVALHO, et al. 2016). The authors found the prevalence of: risk of infection, anxiety, impaired sleep and rest, high blood pressure, impaired ambulation, integrity of impaired skin, weight loss, constipation and impaired body hygiene.

After the selection of pertinente diagnostics I seek to list the respective nursing interventions among the ones selected in the software for later prescription of nursing These interventions aim at contributing for the fastest and safer recovery of the patient who has undergone an anesthetic surgical procedure. In this context, it is up to the nurse to list the nursing interventions to reach expected results in the patient extended to the family (COFEN, 2009). In order to promote prevention, education, protection, recovery and health maintenance from the planning of care plan (SOBECC, 2017).

Sequentially, the prescription of nursing to the patients attended at UPAR and accomplished in the system and printed for the listed caring actions. This is also attributtion of the prescriber nurse, moment in which it is sought to evaluate the needs and possibilitiets of the patient and of the staff for better performing the prescribed care.

It is highlighted that the validity time is given by shifts, with the use of the letters "M" for the

morning shift, "A" for the afternoon shift and "N" for the night shift. In what the implementation of the prescribed care is concerned, the nursing staff when performs them, checks the reffered item what ensures that a specific care was accomplished for the patient. The nursing technicians play an important role inside the NP as they participate in the implementation of the care actions together with the the nurse. This postulation reinforces SALVADOR; RODRIGUES, et al. (2017) ideas when they point out that the nursing technicians need to understand the purpose of the NAS in the patient's care to adhere and participate of the systematization process.

The fifth and last stage of the SNA at UPAR in which I work consists in the evolution of nursing accomplished directly at the patient´s virtual medical records. The respective registration is done by the nurse after the evaluation of alterations that occurred with the patient in a certain period, a report of the detected problems, patient´s reactions refering to the problems brought up and reactions of the patient concerning the adopted manner in the period of anesthesic recovery. This stage heads towards the preconized by SOBECC (2017) in which he emphazises it should be done by the nurse in a continuous and systematic way, with checking of actions, in special if they were effective for the process of recovery and if there is the need of improvement and/or adaptation.

4. Conclusions

The SNA and the NP are not a novelty in the nursing work context and, even so their practice is still a challenge. They make it possible to qualify and organize the nursing work, valuing their performance in the care process. However, it is visible how much this practice is still a difficulty in the professionals' every day work that facing the realities od their activities, which at some times, end up leaving behind the possibility of improvement.

The several demands imposed by the health institutions that suffer with the current economic conditions, not enough labor, scrapping of equipments, lack of materials and medicine. Besides that other demands imposed by the wok of the nurse such as to manage the staff, to execute trainings and to supply assistential needs also demand time and energy from the nurse distancing them from the essence of their work. This fact is worsen by the insufficient number of professionals what makes it difficult for the NP to be applied in all patients.

On the other hand, the lack of knowledge of the nurses was also a difficulty for the implementation and execution of the NP what brought up conflicting feelings among the staff. Some of them reacted positively while others showed aprehension with the new proposal of work. For that, it was made evident by the members of the comission, the need of their awareness concerning the possibilities of the use of SNA as a tool demystifyng the work.

The novely always causes discomfort. Professionals capacitation programs for nurses and nursing technicians in order to fulfill the gaps in their formation are essential for the success of the SNA. The comprehension of the purpose and the competences in the systematization of assistance are barriers for the participation and adhesion.

During the stage of implantation of the NS in the institution, it was made clear the several barriers that the nurses find for its execution such as reduced quantitty of staff, great demand of activities and

demands. However, it is possible to perceive that the diffculties are gradually being softened and we get closer to an ideal. For the SNP to find positive results it is necessary for the staff to dominate the topic.

The improvement of the health systems depend on the available resources and the way they are applied. Trainings and capacitations just tend to contribute for the success of institutions. The empowerment of the nurse as a professional concerning their role in the systematization of assistance doesn´t only reverberates in a humanized and qualified care, but also, in recognition and professional satisfaction that as a leader in the process of caring plays an essential role in primordial warmth to the patient´s, family and community health.

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Estimation of Serum Iron and Ferritin in Patients with Chronic Renal Failure

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Abstract

Background: The incidence of renal failure, and potentially of CRF, is increasing steadily in Sudan. Anaemia is an accompaniment and independent risk factor for the development of cardiac dysfunction along with other complications. It is also responsible for 40-50% deaths in CRF patients. For this reason, the quick and accurate diagnosis of anaemia should help in decreasing the morbidity caused by CRF. The correction of anaemia, e.g. by the administration of iron supplements and/or erythropoietin, should help improving the general outcome of CRF.

methods: Fifty patients with chronic renal failure, already diagnosed clinically and on laboratory basis were selected as a sample group. Another 50 healthy individuals not known to have renal disease were selected as a control group. 5 ml of venous blood was collected in lithium heparin container for iron and ferritin. Concentration of iron was measured by colorimetric method by using SPINREACT™ and serum ferritin by Turbilatex-Ferritin kit. The data obtained were analyzed by using statistical package for social science (SPSS) on programmed computer. **Results:** The mean ± SD of serum ferritin was calculated in patients and controls and it was found 72 µg/L ± 16.2 for patients and 96 µg/L ± 19.7 for controls the (*p-value* 0.000). Also the mean ± SD of serum iron was obtain from patients and controls and was found 41µg/dL ± 29.2 and 87 µg/dL ± 47.5 respectively with (*p-value* = 0.000). There were a weak negative correlation between serum iron and serum ferritin concentrations in patients and controls (R -0.161). **Conclusion:** The study concludes that serum iron and ferritin levels in CRF patients are significantly low in comparison to healthy controls.

Keyword: Ferritin, CRF, Iron

Introduction

CRF is progressive loss of renal function over a period of months to years. High blood pressure and diabetes mellitus are the most important causes of CRF. CRF can lead to cardiovascular disease and anaemia [(1)]. Anaemia is a major and severe haematological complication in these patients. CRF can only be detected

by blood test for creatinine and when it is high it indicates decrease in glomerular filtration rate (GFR) as a result of decreased capacity of the kidney to excrete waste product. Signs and symptoms of kidney failure are hypertension because of increased fluid overload (also leading to swelling and oedema), decrease in calcium level [(1)], metabolic acidosis and erythropoietin synthesis defect which leads to anaemia [(2)]. Anaemia in patients with CRF is due to many factors. Erythropoiesis and iron homeostasis are impaired as a result of a complex chain of events, including the relative deficiency of erythropoietin, chronic inflammation, blood loss, decreased iron absorption and utilization [(3)]. Anaemia is an independent risk factor for the development of cardiac dysfunction like increased cardiac output, cardiac enlargement, left ventricular hypertrophy and congestive heart failure. It also decreases the quality of life and exercising capacity [(4)]. Haeme is an iron-containing porphyrin derivative (an iron chelate of the protoporphyrin IX) that gives haemoglobin its red colour. Functionally, haeme is a prosthetic group for many proteins and enzymes involved in oxygen metabolism and electron transfer reaction. Most (2500mg) of serum iron is bound to the red blood cells haemoglobin, 3mg is bound to transferrin, 500mg is bound to myogloblin and some enzymes (e.g. cytochromes) and 600-1000mg are stored as ferritin or haemosidren [(3)].

Iron is stored inside a protein called ferritin and thus serum ferritin test provides information about the iron level inside the body. Ferritin serves to store iron in a nontoxic form, to deposit it in a safe form, and to transport it to areas where it is required [(5)]. The function and structure of the expressed ferritin varies in different cell types and can be used to diagnose anaemia. The ferritin levels measured have usually direct correlation with the total amount of iron stored in the body. If the ferritin level is low, there is a risk for lack of iron, which could lead to anaemia [(5)]. The normal serum ferritin values are as follow: in children 6 month to 15 years = 7-140mcg/L, in men = 18-270mcg/L and in women = 18-160 mcg/L. Ferritin levels, chronic renal failure, anaemia and their relationship are some of the most researched topics in biomedical field. A study conducted by Khanam *et al.* in Bangladesh (2013) revealed that serum iron & serum ferritin in CRF was significantly low [(6)]. In 2002, Hsu *et al.* published a study on the epidemiology of anaemia associated with chronic renal insufficiency among adults in the USA. The result showed that serum ferritin in 47% of woman and 44% of men was lower than reference value [(7)]. In 2013 Rao *et al.* found that haemodialysis patients had serum ferritin ≥100 mg/L compared to a median patient value of 436 mg/L [(8)]. A Russian study published in 2013 reported a strong correlation between the diastolic dysfunction and left ventricular hypertrophy seen in patients with end-stage renal failure and the severity of renal anaemia. Adequate correction of renal anaemia (and arterial hypertension) has helped in the alleviation of patients' symptoms and it has also resulted in significant reduction in number of cases [(9)].

Materials and methods

This study is a laboratory analytical case control study, which was conducted in Suba University Hospital in Khartoum State, during the period of 3 months. A number of 100 subjects were enrolled in this study, they were classified into two groups, 50 patients already diagnosed clinically and on laboratory basis were selected as a case group. Another 50 healthy individuals not known to have renal disease were selected as a control group. Five mL of venous blood were collected (using 70 % ethanol as skin disinfectant) in lithium heparin. Blood was centrifuged for 3-5 minutes at 4000 rpm/min and plasma was then collected.

Concentration of iron was measured by FerroZine - Colorimetric method. Also the concentration of ferritin was measured by Turbilatex Ferritin methods using SPINREACT™ (manufactured by Spinreact, Santa Coloma, Spain) for iron and ferritin. For internal quality control, normal and pathological control sera were analyzed to monitor the performance of manual assay procedures. The data obtained were analysed by using statistical package for social science (SPSS). T-test was used to compare between control and patients and the results were expressed as (mean ± SD). Also regression analysis was used and the results were expressed as (R) and (R2).

Results

This study was carried out on 50 patients diagnosed as having chronic renal disease and 50 healthy individuals not known of having any renal diseases or a history of other disease.

Table (1) shows comparison of the mean value of serum ferritin level between CRF patients and the control groups. It can be seen there was a significant decrease in serum ferritin in CRF when it was compared with the control group (*p-value* = 0.000).

Table (2) compares the mean value of serum iron in CRF patients and control group, it also shows a significant decrease in serum iron in CRF patients than control (*p-value* = 0.000).

Figure (1) demonstrates a weak negative correlation between serum iron and serum ferritin concentrations in the CRF patients (R= - 0.161).

Table 1: Comparison of mean value of serum ferritin in CRF patients with that in the control group determined by using (Turbilatex-Ferritin) method

T-test	Type	N	Mean	Std. Dev	SEM	P-value
Serum ferritin µg/L	Patients	50	72	16.2	2.1	0.000**
	Control	50	96	19.7	3.4	

P-value less than 0.05 is considered as statistically significant.

**Significant.

Table 2: Comparison of the mean value of serum iron in CRF patients with that in the control group determined by using (FerroZine. Colorimetric) method

T-test	Type	N	Mean	Std. Dev	SEM	P-value
Serum iron µg/L	Patients	50	41	29.2	4.1	0.000**
	Control	50	87	47.5	8.3	

P-value less than 0.05 is considered as statistically significant.

**Significant.

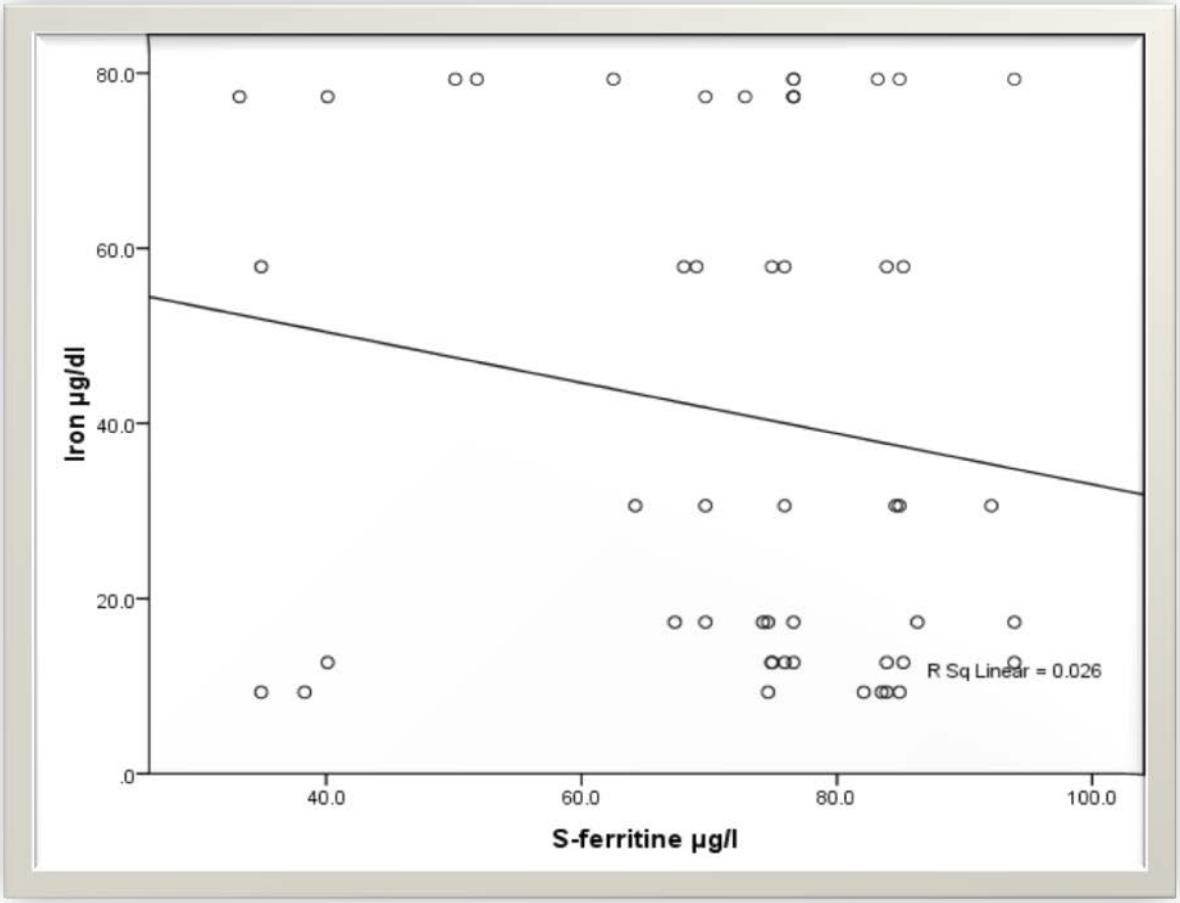

Figure 1: Demonstrates correlation between serum iron and serum ferritin concentrations in the CRF patients

Discussion

Chronic renal failure is a worldwide health problem and a big burden on national health systems. Anaemia is one of the most common complications encountered during the course of the disease. Furthermore, anaemia is a significant risk factor for the development of cardiovascular disease, faster progression of renal failure and decreased quality of life. The present study was undertaken to estimate serum iron and ferritin levels in end-stage renal failure (CRF) patients suffering from anaemia. For this purpose, 50 CRF patients with anaemia were selected as a study group provided that they haven't been put on iron therapy. Another 50 healthy individuals were selected as a control group. The results showed that serum iron levels in CRF patients were significantly lower when compared to healthy individuals, a finding that agrees with results reported by Taralov *et al.* [(10)]. The results of the present study also agree with those of the studies done by Folia *et al.* [(11)], Barry *et al.* [(12)] and Hsu *et al.* who reported that serum iron and ferritin levels were significantly lower in CRF when compared to healthy individuals. Lopez-Sierra *et al.* reported that serum ferritin and serum iron levels were significantly lower in elderly patients hospitalised for chronic diseases when compared to healthy individuals [(13)]. They also concur with Skali *et al.* who found that serum ferritin level was significantly lower in patients suffering already from cardiovascular disease as a result of CRF when compared to healthy individuals [(14)]. A report from Russia showed that serum ferritin levels were significantly

lower in CRF patients when compared to healthy individuals [9]. In addition to the above mentioned studies, the findings of this study concur with Kalantar-Zadeh *et al.* [15], Kaufman *et al.* [16] Milman *et al.* [17], Hutchinson *et al.* [18] Fernandez-Rodriguez *et al.* [19], Patruta *et al.* [20] and Kshirsagar *et al.* [21] who all showed that serum iron and serum ferritin were significantly decreased in patients of CRF. Some conflicting results were obtained by Rao *et al.* [8] and Al-Mukhtar *et al.* [22] and showed that serum ferritin was significantly increased in patients with CRF. This might be due the use of different calculation techniques and the adoption of different cut-off value in their measurements. On the other hand, the results of the present study are similar to the results obtained by, Malovrh *et al.* [23] who used low-dose iron replacement to correct anaemia in haemodialysis patients, Pouresmaeil *et al.* [24] who encountered significantly low levels of iron and ferritin in the course of studying lead levels in haemodialysis patients. In addition, the studies done by Atkinson *et al.* [25], Cuevas *et al.* [26], Rafi *et al.* [27] and Małyszko *et al.* [28], Kalantar-Zadeh *et al*. [29] have all reached similar results. Some researchers suggested that erythropoietin deficiency due to decline in functional renal tissue is a causative factor for decrease in RBC production in CRF patients suffering from anaemia. In addition, they suggested that various factors might be involved in lowering of iron status in patients suffering from CRF associated with anaemia [11]. Some investigators also reported that for the re-establishment of effective erythropoiesis by erythropoietin therapy, it is necessary to ensure sufficiently available iron in patients suffering from CRF [12]. Erythropoietin deficiency is mostly the primary cause of anaemia in CRF. The findings of this study may support the idea that gradual destruction of erythropoietin secreting cells of the kidney in different stages of CRF is the reason behind anaemia, despite the fact that erythropoietin levels in test subjects was beyond the scope of this study. The lowering in serum ferritin occurs in CRF patients is due to changes in iron status and these changes vary with severity of CRF and thus, this may be the reason of the association of severe CRF with chronic infection.

Conclusion

In conclusion, the study shows that serum iron and ferritin levels in CRF patients are significantly low in comparison to healthy controls, most probably due to changes inflicted by CRF and the duration of anaemia. This also indicates the importance of measures that can be taken to correct anaemia (e.g. by erythropoietin) in order to maintain effective erythropoiesis and to achieve target normal level of iron. Further studies should be done to measure serum iron and ferritin levels in different stages of renal failure with large sample size.

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