

**LASALLIAN RESEARCH FORUM**  
**La Salle University**  
**Ozamiz City**

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# *Foreword*

As promised, another refereed journal has come our way as we have ended the academic year 2012-2013. The second issue of the Lasallian Research Forum Refereed Journal is another masterpiece of our university faculty researchers coming from the different disciplines.

This current issue contains research works of faculty members from the College of Education, College of Arts and Sciences particularly English and Mathematics departments.

The first two featured papers are evidences of the university's commitment in coming up with research-based community extension programs. Specifically, the work of Maria Nancy Quinco-Cadosales has produced worthwhile activities that aimed at improving the Day Care Centers and Development workers' capability in carrying out their respective tasks in taking care of the play school children. Meanwhile, the paper of Flordelis Ejercito is kept and used as a baseline data for the Community Extension Program of the LSU-Integrated School. It specifically aids in identifying the needs of the adopted school. The last four articles are indications of university's assurance in improving curriculum and providing new knowledge to the field of Mathematics. The paper of Marylene Tizon regarding senior students' perception towards qualities of English teachers revealed that senior students characterized effective teacher to be someone who is proficient in the use of English language, who can prepare the lessons well, who can treat students fairly in their respective classrooms and who can motivate students to learn. Such result is a very important resource as basis for teachers' training and personal development. Catalina Wapille-Maghamil's work on the other hand has proven that the sophomores and juniors in the Education program of the university have sufficient mastery in the use of the

English language for both academic and social usage. Such result was hoped to be used as basis to improve the syllabus of the Languages Department intended for the target respondents. Lastly, Vinessa Abregana and Jaymar Balihon's pure research papers are seen to have impact by unfolding new concepts in their field of specialization that pave a way for more and future discoveries.

The Institutional Research Office would like to congratulate the Deans of the College of Education and College of Arts and Sciences for motivating their faculty to do research. May you continue inspiring people under your care. Special appreciation is also extended to the researchers for being instruments in the release of this issue. May you can cajole more of your peers in coming up with an article worth publishing for. Lastly, sincere acknowledgment is bestowed on the referees for the patience and brilliance shared by providing their suggestions on how can the articles can be improved. Thank you very much!

# EDITORIAL POLICY

As stipulated in the Institutional Research Office Faculty Manual (2012) of the university, the Editorial Board requires that submitted completed research studies should conform to its set standards of Peer Review System, which are the following:

1. Members of the College/Integrated School Research Council deliberate on submitted complete research study.
2. Paper revision will be done by the authors with the comments/suggestions from the in-house evaluators.
3. English editor edits the completed research study on its grammatical structure and language proficiency.
4. Completed research study will be submitted to the external experts for evaluation.
5. Researchers employ suggested improvements of the study.
6. After incorporating the suggestions and revisions, evaluators will judge whether the research study will be accepted or not.
7. Rejected research studies will not be published.
8. Accepted studies will be published on the Lasallian Research Forum Refereed Journal.

## **The Peer Review System**

The research papers submitted for publication will be sent to peer reviewers (referees or external evaluators who are not from the university and are experts in a specific field of study). The selection

of the external evaluator will be parallel to his/her area of expertise which corresponds to the discipline of a particular research study.

Minimum of three (3) external experts, who do not know each other, will be assigned to evaluate a research study. After they have evaluated the quality and content of the paper, they are required to return the paper to the Editorial Board. Result of their evaluations will be generated through accomplishing the Peer Reviewers Form (PRF) that is provided to them. PRF contains the peer reviewer's comments and suggestions with regard to the paper's weaknesses and recommendations on whether the paper is subject to minor or major revision or no revision at all. In return, the members of the Editorial Board evaluate the comments and suggestions of the referees. After this, the Editorial Board will send back the paper to its author for consideration or compliance of the suggestions, corrections, comments and recommendations of the referees.

**The Lasallian Research Forum** adopts the double-blind review in which the external experts will not know who the authors of the study are as well as the researchers are not given the chance to know who evaluated their study.

Based on the given External Peer Reviewer's Form to the external experts, judgments are as follows:

- a. The paper is recommended for publication.
- b. The paper is accepted but subject to minor revisions.
- c. The paper is accepted but subject to major revisions.
- d. The paper is rejected but encouraged for re-submission.
- e. The paper is rejected for publication.

A research study will be accepted and published in the refereed journal when at least two (2) of its external experts judged any of which rating from (a-d). Further, the study is rejected if at least two (2) of its external experts judged (e).

# **Enhancement Activities for the Day Care Centers and Development Workers**

(Presented during the Mindanao Zonal Teacher Education Forum  
November 27-29, 2012, Badjao Function Hall, Garden Orchid  
Hotel Zamboanga City)

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## **Abstract**

This study assessed the needs of the 88 Day Care Centers and Development (DCCD) workers in the fifty one (51) barangays of Ozamiz City, Misamis Occidental. Data were gathered through the use of documentary analysis, interview, and focused group discussion. Frequency and percentage distribution were used to describe the profile of the workers' educational attainment. The DCCD workers needed enhancement activities in teaching reading through letter sound, teaching the number concepts, teaching strategies, production of instructional materials, and pedagogy. A three- day enhancement activities were designed and conducted to address their needs.

## **1. Introduction**

Day Care Centers and Development are established in the barangays with the purpose of enhancing the cognitive, physical, social and emotional development of young children through the establishment of additional child care centers under the Department of Social Welfare. The day care center workers are supervised by a staff assigned by the City Social Welfare and Development. The day care worker has to be 18 and 45 years of age; high school graduate; physically fit; and has a good moral character. These DCCD workers worked in the center for 3 hours per session. There are workers who handled one session in the morning and one session in the afternoon. Three workers handled two sessions in the

morning and one session in the afternoon due to the big number of children enrolled.

Early childhood education requires workers to be competent in handling and teaching young children. The workers' ability to prepare and teach the lesson is very vital in the children's love for school. Day Care Centers are managed by Day Care Center Workers (DCCWs). These workers contribute to the total development of the early childhood learners. Given the fact that the Day Care Center (DCC) workers teach very young children, the College of Education and Graduate Studies of La Salle University decided to assist them in developing their teaching skills. Helping the Day Care Center workers is one way of building a better community by providing early childhood education to the young. Thus, the DCCWs were chosen to be the partners of the College of Education in the community extension service.

In order to realize the vision of the college's community extension program, coordination with City Social Welfare and Development (CSWD) was conducted. Assessment was done both by the college and CSWD as to what the DCC workers need.

## **2. Review of Related Literature**

Assessment is any variety of procedures used to obtain information (Linn & Gronlund, 2000) to determine the strengths and identify improvement areas (Model for Need Assessment, 2005). A needs assessment is a systematic process to collect and analyze information on what a target group needs to learn. Conducting a needs assessment is being used to develop curriculum for training programs. Needs assessment should be conducted before any adult educational activity so that the available resources can be used to the maximum benefit of the learners (Ratnapalan & Hilliard, 2002). This information serves as basis in planning actions for improvement or enhancement activities. Thus, needs

assessment identifies the areas to be addressed in the enhancement programs. As Khan and Sarwar (2011) said that training in which in this study referred to as enhancement program, provides employees the knowledge and skills needed to do a particular task, and also change their attitude in favor of their performance.

Rouda and Kusy (1995) state that needs assessment is a systematic exploration of the way things are and the way they should be. To conduct a needs assessment, the four steps should be considered. First, perform a “gap” analysis that is to check the current situation to determine the current state of skills, knowledge, and abilities of the people in the organization. In the “gap” analysis of the situation, it is important to identify the desired or necessary conditions for organizational and personal success. Analysis of the situation focuses on the necessary job tasks/standards, as well as the skills, knowledge, and abilities needed to accomplish these tasks successfully. It is important that the actual needs of the people are identified. The difference in the "gap" between the current and the necessary will identify the needs, purposes, and objectives. It is important that in addressing the “gap” the problems, impending change, opportunities, strengths, new directions, and mandated training will be identified. Secondly, identify priorities and importance. The first step produced a large list of needs for training and development, career development, organization development, and/or other interventions. The second step examines these in view of their importance to organizational goals, realities, and constraints. Thirdly, identify causes of performance problems and/or opportunities. Prioritize and focus on critical organizational and personal needs, then identify specific problem areas and opportunities for the organization. Know if people are doing their jobs effectively and if they know how to do their jobs. This requires detailed investigation and analysis of people, their jobs, and the organization. Fourthly, identify possible solutions and growth opportunities. Some training and/or other interventions might be designed if sufficient importance is attached to moving the people and their performance into new directions.



Moreover, learning needs assessments are often conducted to identify deficiencies in knowledge, skill, behavior, or attitude in the current teaching practices (Donald & Donald, 1992). There are several methods of needs assessment described in the literature. This present study utilized the following methods to assess the needs of the Day Care Centers and Development workers, namely: documentary analysis, interview, and focus group discussion.

*Interviews.* Interview is a needs assessment technique. It involves designing the interview plan, handling the mechanics of the interview, interpersonal aspects of the interview, and data collection and interpretation. It is viewed as a conversation with the purpose of gaining in-depth insight into someone's perspective. Qualitative interviewing unveils a broader range of learning needs and opportunities for program development than quantitative methods alone (Crandall, 1998). The interview further assists the day care workers to assess their teaching skills and formulate targets for self-enhancement. As Sadler (2002 cited in Sy, 2011) emphasized that community members need to set their direction through the formulation of meaningful goals which could be performed by themselves. The interview hopes to gather realistic needs that could be addressed in the enhancement activities.

*Focus Groups.* Focus groups are usually, seven to ten randomly selected participants who meet criteria to be considered by learners for a particular service or educational activity. A skilled facilitator, who encourages a sense of synergy but explores differences in opinion, conducts the interview. Planning, developing core questions, facilitating or moderating the session, and analysis of data are the essential steps in conducting focus group interviews (Tipping, 1998). Focus group interviews differ from individual interviews, because members of the group draw strength from one another to express some opinions that they may otherwise view as unpopular. Focus groups provide a broad range of qualitative data in a timely, cost-effective manner and help to clarify and elaborate the quantitative data (Ratnapalan and Hilliard, 2002).

It is hoped to identify the improvement areas to be addressed which will be the bases in designing enrichment activities to help the Day Care Center workers.

### The Problem

This present study assessed the Day Care Centers and Development workers' teaching needs. An action plan for enhancement activities was designed based on the findings of the study. Furthermore, the study sought to answer the following problems:

1. What is the profile of the DCC workers' educational qualifications?
2. What enhancement activities are needed by the DCC workers?
3. What action plan for enhancement activities may be designed for the DCC workers?

### **3. Methodology**

This present study utilized the descriptive method of research. It described, analyzed, and interpreted data concerning the DCC workers' teaching needs for the academic year 2010-2011.

The respondents were the 88 DCC workers employed in Day Care Centers of Ozamiz City in the academic year 2010-2011. Data were gathered through the use of documentary analysis, interview, and focused group discussion. Frequency and percentage distribution were used to describe the profile of the DCC workers' educational attainment.

#### 4. Results and Discussion

This section presents, analyzes and interprets the data gathered on the teaching needs of the Day Care Center workers in Ozamiz City.

##### **Profile of the Day Care Center and Development Workers' Educational Attainment**

The DCWs' educational attainment categorized into undergraduate and college education is shown in Table 1.

Table 1: DCCDWs' Educational Attainment

Educational Attainment	Frequency	Percentage
Undergraduate	47	53
Graduate	41	47
BSED	(7)	
BEED	(13)	
Other Degrees	(21)	
TOTAL	88	100

The data show that there are more Day Care workers who are undergraduate than those who finished a degree. These data were taken from the Master list of Ozamiz City Day Care Workers in June 2010. In an interview with Mrs. Marivic P. Kaamiño, Chief Technical Assistance Division TAD and Mrs. Gemma M. Hornijas, Day Care Center Worker 1 DCW/ Day Care Officer Designate, they pointed out that applicants may be accepted to teach in Day Care Centers if they had taken at least 72 units in college. Thus, any applicant with other degrees aside from Education may be accepted to teach in a Day Care Center. Mrs. Kaamiño and Mrs. Hornijas further reported that some were recommended workers by the local officials. Hence, there were DCCD workers who were agriculture, midwifery, computer, and commerce graduates.

It can be noted in the data, that more than half (47 Or 53%) of the DCCD workers did not have a college degree. In an

interview with the Officer of CSWD, applicants recommended by the barangay captain and city mayor were accepted to work in the day care centers even if they were undergraduates. Moreover, Table 1 shows that twenty of them were education graduates. These education graduates were non-Licensure Examination for Teachers (LET) passers. While waiting for their board exam result, they decided to work in DCC for a teaching experience. In most cases, once they pass the LET they transfer to the public schools. The same reason was given by those who finished other degrees. They were teaching in DCC rather than not working at all.

The data above manifest that the majority of the DCCW's lacked the teaching skills in teaching young children. Thus, this scenario does not conform to Khan and Sarwar's (2011) standard that the teacher needs to have mastery of the content and curriculum, appreciation of the various forms of standards, awareness of assessment, ability to organize the lessons, and the ability to engage students in instructional decisions. The ways in which a teacher interacts with students and organizes instruction are critically important aspects of helping each child learn (Tharp, 1999; Tharp et al., 2003 in Khan & Sarwar, 2011).

Based on the results of the interview and focused group discussion, the College of Education and Graduate Studies conceptualized enhancement activities to improve the DCCD workers teaching skills.

### **Enhancement Activities Needed by the Day Care Centers and Development Workers**

In an interview with Mrs. Gemma M. Hornijas on February 2, 2011 regarding the teaching needs of the Day Care teachers, she pointed out the difficulties of the workers in teaching the letter sounds. This concern is part of the lesson content in teaching beginning readers. Mrs. Hornijas further showed Form 2A on Accreditation Tools for Center-Based ECCD Program. This

accreditation tool addressed Area A which is on advancement of children's growth and development. Children enrolled in Day Care Centers need to know the basic letter sounds for them to cope with the learning challenges in kindergarten.

During the focused group discussion (FGD) facilitated by Dr. Flordelis J. Ejercito, Vice-Chancellor for Research, Development, Evaluation and Linkages, and Dr. Maria Nancy Quinco-Cadosales, Dean, College of Education and Graduate Studies on February 4, 2011, the Day Care Center workers affirmed that their first need was on how to teach the letter sounds followed by needs on teaching strategies and preparation of the instructional materials. The questions raised during the FGD were centered on what difficulties they encountered in teaching day care pupils; teaching difficulties they experienced and specific activities for enhancement and other needs related to teaching young children.

These needs affirm Khan and Sarwar (2011) findings that teachers need training in preparation of instructional materials, lesson planning, use of audio-visual aids, time table development, test formation, preparation of question papers, marking of tests, interpretation of results and feedback based on evaluation. In this study, similar needs that of Khan and Sarwar (2011) were expressed by the DCC workers since they are being evaluated also. Thus, an action plan for their enhancement activities was designed to address the Day Care Center workers' teaching needs. A meeting with the faculty of the College of Education was chaired by the Dean to put in place the enhancement activities.

Moreover, Buivydas et al. (2011) emphasized the value of "top down" training seminars or workshops in partnerships with colleges and universities for professional development. The framework employed by the College of Education was also "top down" since the conceptualization of the activity originated from top administrators of CSWD and La Salle University (LSU). On the side of CSWD, they expressed that they need experts in the

teaching field to help DCCD workers and on the end of LSU, this was the community extension service of the college. With this, it was the aim of the College of Education, La Salle University to be the delivering institution of the enhancement activities of the DCWs. Isani and Virk (2004 in *Ullah, Khan, Murtaza, & Din, 2011*) emphasized that institutions of higher education have the main responsibility for equipping individuals with advanced knowledge and skills required for positions of responsibility in government, business, and the professions. In this case, the College of Education strived to provide basic knowledge and skills of teaching before they can proceed into providing DCC workers advanced knowledge. Thus, after a thorough analysis of the needs of the DCWs from multiple sources, an action plan for the enhancement activities was conceptualized.

### **Action Plan for Enhancement Activities**

Staff development aims at building and promoting an effective personality through learning and trait strengthening programs. It includes development of skill oriented vision, mental poise, unbiased perception, vigilance, drive, communication skills, team building, competence in decision making and problem solving capabilities, honesty etc, and the art of encouraging as well as tolerating different viewpoints (Sisodia, 2000 in Khan & Sarwar, 2011).

Moreover, staff development provides activities intended to upgrade and update the knowledge, skills, and understanding of the human resource in schools. It aims to create positive and productive changes in the human resource's thinking and behavior, and to secure compliance with school and national policies (Seyfarth, 1991 in Bago, 2008).

Further, Hicks (1984 in Anvari, Amin & Seliman, 2010) argued that if employees are given reasonable information about the training program, the employees can see how training fits with their

needs. If they feel that the match is good, they have a heightened desire to learn (Porter et al., 1974, in Anvari, Amin, & Seliman, 2010), which is a prerequisite to strategize training. It is clear that training attitudes in strategizing training as a dimension of personal analysis needs was discovered by results. Hicks (1984 in Anvari, Amin, and Seliman, 2010) indicated that employees who received the reasonable training and those who had a higher degree of choice were more likely to perceive the seminar to be appropriate for them to take and were better able to profit from training. Also, they were more committed to their decisions to attend the training.

In this present study, the teaching needs of the Day Care Center workers were identified and became the bases in the action plan for the enhancement activities. These enhancement activities aimed to improve the abilities of the workers to handle and teach early childhood learners. Part of the input was on “No to Styro” since La Salle University does not allow the entry of any styro in the campus. Second, is on the virtues of a teacher written by St. John Baptist De La Salle. The input hoped to remind the DCC workers of the virtues they need to live. The action plan for enhancement activities is shown in Table 2. After the conduct of the enhancement activities, evaluation was conducted. The result of the evaluation would then serve as bases for the development programs for the Day Care Center teachers in the following year.

Table 2: Enhancement Activities for the Early Childhood Care and Development Workers May 18, 19, 20, 2011

Day/Time	Activity	Topic	Methodology	Materials Needed	Responsible Person	Expected Output
<b>Day 1: May 18, 2011</b>						
8:00 – 8:30 AM	Registration of Participants		Fill-up the Registration Form	Registration forms Ball pens Seminar Kits	CED Secretary	Accomplished registration forms
8:30 – 9:00	Opening Program	*Invocation *Pambansang Awit *Opening Remarks: CSWD Director *Messages: - LSU President -CSWD Director *Orientation on the Mechanics of the Seminar-Work shop		Program for the Seminar-Workshop	Dean, CED Secretary Ms. Mary Grace Daga-ang	Programs involved the people concerned
9:00 – 10:00	Input	No to Styro	Lecture	LCD, Notes	Engr. Larubis	Suggested ways on other alternatives aside from using styro.
10:00 – 10:30	Snacks					
10:30 – 12:00	Input	Virtues of A Good Teacher	Lecture	Handouts, LCD	Dr. Maria Nancy Quinco-Cadosales	Strengthen the commitment of the workers
12:00 – 1:00 PM		Lunch				
1:00 – 4:30	Input	Letter Sound	Oral Activi-ties	Hand outs	Ms. Irene Eguico	Produced the correct sound of each letter
4:30 – 5:00	Processing of the first-day activity		Open forum		Dr. Maria Nancy Quinco-Cadosales Mrs. Marivic Kaamiño	Difficulties of the participants for the first-day activities are identified
<b>Day 2: May 19, 2011</b>						
8:00 – 8:30 AM	Preliminary Activities	Morning Prayer, Checking of Attendance, Energizers			Ms. Mary Grace Daga-ang	Prepared the participants for the days' activities
8:30 – 12:00 NN	Input: Teaching Strategy	Marunko Approach	Lecture-discussion	Hand-outs	Dr. Calixta Colarte Ms. Irene Eguico Dr. Wenny Caseros Ms. Pablita Posadas	Wrote a lesson plan using the Marungko Approach
12:00 NN – 1:00 PM	LUNCH					
1:00 – 3:00 PM	Teaching Demonstrations		Critiquing of the	Teaching Materials	Dr. Calixta Colarte Dr. Wenny	Demonstrated using the Marunko



		Demonstrations			Caseros Ms. Pablita Posadas Ms. Irene Eguico Ms. Mary Grace Daga-ang	Approach
<b>Day 3: May 20, 2011</b>						
8:00 – 8:30 AM	Preliminary Activities	Morning Prayer, Checking of Attendance, Energizers			Ms. Mary Grace Daga-ang	Settled the participants for the days' activities
8:30 – 12:00 NN	Input: Teaching Strategy	Number Concept	Lecture-discussion	Hand-outs	Dr. Calixta Colarte Dr. Wenny Caseros Dr. Emma Suana Dr. Maria Nancy Cadosales	Wrote a lesson plan using the Number Concept Approach
12:00 NN – 1:00 PM	<b>LUNCH</b>					
1:00 – 3:30 PM	Teaching Demonstrations	Critiquing of the demonstrations	Teaching Materials		Dr. Calixta Colarte Dr. Wenny Caseros Dr. Emma Suana Dr. Maria Nancy Cadosales	Correctly demonstrated the Number Concept
3:30 – 5:00 PM	Closing Program	Evaluation of the 3- day enhancement activities	Answering the evaluation	Evaluation Tool	LSU Planning Officer	Conducted an evaluation of the activity
		Impressions from the Day Care Teachers	Open forum		2 teacher-participants	Expressed their impressions
		Closing Remarks	Speech		Dr. Flordelis Ejercito VC-RDEL	Synthesized the 3- day activities
		Distribution of Certificates	Awarding of Certificates	Certificates	Dr. Emma Suana Dr. Maria Nancy Cadosales	Distributed the certificate of participation

The College of Education provided the snacks during the three-day enhancement sessions. Each participant was budgeted Php 50.00 for snacks per day. Seventy (70) people participated in the enhancement activities which include the participants and resource speakers. Thus, the whole program spent Php 10,500.00 for its actual implementation to cover, two snacks, lunch, and instructional materials.

## **5. Summary, Conclusion, and Recommendations**

### Summary

The present study found that there were more undergraduate and non-education graduates among the Day Care Center workers. The educational qualification of the Day Care Center workers to teach is the main reason why they had teaching needs. Thus, an action plan for enhancement activities was designed.

### Conclusion

Day Care Center and Development workers needed enhancement activities to improve their teaching skills. Many of them were academically not qualified to teach in day care. However enhancement activities made them better workers and qualified to teach young children. Workers therefore, need to be equipped with the necessary knowledge, skills, and pedagogy in teaching early childhood.

### Recommendations

1. The CSWD personnel should annually assess the Day Care Center workers' teaching needs as bases of a development plan.
2. Seminar-workshops on teaching competencies should be conducted to enhance the Day Care workers' teaching competencies for SY 2011-2013.
3. Further study on other teaching skills and professional needs of Day Care Center workers in Ozamiz City may be conducted.

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# **Demographic Profile of Misamis Annex Elementary School- Community Extension Services Partner School of LaSalle University Integrated School**

**Dr. Flordelis J. Ejercito**  
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## **Abstract**

The study aimed to establish the demographic profile of the Misamis Annex Elementary School (MAES), the partner school of La Salle University-Integrated School in its community extension services. The descriptive method of research employing frequency and percentage distribution was utilized to describe the demographics of the pupils in terms of their gender and year level and the teachers' educational qualification, teaching experience, seminars attended, and membership in professional organizations. The data were obtained from the documents provided by the principal. The findings revealed that most of the MAES pupils are boys and the largest enrolment is in Grade 1. Though the teachers lack membership in professional organizations, they are experienced, qualified and updated with the latest development in their respective field because of their continued studies and attendance in seminars.

## **1. Introduction**

### **Background of the Study**

Community involvement is a basic and all-pervasive aspect of the school. In the Philippines, the involvement of the school in the community maybe equated to the total effort whereby the school relates itself to national, regional, and local issues, problems, and development.

On September 24, 2010, Misamis Annex Elementary School (MAES) and La Salle University-Integrated School (LSU-IS) entered into a partnership for the conduct of La Salle University-Integrated School's community extension services. This partnership

was based on the Public-Private Partnership (PPP) framework. As of today, there is no hard and fast definition of PPP. However, McCann FitzGerald legal briefing described it as: “PPP refers to “partnerships between the public sector and the private sector for the purposes of designing, planning, financing, constructing and/or operating projects which would be regarded traditionally as falling within the remit of the public sector.”

PPP entails a sharing of responsibility between government and the private sector. According to J. Pierce and I. Little (2002), the key features of PPP that have been identified are:

1. a private partner investing in public infrastructure, and providing related non-core services to the government or to the community on the government's behalf
2. the government retaining responsibility for the delivery of core services such as teaching and clinical services, and
3. the government and private party working together under long-term arrangements, whereby the payments to the private sector party depend upon its continuing to deliver the specified services to the agreed performance standards. Failure to meet these standards results in the private partner not being paid.

Of the key features mentioned above, the framework that LSU-IS and MAES would like to adopt is the delivery of core services such as professional and spiritual formation of teachers and students in different areas.

One of the basic requirements in a partnership agreement is sufficient information about each other as partners to identify the services which LSU Integrated School can provide to MAES to answer their needs. Hence, there is the need for a study to establish a demographic profile of Misamis Annex Elementary School (MAES), the partner school of La Salle University-Integrated School. It is in this light that this study was conducted.

## 2. Related Literature and Studies

Some literature and studies on the concepts and variables related to demographics were reviewed by the researcher to discover what have been learned and remained to be learned along this area of concern. These materials which were written by local and foreign authorities and researchers are briefly presented under two general headings, namely: pupil and teacher demographics.

Demographics or demographic data are the characteristics of a human population. Gender, race, age, income, disabilities, mobility (in terms of travel time to work or number of vehicles available), educational attainment, home ownership, employment status, and even location are the most commonly used demographics. (Wikipedia Foundation, 2011.)

In this study, the researcher combined several variables to establish the demographic profile of Misamis Annex Elementary School, La Salle University- Integrated School's partner institution. Data from two sectors of MAES, the pupils and teachers were examined.

### Pupil Demographics

#### *Gender*

Gender is one of the variables that can provide the basis of determining the community extension services programs that will be given to MAES. It refers to the social and psychological aspects of being male and female. There are sets of expectations that prescribe how females and males should act, feel, and think in a particular culture. In many cases, gender provides the basis of comparison of the performance of the pupils. In the study of Eccles, et al., (1993), it was mentioned that even at a very young age, boys and girls feel more or less competent in certain subjects. In their

study, boys tend to feel more competent in sports and mathematics, whereas girls feel more competent in reading and music.

### *Grade Level*

As defined by the Kernerman English Multilingual Dictionary (2010), grade level refers to a class or year at school or level of education that students are assumed to have attained. As used in this study, it refers to the level of schooling of the MAES pupils such as Kindergarten, Grade 1, Grade 2, until Grade 6.

In 2008, a survey research was conducted by Wida Consortium on their CAN DO Descriptors-a collective representation of five English language proficiency standards. The survey results pointed out the need of expanding their K-12 CAN DO descriptors into grade level cluster descriptors as requested by the administrators and teachers serving English language learners within their consortium. According to the respondents, grade level cluster descriptors can more accurately communicate the performance of English language learners within a specified age range. As a result, the descriptors can be easily synchronized to language and content instruction. This finding showed the importance of identifying the pupils by year level. This is the reason why this variable was included in the study.

### Teacher Demographics

#### *Educational Qualification*

The influence of a teacher's professional preparation to students' performance had been the subject of many foreign and local literatures and studies.

A systematic analysis on the strengths, weaknesses, opportunities and threats on the performance of teachers was undertaken by Herrera (2000) who reported that the strength of



performance was very evident among teachers who had earned masteral/doctoral degrees. As a matter of fact, among the expert teachers in the study of Reyes (2002), thirty-five of them had doctoral degrees, twenty-six had master's degrees while, three still pursued their doctoral studies. Three other experts worked on their master's theses while two or more were enrolled in master's programs.

Other studies on teachers' educational qualifications indicate that master's degrees had slightly negative impact on student achievement. Very few studies diverge from this consensus. For instance, the findings of Oliva (1993) disclosed that there was no significant relationship between the teachers' professional preparation and their students' achievement. More recent studies have shown that having a master's degree increased or improved student achievement in grades one to seven but had no impact in grades eight to twelve. This finding indicates that having a master's degree does not necessarily imply that it is really the cause and effect in the improvement of the students' academic achievement. Hence, according to Walsh and Tracy (2000), whether one is a master or not, it is likely that the amount of students' accomplishments may not be affected.

Though the study did not intend to determine if there is a correlation between teachers' educational qualification and pupils' achievement, the contrasting findings motivated the researcher to present the educational qualification of MAES teachers.

### *Teaching Experience*

Every teacher brings to the classroom his teaching experience which could positively or adversely affect instruction (Lupdag, 1984 cited in Ejercito, 2000). A number of studies mentioned the positive influence of teaching experience in the teaching-learning process. In a study conducted by Darling-Hammond (2002) on teaching efficacy and teaching performance,

she disclosed that experienced teachers were more effective than beginners not only in classroom teaching but also in resolving a number of instructional problems like maintaining discipline, motivating students and adapting instruction for students with diverse learning needs. Similarly, the Publication Report (2000) disclosed that the teacher's knowledge of a subject matter is enriched by his experience. This idea was also supported by Adam and Berliner (2004) when they stated that extensive practice is a pre-requisite to teaching practice. They also pointed out that new teachers were less effective than experienced teachers. However, Al-Jasees (2003) revealed contrary findings. The study pointed out that teachers with limited academic experience had more positive teaching performance as proven by their positive impact on the students' achievement level than the senior teachers. Al-Jasser attributed this contention to the possibility that teachers who have recently become involved in the teaching career continue to acquire fresher pedagogical and professional knowledge in their educational field. Their teaching can also be attributed to their higher enthusiasm for teaching. The study concluded that while it is true that some senior teachers are undoubtedly more experienced but their long successive years of teaching the same discipline could have negatively influenced their teaching motivation which in turn is then reflected in their teaching performance.

### *Seminars Attended*

It is important to the members of a profession that its organization provides fully for their educational needs (Siddiqui, 2010). No profession can remain strong if it ignores new developments and knowledge affecting it, particularly in this day of rapid scientific advances. This is also true to teaching. The competency level among the teachers may vary according to the off-school trainings they have undergone. Ejercito (2000) in her review on researches on teaching effectiveness found that a teacher who is more exposed to training along his field and its related fields is far better than a teacher with less exposure. This is so because

from the seminars and workshops one has attended, knowledge and other gainful experiences are obtained.

Lardizabal and others (1978) strongly emphasized the need of a teacher to continue to grow professionally. They further stressed that a teacher has to keep abreast with all the changes in his profession. This involves keeping up with the changes and newer development in his subject area, in the theory and practice of teaching, in current experimentations in education and in other areas of knowledge relevant to teaching.

This study described the seminars attended by the teachers for their professional development.

### *Membership in Professional Organizations*

Through the professional organizations, the teachers will be able to gather and gain access to a variety of opinions and ideas (Curtis, 2011). Ideas and a wealth of other topics that are seldom discussed in books, magazines or journals will likely be exchanged.

Joining professional organizations opens the possibility for a linkage with other teachers who are experts in different types of teaching techniques. This will allow one to learn from others or peers and perhaps set up some sort of a mutual referral system directed toward a noble cause to improve teaching and learning.

The result of this study would provide the University a demographic profile of MAES thereby establishing a source of substantial information about this school; thus, creating a mental picture of its hypothetical aggregate which is necessary in the partnership.

## Research Locale

Misamis Annex Elementary School is a complete public elementary school. It also houses the extension classes for first year students of Ozamiz City National High School. The school has a total land area of 5,808 square meters with 16 instructional rooms including the preschool. It is located along the seashore of **Purok 6**, Barangay Carmen Annex, Ozamiz City. This barangay, of 12 puroks with a total population of 6,598, is one of the urban coastal barangays. It is situated in a moderately critical area in the city.

## Statement of the Problem

This study aimed to establish the demographic profile of Misamis Annex Elementary School (MAES). Specifically, it sought to answer the following questions:

1. What is the profile of the pupils in terms of :
  - a. gender,
  - b. grade level
2. What is the profile of the teachers in terms of:
  - a. educational qualification,
  - b. teaching experience
  - c. seminars attended
  - d. membership in professional organizations

## 3. Methodology

The study used the descriptive method to determine the demographic profile of the pupils and teachers of MAES. Specifically, frequency and percentage distribution was used to describe the pupil's gender and year level distribution, teachers' educational qualification, teaching experience, seminars attended and membership in professional organizations.

The data were taken from the documents provided by the Principal of MAES. The documents include enrolment statistics and teachers' personal data sheet.

#### 4. Results and Discussion

The present study sought to find out the status of the partner school MAES in terms of its pupils' profile reflected in its enrolment and faculty profile.

##### *Pupils' Profile*

MAES is a complete elementary school. It offers classes from Grade 1 to Grade 6. Tables 1 and 2 show the enrolment statistics of the pupils by gender and year level.

Table 1: Enrolment by Gender for SY 2010-2011

<b>Gender</b>	<b>No. of Pupils</b>	<b>Percent</b>
Male	283	53.70
Female	244	46.30
<b>Total</b>	<b>527</b>	<b>100.00</b>

The data show that there were more boys than girls enrolled in the school. In an interview, the School Principal explained that in the area where the school is located the population of the boys is higher than that of the girls. She also added that the pupils of MAES do not come from Barangay Carmen Annex only but many come from other neighboring barangays. Purok 6, where the school is situated, is the boundary between Barangay Carmen Annex and Barangay Catadman.

This finding is contrary to the finding of Lumanta (2005) who disclosed that there were more females than males who were enrolled in elementary and high school.

Table 2 shows the enrolment from Grade 1 to Grade 6 in School Year 2010-2011.

Table 2: Enrolment by Grade Level for SY 2010-2011

<b>Grade Level</b>	<b>Number of Sections</b>	<b>Number of Pupils</b>	<b>Percent</b>
Grade 1	3	122	23.15
Grade 2	2	87	16.51
Grade 3	2	90	17.08
Grade 4	2	77	14.61
Grade 5	2	67	12.71
Grade 6	2	84	15.94
<b>Total</b>	<b>13</b>	<b>527</b>	<b>100</b>

The table reveals that the largest enrolment was in Grade 1 having three sections. However, according to the principal, two of these Grade 1 pupils already dropped out of school because of transfer of residence. It can be noted that the smallest enrolment was in Grade 5 where two dropped due to lack of interest in schooling and the need to work to augment family income.

### *Faculty Profile*

Teaching is one of the most important jobs in any society. Teachers are people who work in schools, instructing students on various academic subjects. They are responsible for teaching students a variety of subjects including values in order to prepare them to become successful and responsible adults.

Teachers' profile includes teachers' educational qualification, years of service, seminars attended, and membership in professional organizations.

### *Educational Qualification*

To be able to teach in the public and private elementary schools, one must have at least a bachelor's degree in elementary

education (Manual of Regulations for Private Schools, 1998). This is also the minimum academic qualification required by the Department of Education for one to be able to teach in the elementary school.

Table 3 shows the educational qualifications of the teachers of MAES.

Table 3: Educational Qualifications of the MAES Teachers

DEGREES COMPLETED	PERMANENT FACULTY		SUBSTITUTE FACULTY		TOTAL	
	No.	%	No.	%	No.	%
Master's in field of specialization	3	23			3	23
Master's in other fields						
Working Towards Master's Degree	8	61			8	61
Bachelor's degree	1	8	1	8	2	16
<b>TOTAL</b>	<b>12</b>	<b>92%</b>	<b>1</b>	<b>8%</b>	<b>13</b>	<b>100%</b>

As reflected in Table 3, the majority of the teachers (61%) had earned some units in masteral degree programs while 23% had already earned their master's degree in education. Nonetheless, 16% of the teachers are still bachelor's degree in elementary education only.

The data further show that the teachers possessed the minimum requirement to teach in an elementary school; hence, they are academically qualified.

### *Teaching Experience*

Table 4 presents the total number of years the teachers have been teaching in MAES or in other schools.

In this study, teaching experience refers to the length of time or service a teacher has been teaching either in a public or private

school. It was categorized into experienced and novice in the research that was conducted by Salcedo in 2006. Teachers whose length of time served in the teaching profession is four years or over are classified as experienced teachers and those below four years as novice teachers. This basis for classifying teaching experience was adopted by the researcher.

Table 5: Teaching Experience of the MAES Teachers

Years of Experience	Total Number of Years in Teaching	
	No. of Teachers	Percent
0-3	4	31
4-7	3	22
8-11	1	8
12-15	1	8
16 years and above	4	31
<b>Total</b>	<b>13</b>	<b>100 %</b>

Table 5 reveals that there are many teachers in MAES who have less than 4 years of teaching experience, hence they are novice or new. The data also show that the number of teachers who had been in the teaching profession for more than 15 years is the same as the number of novice teachers. It is also worth noting that 69% of the teachers had been teaching for more than 3 years and can be classified as experienced teachers. These teachers have more experience in managing students and in choosing the appropriate teaching strategies to make their pupils learn.

### *In-Service Training*

The teacher has responsibility to himself and to his profession. In order to enable the teacher to have new dimensions in his teaching, he must be engaged in continuing search for new ideas or concepts to awaken and enkindle enthusiasm in students. The teacher should not only excel in terms of number of degrees obtained but also in terms of growth in wisdom, knowledge and



understanding, and in improved procedures and techniques in teaching particularly at present with rapid scientific advances.

Generally, seminars are designed to orient, update and assist all personnel involved about educational programs which are to be implemented. One way of growing professionally is through in-service training programs. Through these, the teachers are able to update themselves with the new trends and issues in teaching.

Table 6 summarizes the in-service trainings attended by the teachers of MAES in the last 2 years.

Table 6: In-Service Trainings Attended by the MAES Teachers in the Last Two Years

No. of Seminars Attended	No. of Teachers	Percent
1-2	8	61
3-4	4	31
5 or More	1	8
<b>Total</b>	<b>13</b>	<b>100</b>

As revealed in Table 6, all teachers were able to attend seminars either done in their school or outside their school. However, a majority of them had attended only 1 or 2 seminars in the last two years. Both teachers and administrators have to look into this need for more seminars. As Ejercito (2000) pointed out that it is important for the members of a profession that its organization provides fully for their in-service educational needs. They further emphasized that no profession can remain strong if it ignores new developments and knowledge affecting it, particularly in these days of rapid scientific advances. Furthermore, Avalos and Haddad (1991) in their review on teacher effectiveness disclosed that a teacher who is more exposed to training along his field and its related fields is far better than a teacher with less exposure. This is so because from the seminars or workshops he has attended, knowledge and other gainful experiences are obtained.

## *Membership in Professional Organizations*

Joining a professional organization allows a teacher to expand his knowledge of the teaching profession and develop new teaching skills. In fact, these organizations can be beneficial for both career and personal development and can help one to be aware of what is happening in the academic world.

Table 7 presents the membership of the teachers in professional organizations.

Table 7: MAES Teachers' Membership in Professional organizations

<b>Professional Organizations</b>	<b>No. of Teachers who are Members of Professional Organizations</b>	<b>Percent</b>
COPSTEA, PTEMCO, and PPSTA	2	15
Regional Mathematics Club	1	8
Science Club	1	8
None	9	69
<b>Total</b>	<b>13</b>	<b>100</b>

Table 7 shows that only few (31%) teachers are members of professional organizations like COPSTEA, PTEMCO, PPSTA, and other organizations. They are the only ones who have the chance to expand their knowledge about their profession and to improve their skills through intellectual discussion with their peers which most of the time cannot be found in published materials (Curtis, 2011).

## 5. Summary, Conclusion and Recommendations

### Summary of Findings

Based on the data obtained from this study, the following are the findings:

1. There are more boys than girls enrolled in Misamis Annex Elementary School.
2. The largest number of pupils is from Grade 1 and the smallest number is from Grade 5.
3. Majority (61%) of the MAES teachers are working towards their master's degree, 23% have already earned their master's degree and 16% are holders of bachelor's degree in elementary education.
4. There is an equal number of teachers with less than 4 years of teaching experience and with more than 15 years of experience. Sixty-nine percent have taught for more than 3 years
5. Many (61%) of the teachers have attended 1 or 2 seminars, 31% have attended 3 or 4 while 8% have attended more than 4 seminars in the last 2 years.
6. A big number (69%) of the teachers are not members of any professional organization.

### Conclusion

The pupils of Misamis Annex Elementary School are composed of more boys than girls. As expected, the biggest enrolment is from Grade 1 but gets smaller in the higher grade levels.

The teachers of MAES are experienced and qualified to teach in the elementary school. They are updated with the latest development in their field because they have attended seminars and have finished or pursued master's degree. However, they lack the

opportunity to join in intelligent discussions with peers because of their lack of membership in professional organizations.

### Recommendations

1. La Salle University-Integrated School and administration of MAES and Department of Education Ozamiz City Division should use the demographic profile to come up with programs that would develop the pupils and teachers.
2. Since most of the pupils are boys, the programs that will be developed must address to the needs of these boys.
3. Teachers must be encouraged by the administration of MAES to join professional organizations.
4. Further study should be made on the socio-economic status of the pupils to add more to the demographic profile of the pupils of MAES as a reference with which to compare future observations or results.

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# LSU Graduating Students' Perceptions on Qualities of Effective English Teachers

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## Abstract

This study primarily sought at finding out the 105 LSU graduating students' perception on the effective qualities of English teachers as measured using a questionnaire adapted and slightly modified from Park & Lee (2010). To ensure validity of the analysis of the study, the following statistical treatment tools were used: weighted mean, and sum of ranks for determining the rank of significance of each category. The results showed that the English proficiency skills, pedagogical skills and socio –affective skills were perceived highly important ranking the English Proficiency first. It was also found out that there is no significant difference on the perception of both male and female on the characteristics of effective English teachers.

## 1. Introduction

"The best teacher is the one who suggests rather than dogmatizes, and inspires his listener with the wish to teach himself." - Edward Bulwer-Lytton

The teacher has a great role on students' learning. Their efficiency in teaching has a great impact on their students' success in learning. Thus, poor teaching results to poor learning.

Teachers should then possess the abilities not only to teach well but also to have a desirable personality so that they may establish smooth relationships in the classroom. Thus, they must build good relationships/ friendships with students, establish a conducive environment where students are motivated to ask questions, negotiate and process learning, and become creative in

doing their tasks.

What does it mean to become efficient teachers? Many experts describe their effectiveness with regard to their expertise in teaching, their organizational and managerial capability, effective use of instructional materials; they must also provide students with a conducive classroom atmosphere, ample ideas to enhance their knowledge and enough chances to participate in class activities by utilizing appropriate teaching strategies and techniques.

The qualities of an efficient teacher vary in many aspects. In fact, in La Salle University, graduating students have different perceptions on the characteristics of their English teachers as revealed in their exit interview with the guidance personnel. Some of them express their gratitude to their teachers who have helped them improve their communicative skills.

Since teachers play a great role in the achievements of students, a number of researches are focused on investigating what characteristics are considered effective and are beneficial to the learners. Moreover, for La Salle University, perceptions of college students on their mentors' qualities are deemed necessary. Thus, the researcher was motivated in identifying the qualities of the teachers as to students' opinions.

## **2. Review of Related Literature and Studies**

A number of investigation on the qualities of effective English teachers were done to discover their effectiveness and influence on students.

In the study of Brosh (1996) the two groups (teachers and learners) gave the highest importance on the command of English language and comprehensive teaching. Students attributed more

importance to teachers who showed fair treatment and who gave interesting lessons.

An investigation on gender- specific features of students in Japan was done by Makarova & Ryan(1998) (cited in Shishavan, 2010) and it was revealed that male learners considered some qualities of effective teachers to be highly important yet female learners perceived them unimportant.

In a similar vein, no cases were found to be considered highly important by female students while being considered unimportant by their male counterparts. However, they noticed that there was a significant variation in the importance of some items. For example, female students more than males believed that good English language teachers create a stress-free and non-threatening learning environment.

An investigation on the characteristics of teacher done by Koutsoulis (2003) found that teacher's ability to show understanding is the most listed characteristic followed by the teacher's friendly attitude.

Another study done by Park & Lee (2006), showed that teacher respondents perceived English proficiency the highest among the categories while student respondents ranked pedagogical skills the highest.

Moreover, Chen & Lin (2009) found out that female respondents as compared to males find teacher's personality and teacher –student relationship more significant. A difference in both respondents was also shown: teacher's ability to motivate students to learn was ranked higher by girls while teacher's sense of respect and ethics was considered more important by male respondents. Furthermore, the quantitative study of Wichadee (2010) revealed a no difference on the perceptions of students on the characteristics of effective teacher.

## The Conceptual Framework

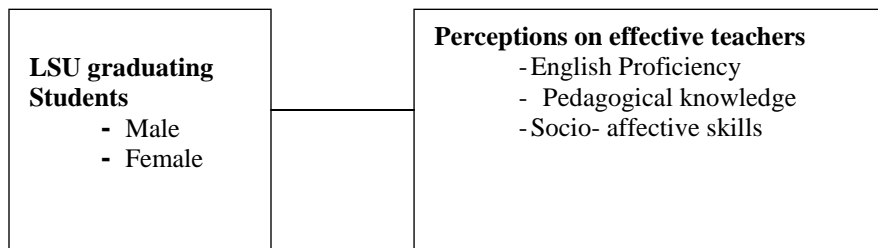


Figure 1

In this study as shown in Figure 1, the graduating students' perceptions (both male and female) on effective teachers would be determined. These perceptions focused on the three categories namely: English proficiency, pedagogical knowledge, and socio – affective skills.

### Statement of the Problem

This study desired to determine what are the qualities of effective English teachers in their three skills: English proficiency, pedagogical knowledge and socio- affective and to discover whether the perception of the female respondents differ from the male. This specifically sought answer to the following questions:

1. What is the level of respondents' perception as regard to the three categories of characteristics?
  - 1.1 English Proficiency
  - 1.2 Pedagogical Knowledge
  - 1.3 Socio- affective skills
2. Which of the three categories is perceived most important?
3. Is the perception of the males different from the females?

## Significance of the Study

It is worthwhile to study the learners' perceptions on teachers' effective qualities. As such this study would specifically benefit the following:

*ENGLISH Teachers:* they could be informed as to their students' perceptions of an effective English teacher and eventually they may be helped in determining the impact of these to their teaching ability. This study would be a help to teachers to better live up to their expectations. Furthermore, they would be guided in improving the quality of their teaching to meet their students' needs.

*Students:* they would be provided with the chance to express what they think of an effective English teachers.

*School Administrators:* the perceptions of the students would enable them to evaluate the supervision tools for teaching competence and they would be guided in developing programs and trainings for teachers to be more competent in the field of teaching English.

## Scope and Limitation

This study was confined only at determining the perceptions of the 105 college students on the qualities of the English teachers. The respondents graduated last October 22, 2011 in La Salle University, Ozamiz City.

## 3. Methodology

This chapter deals with the research methodology of the study which includes the research method used, the respondents of the study, the instruments used, data collection technique and the statistical treatment.

## Research Design

This study made use of descriptive method.

## Research Participants

The researcher decided to include the 105 college graduating students of La Salle University Ozamiz as the respondents. Both male and female were selected to find out if they vary on their perceptions of an effective English teacher.

## Research Instrument

The characteristics of effective teachers as perceived by the LSU graduating students were determined employing a 27- item test adopted and slightly modified from Park & Lee (2010). For the purpose of data collection in this study, the instrument contained three parts: English proficiency (8 items), pedagogical knowledge (10 items), and socio-affective skills (9 items). Moreover, the participants were asked to rate based on a five-point (5- Highly Important, 4-Moderately Important, 3- Important, 2-Seldom or hardly Important, 1- Not Important) Likert Scale.

As to the mean score, below are the verbal interpretations.

<b>Mean</b>			<b>Verbal Interpretation</b>
4.21	-	5	Highly Important
3.41	-	4.20	Moderately Important
2.61	-	3.40	Important
1.81	-	2.60	Seldom/hardly Important
1	-	1.80	Not Important

## Statistical Treatment of Data

To ensure validity of the analysis of the study, the following statistical tools were used.

Weighted mean was utilized for analyzing the importance of each of the item in the three categories. To determine rank of significance of each category, Sum of Ranks was utilized. Finally, Mann- Whitney U Test was employed to determine if the perceptions of the male respondents differ from the females.

## Data Gathering Procedure

To make sure that the questionnaire would be administered to all graduating students, the researcher asked the help of the DSA (Dean of Students' Affairs) as well as the assistants in administering the questionnaire during the final practice for graduation.

The students were asked to cooperate by answering the questions. They were given an assurance that their answers would be held with utmost confidentiality.

It took the students about 25 minutes to answer the questionnaire. After all the questionnaires were answered, they were retrieved as soon as they were done answering. Then, the answers were tallied, analyzed and interpreted.

## **4. Results and Discussion**

This chapter deals with the presentation, analysis and interpretation of the gathered data. The data found in this chapter are arranged according to the problems focused in this study.

Problem No. 1: What is the level of respondents' perception as regard to the three categories of characteristics?

Table 1 depicts the respondents' perception on the teachers' characteristics in the three categories.

Table 1 *Respondents' Perception on the Teachers' English Proficiency*

<b>A. English Proficiency</b>	<b>Mean</b>	<b>Verbal Interpretation</b>
An effective English teacher is someone who should:		
1. understand spoken English well	4.85	Highly important
2. be familiar with English Culture well	4.56	Highly important
3. read English well.	<b>4.90</b>	Highly important
4. possess a high level of proficiency with English vocabulary.	4.75	Highly important
5. write in English well	4.80	Highly important
6. pronounce / enunciate English well	4.82	Highly important
7. speak English well.	4.81	Highly important
8. be fully conversant with English grammar.	4.72	Highly important
<b>Weighted Mean</b>	4.78	Highly important

As reflected in the above table, all items under English proficiency were perceived to be highly important. It can be noted that item no. 3 obtained the highest mean of 4.90. This implies that the teacher's ability to read English well is considered to be the highest as the respondents are certain that if the teacher orally reads well they can hear words well; thus, their listening is also developed and eventually their ability to pronounce could be enhanced.



Table 2 below shows how respondents perceived the pedagogical skills of the teachers.

Table 2 *Respondents' Perception on the Teachers' Pedagogical Knowledge*

<b>B. Pedagogical Knowledge</b>	<b>Mean</b>	<b>Verbal Interpretation</b>
An effective English teacher is someone who should:		
1. make /prepare lesson well	<b>4.69</b>	Highly important
2. provide students outside the classroom learning (e.g. watching the English news/ programs, etc)	4.41	Highly important
3. utilize a number of technologies such as video, audio, and other forms of multi-media	4.49	Highly important
4. impart knowledge in English suited to students' level of proficiency	4.51	Highly important
5. provide a conducive classroom environment	4.35	Highly important
6. teach English in English	4.59	Highly important
7. evaluate or assess students' learning	4.50	Highly important
8. incorporate varied styles in learning among the students	4.55	Highly important
9. give the students more chances to use English in worthwhile activities	<b>4.69</b>	Highly important
10. be able to arouse students' interest in English through worthwhile activities	4.67	Highly important
<b>Weighted Mean</b>	4.54	Highly important

As illustrated in Table 2, similarly all items which belong to the pedagogical knowledge of the teachers were rated highly important. Two items (nos.1 and 9) both received the highest mean of 4.69. This implies students most likely to admire teachers who could prepare the lessons well so that they could be assured of a better and effective learning. Moreover, students think that effective

learning can also be attained if they will be provided with opportunities to use English through meaningful activities. Thus, teachers should be more creative to look for exciting and communicative activities that will motivate the students to speak English. Teachers’ talking time should not be too much instead adequate students’ speaking time should be prioritized.

Table 3 manifests the respondents’ perception on teachers’ socio- affective skills.

Table 3 *Respondents’ Perception on the Teachers’ Socio-Affective Skills*

<b>C. Socio-Affective Skills</b>	<b>Mean</b>	<b>Verbal Interpretation</b>
An effective English teacher is someone who should:		
1. extend help to students in and out of the classroom	4.59	Highly important
2. alleviate students sadness in an English class	4.61	Highly important
3. pay attention to the personal views of the students	4.62	Highly important
4. develop students’ self – confidence in learning English	4.67	Highly important
5. establish rapport with students and become congenial to learners	4.58	Highly important
6. show a good sense of humor	4.58	Highly important
7. not discriminate between learners and should practice fairness	<b>4.73</b>	Highly important
8. arouse students’ interest in learning English	<b>4.73</b>	Highly important
9.show concern to students as well as their English learning.	4.61	Highly important
<b>Weighted Mean</b>	4.64	Highly important

As shown in the table above, all items under the socio-affective skills were considered highly important. Among the items, numbers 7 and 8 garnered the highest mean of 4.73. Students really consider fairness very important in the classroom. If they are treated fairly and justly then they feel happy and they learn to appreciate

and value one another. Furthermore, teacher's ability to motivate is indeed significant in students' success in learning. Better learning is achieved when motivation is great.

Problem 2: Which of the three categories is perceived most important?

Table 4 depicts how the respondents rank the three categories.

Table 4. *Respondents' Perception on the Three categories of qualities*

<b>Categories of Characteristics</b>	<b>Sum</b>	<b>Rank</b>
A. English Proficiency	146.00	1
B. Pedagogical Knowledge	235.00	2
C. Socio-Affective Skills	248.00	3

As reflected, English proficiency was ranked first. This means that the respondents perceived the English proficiency of the teachers to be the most important to be possessed by their mentors. This finding is in agreement with the study done by Park & Lee (2006) which ranked English proficiency the first. This implies that students believe that teachers' fluency in their teaching skills is very necessary in attaining effective learning.

Problem 3. Are the characteristics of EET perceived by male students different from those perceived by female students?

Below is the table which shows whether the perception of the male differs from the female students.

Table 5. Three Categories of Characteristics as Perceived by Both Male and Female Respondents

Test Statistics <sup>a</sup>						
	Asum	Bsum	Csum	IIA	IIB	IIC
Mann-Whitney U	1059.000	1048.500	1041.000	1039.000	1022.500	963.000
Wilcoxon W	3909.000	1513.500	3891.000	1504.000	1487.500	3813.000
Z	-.481	-.546	-.602	-.762	-.793	-1.265
Asymp. Sig. (2-tailed)	.630	.585	.547	.446	.428	.206

a. Grouping Variable: gender

As manifested in Table 5, there is no significant difference between male and female’s perceptions and ranking with regard to the three categories of characteristics. Both respondents perceived all three categories to be highly important. This no difference result is same with the quantitative study of Wichadee (2010) which revealed that the students placed an importance on overall characteristics at a high level. However, the male students did not significantly demonstrate different characteristics from the female students. Thus, in this study, there was no statistically significant difference found in the students’ perceptions on characteristics of effective teachers in terms of their fields of study at  $p < 0.05$ .

## 5. Summary, Conclusion and Recommendations

In this chapter are the summary, conclusions, and recommendations formulated.

This study primarily aimed at determining the perception of the 105 college graduating students of La Salle University Ozamiz. The qualities of effective teachers were measured through a questionnaire adapted and slightly modified from Park & Lee (2010). For analysis of the study, the following statistical treatment tools were used. Weighted mean was utilized for analyzing the importance of each of the item in the three categories. Sum of Ranks was used in determining the rank of significance of each

category. Finally, Mann- Whitney U Test was applied for finding the significant difference on the perception of male and female respondents.

## Findings

From the data obtained, the following are the findings:

1. All the three categories of characteristics namely: English proficiency, pedagogical knowledge and socio- affective skills were perceived highly important garnering weighted mean of 4.78, 4.54, and 4.64 respectively, ranking the English proficiency first or the most important among the three.
2. There is no significant difference between male and female students on their perception on the characteristics of an effective English teacher.

## Conclusion

As perceived by the graduates of October 2011, the three categories of the characteristics of effective English teachers are indeed very important in attaining success in the teaching – learning process as the teachers play a great impact on the success or failure of students’ learning. Thus, they are the considered the greatest motivators of students to learn.

## Recommendations

The researcher would like to recommend the following:

1. Teachers teaching English should enhance more their English proficiency and motivate more the students by providing them a well –prepared lesson and opportunities to use English through meaningful activities.

2. Since students would like their teachers to provide them more opportunities to speak English, they must be as well cooperative and participative at all times.
3. The administrators should continue to develop programs and trainings for teachers to enhance their English proficiency skills, pedagogical skills and socio- affective skills for them to be more competent in the field of teaching English.
4. Other researchers should explore new research avenues which will determine the relationship of teachers' characteristics to their job efficiency and the students' academic performance in English.

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# Oral English Communication Skills of 2<sup>nd</sup> and 3<sup>rd</sup> Year BEED Students

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## Abstract

This paper which discussed the oral communication skills of the 2<sup>nd</sup> and 3<sup>rd</sup> Bachelor of Elementary Education students showed that majority of the respondents had sufficient mastery in the use of the oral English language for both social and academic use. This descriptive research on Oral Communication Skills of 2nd and 3rd Year BED Students aimed to identify the oral communication skills of the said respondents in terms of social and academic use. Through the use of simple observations, all the 65 sophomore and junior students who were enrolled in Bachelor of Elementary Education on the first semester of SY 2011-2012 were evaluated in terms of their social and academic use of the English language. The Language Band System and the Oral Interaction Assessment Scale designed by Carroll (1980) were used by the researcher in determining the communication proficiency level of the students. For social use of the language, the students were asked to engage in paired and/or group communicative activities. On the other hand, the students also participated in debates and classroom reports in order to determine their competency in using the English language for academic purposes. The results revealed that majority of the respondents were in level 6 which means that they have sufficient mastery in the use of the English language for both academic and social usage. The respondents may stumble and hesitate at times in communicating but they were able to follow topic switches and maintain theme of dialogue. The results of this study will be used as basis to improve the syllabus of the Languages Department intended for Elementary Education students, specifically in English 2a and English 3E subjects.

## 1. Introduction

Communication, the art of transmitting information from one person to another through the use of symbols such as words, pictures, and graphs (Fernando, Habana, Cinco, 1975), is vital for



any society to exist and flourish. Through it, things can be expressed, ideas can be shared, and thoughts can be joined; however, without it, the society becomes isolated. It is, therefore, a necessity in social and business networking, in spreading and promoting ideas, and in co-existing (Kam, 2009).

Between oral and written communication, the latter is the higher and more intellectual skill; however, the former is the more useful and accessible form of communication. In fact, a number of earlier studies have identified oral communication skills in English as one of the skills preferred by employers when recruiting an employee for business positions. Businesses, companies and organizations prefer applicants who can effectively manage people, work with people and communicate with people. This is because in the workplace, managers spend seventy five percent (75%) of their time communicating some messages to another (Mohd & Sallehi, 2000).

When conveying messages, people prefer oral communication channels compared to written ones. This is because talking takes less time and needs no keyboarding, rewriting, duplicating or distributing. More importantly, it provides the opportunity for feedback. When people communicate orally, they can ask questions, share ideas and clarify doubts and work together to solve problems. It is also the best channel if there is an emotional component in the message (Mohd & Sallehi, 2000).

The importance of oral communication is further manifested, not just in the arts and in business, in social and political forums, but more so in education and the teaching field. Since teaching requires the constant imparting of ideas and transmitting of information, communication is a very important tool. Teachers and students discuss, interact, argue, and impart knowledge and information through the use of language. Communication, then, plays a very crucial role, in the education of the students.

Communicative competence then is a necessary skill that every teacher must possess in order to become an effective facilitator of learning. The teacher must show considerable skill not just in written communication, but more so, in oral form.

The study of Maghamil (2009) revealed that students acquire the oral communication skills of the teachers. When teachers speak the language well, they tend to listen well and try to emulate the teachers' communication skill. However, when the teachers do not speak the language well, the students are not motivated to learn and have even shown evidences that they acquire the same errors of the teachers in pronunciation, intonation, phrasing, and stressing.

In La Salle University where teacher education is one of the more popular programs, varied opportunities and training activities are provided for the students to become better users and communicators of the English language. Classroom discussions are facilitated through the use of English and business and official queries have to be transacted in the same language.

However, no study has been conducted yet to determine the oral communication skills of the Basic Education students. This study is therefore conducted to identify the language proficiency of the Basic Education students. Knowing that the BED students will be handling the elementary pupils in the future, it is imperative that they would be proficient with the language so their pupils will be benefited from them.

#### Theoretical/Conceptual Framework

This study is anchored on the Language Band System which Carrol developed in 1980.

The ability to speak confidently, concisely, and convincingly has always been the goal of most individuals who are

concerned in developing their oral language skills. Oral proficiency in English is very much important to the students because it enables them to acquire sufficient command of the language deemed necessary in bringing their ideas across to others. If a student is an expert speaker of English language, he/she is able to express his/her emotions, to communicate his/her intentions, to react to other persons and situation, and to influence other human beings in a very nice and proper delivery which can be easily understood by the recipient of the messages.

### Oral English Proficiency

The study of Lector (1997) on the Speaking Proficiency of the Fourth year Science Curriculum students showed that these students had very good pronunciation, fluency, and comprehensibility; however, the students were found to be most deficient in the vowel sound production. In like manner, the study conducted by Manginsay (1999) on the oral English proficiency of the Senior students in Liangan National High School as gauged by the Speaking Proficiency English Assessment Kit (SPEAK) test displayed that the respondents had difficulty in learning the English language, and had no sufficient exposure on the utilization of English language as revealed by the Strategy Inventory for Language Learning (SILL) test.

De Gracia-Casiño (2003), in her study on the Oral English Proficiency of English 2a students in Immaculate Conception College-La Salle revealed that the oral proficiency of students was only good. Most students had problems expressing themselves orally in English (as revealed in the SPEAK test) because they lacked the vocabulary and pronunciation skills. She stressed further that the students' responses to even conversational topics were only fair, sometimes even incomprehensible.

The study of Maghamil (2009) on Oral English Threshold Level and the HELP Program for LSU College Froshies further

discussed the oral English proficiency of the students which revealed that the said students still belonged to the second threshold despite their being in college. This means that the students only had sufficient mastery in the use of the oral form of the English language for both social and academic purposes. It was also revealed in the said study that lack of vocabulary was their main oral communication problem.

### Language Band System

Fulcher (1987), in his study on *Tests of Oral Performance: The Need for Data-based Criteria*, discussed: “It has become almost axiomatic for ‘communicative’ testing theory that the tests should contain exercises which are based on ‘real-life’ communicative situations (Morrow 1979). The notion of ‘sampling real life’ has, however, been extensively criticized (Oller 1979: 184; Alderson 1981:57), mainly because testing has been seen as the reliable prediction of success in some behavioral performance in a non-test situation. Communicative testing theory tries to tap the performance directly.”

In determining the oral proficiency of second language users, Carroll (1980) designed the nine-point language band system. The matrix below shows the band performance scales.

Matrix 1: Nine-Point Language Band System

<b>Band Performance Levels</b>	
9	<b>Expert Speaker.</b> Speaks with authority on a variety of topics. Can initiate, expand and develop a theme.
8	<b>Very good non-native speaker.</b> Maintains effectively his own part of a discussion. Initiates, maintains, and elaborates as necessary. Reveals humor where needed and responds to attitudinal tones.
7	<b>Good speaker.</b> Presents case clearly and logically and can develop the dialogue coherently and constructively. Rather less flexible and fluent than Band 8 performer but can respond to main changes of tone or topic. Some hesitation and repetition due to a measure of language restriction but interacts effectively.
6	<b>Competent speaker.</b> Is able to maintain theme of dialogue, to follow topic switches and to use and appreciate main attitude markers. Stumbles and hesitates at times but is reasonably fluent otherwise. Some errors and inappropriate language but these will not impede exchange of views. Shows some independence in discussion with ability to initiate.
5	<b>Modest speaker.</b> Although gist of dialogue is relevant and can be basically understood, there are noticeable deficiencies in mastery of language patterns and style. Needs to ask for repetition or clarification and similarly to be asked for them. Lacks flexibility and initiative. The interviewer often has to speak rather deliberately. Copes but not with great style or interest.
4	<b>Marginal speaker.</b> Can maintain dialogue but in a rather passive manner, rarely taking initiative or guiding the discussion. Has difficulty in following English at normal speed; lacks fluency and probably accuracy in speaking. The dialogue is therefore neither easy nor flowing. Nevertheless gives the impression that he/she is in touch with the gist of the dialogue even if not wholly master of it. Marked L1 accent.
3	<b>Extremely limited speaker.</b> Dialogue is a drawn-out affair punctuated with hesitation and misunderstandings. Only catches part of normal speech and unable to produce continuous and accurate discourse. Basic merit is just hanging on to discussion gist, without making major contributions to it.
2	<b>Intermittent speaker.</b> No working facility; occasional, sporadic communication
1	<b>Non-speaker.</b> Not able to understand and/or speak.

According to Carroll, there are few demands to assess the language performance of both expert users and non-users of a language which makes it possible only for a seven-level system, Bands 2 to 8, with a “ceiling” and a “floor” as polarity markers.

## Group Work

Since some of the activities used in determining the English proficiency required group work and cooperation, the following studies are helpful in this research.

Studies done at the University of Delaware found out that groups of students working together on shared problems are capable of generating knowledge that individual students working alone could not do (Donato, 1989). The concerted effort of working as a collective promotes the growth of information and knowledge that can be shared by all members of the group and can be used by them individually (Di Pietro, 1987).

Dickie (1980) likewise conducted studies on cooperative learning which included measures of student’s self-esteem. It is assumed that students in cooperative groups will feel more liked by their classmates because of the increased opportunities to interact. When students feel they are making significant contributions to the group process and these contributions are valued by the group members, they are more likely to feel successful academically.

Collaborative activities also make it possible for the students to develop their skills. Through these activities, less confident students get the chance to put their knowledge into practice in a non-threatening environment. Instead of being dependent on the teacher, students get used to helping and learning from each other. On the other hand, the teacher is left free to monitor the progress and give help, advice, and encouragement when it is needed. It is worth noting that during collaborative activities, especially in language classes, the level of noise is higher

compared to the normal classroom discussion. According to linguists, teachers must make sure that the level of noise must not be disruptive and that pupils make healthy noise. These language exercises help students to gain confidence, improve their skills, and develop their oral proficiency in English language use.

Through cooperative learning, students can become real partners in the learning enterprise. Since most consequential problems are solved via collaboration, students who learn to work together in an educational setting are better prepared to meet life's obligations. Through cooperative learning, students are asked to do things in the English as a Foreign Language (EFL) classroom that they are asked to do in real life—take charge of and be responsible for their own learning.

### Practical Work

Since some of the activities used in determining the English proficiency required practical work, the following studies are helpful in this research.

Another way of developing the English language proficiency of the students is by providing practical work. Practical works help students to learn through their own activity (Lardizabal, 1991). The students observe, compare, analyze, and draw conclusion from the work given. Thus, whatever is learned is learned thoroughly and retained longer.

Retention rate levels of learners depend on how they received any new information (Tenedero, 1998). Practical work is a kind of strategy that is referred to as “hands-on and minds-on” activity. Students are given tasks where they can practice what they had learned. These exercises served as enrichment and enhancement activities to reinforce the skills gained by the students. Students retained 90 percent of what they learned if they actually perform the assigned tasks.

The study of De Gracia-Casiño (2003) revealed that students find doing English work with practical value very helpful in understanding and using the language more frequently. In fact, Collins (1990,) also states that students need to work on tasks they will use in the world, activities that are authentic and intrinsically motivating. Through meaningful activities, students' thinking and language abilities are incessantly learned, elevated, and churned.

There is only a limited study, if none at all, concerning students' oral English proficiency in terms of academic and conversational use. This study serves as a follow-up study to the one conducted by Maghamil (2009) on the Oral English Threshold Level and the HELP Program for LSU College Froshies.

### Statement of the Problem

This paper aimed to identify the profile of the 2<sup>nd</sup> and 3<sup>rd</sup> BED students in terms of their oral English communication skills for social and academic use. Specifically, it sought to answer the following question:

1. What is level of the oral communication skills of the respondents in terms of :
  - a. academic use
  - b. social use

### Significance of the Study

This study will be used as basis to improve the syllabus of the Languages Department intended for Elementary Education students, specifically in English 2a and English 3E subjects. It is further significant in the following respects:



## Elementary Education students

The results of this study would help the 2<sup>nd</sup> year and 3<sup>rd</sup> year Basic Education students to do something with their English oral communication skills so they would become more active and better users of the language.

## Languages Department

With the results of the study, the department could now design a speech program to help the students improve their oral communication performance.

## College of Education

The faculty of the College of Education would now better understand the communication skills of their students and provide more opportunities for them to interact and communicate using the English language.

## Scope and Limitation of the Study

This study focused only in describing the oral English communication skills of the 2<sup>nd</sup> year and 3<sup>rd</sup> year Elementary Education students who were taking English 3E during the first semester 2011-2012. As the subject focuses on interactive English, only the social and academic use of the English language in its oral form was taken into account. Also, only the language band system designed by Carrol (1980) used in assessing the students' competency.

## **2. Methodology**

This presents the research design, local, the respondents, the research instruments, and the statistical treatment that were used in the analysis of the obtained data.

### **Research Design**

This study used the descriptive method of research focusing on the use of observation in gathering data using the language band system designed by Carroll (1980) as a guide in rating the respondents' oral communication skills.

### **Research Locale**

This study was conducted in the College unit of La Salle University.

### **Respondents**

All second year and third year students of Bachelor in Elementary Education who were enrolled in English 3E: Interactive English were taken in as respondents of this study. There were a total of 65 students - 8 males and 57 females.

### **Data Gathering Procedure**

### **Research Instrument**

This research used simple observations and evaluations in determining the oral English proficiency skills of the students. Through the activities specifically designed by the researcher/teacher, the students were made to participate and perform in the said activities to determine their oral English communication skill in terms of social and academic use. Such activities include: reporting and debating (for academic use) as well

as role playing, group story-telling, and gossiping (for social use of the language). Topics and questions were provided for the students in these said activities for them to further understand the activity and perform well. These said topics and questions were all taken from the content specifications and characterization of the Threshold Level as prepared by the Council of Europe (1990).

While the students were performing the activities, the teacher-researcher was rating the individual student's responses using the Language Band System designed by Carroll (1980).

The responses were evaluated in terms of size, complexity, range, speed, flexibility, accuracy, appropriacy, independence, repetition, and hesitation. The nine-point language band system designed by Carroll (1980) for second language users was used to rate the respondents' responses.

In this study, however, discriminating the language performance of students started at Band 1 up to Band 9. The purpose of which is to find out at the same time if there were expert users or non-speakers of the language among the respondents.

To determine the oral communication skills of the respondents using the Band levels, the following performance scale is devised based on the Oral Interaction Assessment Scale of Carroll (1980).

#### Oral Performance Scale

<b>Band Levels</b>	<b>Interpretation</b>
7-9	Excellent Mastery
4-6	Sufficient Mastery
1-3	Insufficient Mastery

Using the scale shown above, the researcher would be able to identify the oral communication skill of the respondents. If the respondents fell under Bands 7-9 for either or both social and academic use of the language, it means that they possess excellent

mastery of the language. Similarly, if they were in Bands 4-6, their mastery of the language for either or both uses would only be sufficient. Belonging to Bands 1-4, likewise would mean that their mastery of the academic and/or social use of the language was insufficient.

### Statistical Treatment

For in-depth treatment of the data, Frequency and Percentage Distribution was used to describe the oral English communication skills of the respondents.

### 3. Results and Discussion

The results of the study conducted are presented in the following tables and discussions.

#### Band Scale Levels of the Respondents

Table 1 shows the band scale level of the students in terms of academic use.

Table 2: Band Scale Level of Students in Terms of Academic Use

<b>Band Scale Levels</b>	<b>F</b>	<b>%</b>
9	0	0
8	4	6.2
7	12	18.5
6	31	47.7
5	14	21.5
4	4	6.2
3	0	0
2	0	0
1	0	0

<b>Total</b>	<b>65</b>	<b>100</b>
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As shown in Table 1, most of the respondents (47.7%) belonged to level 6 in terms of their academic use of the language which means that they were competent speakers. They were able to maintain theme of dialogues, follow topic switches but stumbled and hesitated at times with some errors and inappropriate language use. No one among the respondents, nonetheless, were expert speakers (level 9) nor extremely limited, intermittent, and non-speakers (levels 3-1).

Even though their cognitive academic language proficiency (CALP) focuses on the use of abstract and context-reduced language, students are able to participate in the discussion, albeit minimal. Noticeable, however, are their grammatical errors and inappropriate language use. Considering the fact that these students were already in their second year of college education and are therefore expected to have already gained an excellent mastery of the use of the academic language and that they were given sufficient time to prepare for their reports and debates, the students were not able to participate well in the activity owing to some errors in grammar and fluency.

Maghamil (2009) noted that most students perform well in academic tasks because they were given sufficient time to prepare for and sometimes memorize the content of the given topics; however, when they would be asked questions regarding the topics reported or debated on, they tend to hesitate and stumble for words and ideas.

Table 2 shows the band scale level of the students in terms of social use.

Table 2: Band Scale Level of Students in Terms of Social Use

<b>Band Scale Levels</b>	<b>Tally</b>	<b>Percentage</b>
9	0	0
8	7	10.8
7	14	21.5
6	22	33.8
5	18	27.7
4	3	4.6
3	1	1.5
2	0	0
1	0	0
<b>Total</b>	<b>65</b>	<b>100</b>

The table above shows that 33.8% of the respondents were competent enough in using the English language in terms of social use. When asked to gossip, tell a story, and present a role play, they were able to hold their ground in the communication process despite some hesitancy and grammatical errors. They also showed some independence and initiative in moving the discussion along.

Since the topics for discussion were given on the spot, the students were given only a very limited time, if none at all, to prepare for the activities. This is evident in their inability to fluently express their opinions on the given topics, even though these were very familiar topics which are often discussed in day-to-day conversations using the native language.

This might be attributed to the fact that, although they have been frequently exposed to English in school and in the mass media which allow them to use the language in both purposes, they have not been given sufficient time and opportunities to engage in meaningful interactions in the target language which should have allowed them to concentrate not only in the form of their utterances

but also in the communicative act itself. This explains the significant errors and hesitations the students commit. As Troike asserts in De Gracia-Casiño (2003), “Oral and structural proficiency of a language is better if it is learned through situational contexts.”

In addition, the results support the claim of Maghamil (2009) that most students, and thereby most people for that matter, are more at ease in using the local language during conversations but found it awkward to use the second language for the same topics. Similarly, Ajileye (2007) mentioned that many non-native speakers of English do not use the language during conversations because they have a more expressive and convenient means of communicating with most people around them.

Once the Band scale levels were identified, the next step was to determine their oral communication skills in terms of their academic and social use of the language.

Table 3 shows the oral communication skills of the respondents in terms of academic and social use

Table 3: Oral Communication Skills in terms of Academic and Social Use

Band Levels	Academic		Social	
	Tally	Percentage	Tally	Percentage
7-9	16	24.6	21	32.3
4-6	49	75.4	43	66.2
1-3	0	0	1	1.5
<b>Total</b>	<b>65</b>	<b>100</b>	<b>65</b>	<b>100</b>

Table 5 revealed that majority of the respondents belonged to Level 2 in both their academic (75.4%) and social (66.2%) use of the language.

This means that the respondents only have sufficient mastery in using the English language for both academic and social use. Their speaking skills range from competent to modest to marginal. It means that they initiate and maintain dialogue despite

some errors and inappropriate language use. Moreover, the respondents give the impression that they are in touch with the gist of the dialogue even if not wholly master of it. They may stumble and hesitate at times but are reasonably fluent otherwise.

What is significant to note, however, is the fact that although these students are second year college students, they still do not possess excellent mastery in the use of the English language for both academic and social use. They only have sufficient mastery for both skills.

This might be explained with the fact that, although the students have been bombarded with grammatical lessons and exercises since elementary, their knowledge is purely theoretical. When asked to apply this knowledge in practical uses such as in dialogues and conversations, they have difficulty in applying these grammar lessons.

As pointed out by Gatenby (2005), the rate of students' progress in oral communication is largely dependent upon the amount of time allotted to learn the English language. Cummins (1980) also stresses that it takes six months to two years for non-native speakers to gain proficiency in basic interpersonal communication skills while an even longer time – five to seven years – must be devoted for the development of the learners' cognitive academic language proficiency. In this present study, although the students have been studying and using English since Grade 1, they are given only limited time and opportunities in the classroom to actually use the language; hence, they still are unable to overcome their L1 accent.



## **4. Findings, Conclusion, Recommendations**

### Salient Findings

This study aimed to identify the oral ENGLISH communication skills of the BED 2<sup>nd</sup> year students in terms of social and academic use. There were a total 65 respondents – 8 males and 57 females.

The obtained data generated the following findings: (1) most students belonged to level 6 in terms of the academic use of the language which means that they were competent speakers of the language; (2) in terms of social use, the respondents again were competent enough to use the language since most of them belonged to level 6; (3) the respondents only have sufficient mastery in the use of the English language for both academic and social use.

### Conclusion

Based on the findings of this study, the researcher came up with the following conclusions: (1) As 2<sup>nd</sup> year Elementary education students, the respondents were competent speakers of the English language; they may stumble and hesitate at times during the communication process but were otherwise fluent. (2) They only have sufficient mastery of the use of the English language for both academic and social use.

### Recommendations

Based on the findings and conclusions made, the following recommendations are given: (1) English and Education instructors must provide more opportunities for students to academically use the English language through reports, debates, panel discussions, open forum, and the like. (2) Situational activities, whether individual or by group, must also be given in English classes in order to develop students' social use of the language. (3)

Conversations and transactions between students and teachers, whether formal or informal, academic or social, must be done in English in order to prepare the students for their actual teaching in the field.

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# Vertex Cover of Powers of Paths and Cycles

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## Abstract

Let  $G$  be a graph. A set  $U$  of vertices in  $G$  is a vertex cover of  $G$  if every edge in  $G$  is incident with a vertex in  $U$ . The vertex covering number  $\alpha(G)$  of  $G$  is the cardinality of a minimum vertex cover of  $G$ . This paper gives the vertex covering number of powers of paths and cycles.

## 1. Introduction

### Background of the Study

Graph theory is one of the most stimulating and exciting areas in Mathematics. Many great accomplishments of the modern world were based on graph-theoretic ideas and concepts. One of these is the concept of covering vertices and edges of graphs by other vertices and edges. In this study, the researcher considered the notion of covering edges by some vertices in  $G$ , which is well-known as the classical vertex covering problem.

The ideas presented in this paper only add to the existing studies by the following authors: Harary (1969), Read (1972), Foulds (1992), Thulasiraman and Swamy (1992) and Gervacio (1995), Gervacio and Rosalejos (2001). Harary (1969) associated coverings to independent sets in a graph.

Karp (1972) showed that 21 diverse problems from graph theory and combinatorics are NP-complete. One from this set is the vertex cover problem which is concerned in minimizing the size of vertex cover. This problem has been extensively studied by several

mathematicians. Some were Fernau and Manlove (2009) and Behsaz, et.al (2008). Their papers include the characterization of minimum vertex covers in generalized Petersen graphs (Bar-Yehuda, et. al (2010) and the presentation of ideason total vertex cover of graphs (Bar-Yehuda, et. al, 2010). In the year 2003, Uy (2003) was able to find the vertex covering numbers of paths, cycles, complete graphs, complete bipartite graphs and the graphs  $G(n; k)$ . He also presented some characteristics of vertex cover of graphs. The following year, Eguia and Uy (2004) were able to find the vertex covering number of the graphs resulting from the product and sum of graphs and obtain the vertex covering number of complete n-partite graphs. In this paper, the researcher was motivated to obtain more results on the vertex cover of graphs.

## 2. Review of Related Literature

In Chao and Jost (2012), the concept of vertex cover and vertex covering number of a graph were characterized and relate to other graph theoretic ideas. Some of these concepts are hamiltonicity, subgraph and connectivity. These are some known results from previous studies on vertex cover of graphs. Some of these are useful in proving the results in Chapter 3.

**Theorem 1.2.1** [13] Let  $G$  be a spanning subgraph of a complete graph  $K_n$  where  $|E(G)| = |E(K_n)| - 1$ . Then  $\alpha(G) = n - 2$ .

**Theorem 1.2.2** [13] Let  $G$  be a connected graph. Then  $\alpha(G) = 1$  if and only if  $G$  is a star.

**Theorem 1.2.3** [13]  $K_{m,n}$  is hamiltonian if and only if  $m = n$ .

**Theorem 1.2.4** [13] If  $H$  is a subgraph of a graph  $G$ , then  $\alpha(H) \leq \alpha(G)$ .

**Theorem 1.2.5** For the path  $P_n$  of order  $n$ ,  $\alpha(P_n) = \left\lfloor \frac{n}{2} \right\rfloor$ .

**Theorem 1.2.6** For the path  $C_n$  of order  $n$ ,  $\alpha(C_n) = \left\lceil \frac{n}{2} \right\rceil$ .

**Theorem 1.2.7** For the complete graph  $K_n$ ,  $\alpha(K_n) = n - 1$ .

**Theorem 1.2.8** If  $H$  and  $J$  are disjoint subgraphs of  $G$ , then.

$$\alpha(H) + \alpha(J) \leq \alpha(G).$$

**Theorem 1.2.9** For a complete bipartite graph  $K_{m,n}$ ,  $\alpha(K_{m,n}) = \min\{m, n\}$ .

The next result presents the vertex covering number of graphs resulting from the product and sum of graphs.

**Theorem 1.1.4** If  $H$  and  $J$  are disjoint graphs, then

$$\alpha(H \cup J) = \alpha(H) + \alpha(J).$$

**Theorem 1.1.5** Let  $G$  be a graph. If  $n \geq |V(G)|$ , then

$$\alpha(\overline{K_n} + G) = |V(G)|.$$

**Corollary 1.1.6**  $\alpha(\overline{K_n} + \overline{K_m}) = \min\{m, n\}$ .

**Corollary 1.1.7** For any graph  $G$ ,  $\alpha(K_1 + G) = 1 + \alpha(G)$ .

**Corollary 1.1.8**  $\alpha(\overline{K_m} + K_n) = n$ .

## Statement of the Problem

This paper aimed to obtain the vertex covering number of some graphs which are not considered in the papers "Vertex Cover of Graphs" (Uy, 2003) and "Vertex Cover of Product and Sum of Graphs" (Eguia and Uy, 2004). These are graphs resulting from the graph operation, powers of graphs.

## Significance of the Study

The vertex cover problem is an optimization problem of finding the smallest vertex cover in a given graph. An example of a practical application involving the vertex cover problem arises in efficient assignment of surveillance cameras for security of a certain area. In this case, the researcher treats hallways and roads as the edges of the graph and the cameras as the vertices of the graph,

such that a camera can look out hallways and roads incident to it. Thus, the vertex covering number represents the minimum number of cameras needed to assure a full surveillance of the area. Other applications of this study are on network problems, travelling salesman problem and the shortest and longest paths problems.

The researcher hopes that the results of this study could help those who wish to study further vertex covering and other related topics.

### Scope and Limitation

All graphs considered in this paper are finite and simple, that is, loopless and without multiple edges. Symbols and concepts are found and defined in the Chapter 2: Basic Concepts are sufficient in obtaining the results in Chapter 3.

## Basic Concepts and Definitions

### Basic Definitions

This section contains basic definitions in graph theory, set theory and the definition of vertex cover and vertex covering number, which are useful in this study. The basic concepts are taken from (Harary, 1969) and (Pinter, 1971).

**Definition 2.1.1** A graph  $G$  consists of a finite nonempty set  $V=V(G)$  together with set  $E = E(G)$  of unordered pairs of distinct elements of  $V$ . Each element of  $V$  is called vertex. If the pair  $e = [u; v]$  is in  $E$ , then  $e$  is an edge of  $G$ , and  $e$  is said to join  $u$  and  $v$ . In this case, it is customary to write  $e = uv$  and say that  $u$  and  $v$  are adjacent, while  $u$  and  $e$  are incident, as  $v$  and  $e$  are. The degree,  $\text{deg}(v)$  of a vertex  $v$  is the number of incident edges to  $v$ . Adjacent vertices are called neighbors. The sets  $V(G)$  and  $E(G)$  are respectively the vertex set and edge set of  $G$ .

**Definition 2.1.2** A subgraph of a graph  $G$  is a graph having all of



its vertices and edges in  $G$ . A spanning subgraph is a subgraph containing all the vertices of  $G$ . For any set  $S$  of vertices of  $G$ , the induced subgraph is the maximal subgraph of  $G$  with vertex set  $S$ . Thus, two vertices of  $S$  are adjacent in the induced subgraph of  $G$  if and only if they are adjacent in  $G$ .

**Definition 2.1.3** A path, denoted by  $P_n, n \geq 1$ , is a graph with distinct vertices  $x_1, x_2, \dots, x_n$  where  $x_i$  and  $x_{i+1}$  are adjacent for all  $i = 1, \dots, n$ .

**Definition 2.1.4** The distance  $d_G(u, v)$  between two vertices  $u$  and  $v$  in a connected graph  $G$  is the length of the shortest path joining  $u$  and  $v$ .

**Definition 2.1.5** A graph  $G$  is called complete graph if every pair of its vertices are adjacent.  $K_n$  denotes the complete graph of order  $n$ . The graph  $K_1$  is called the trivial graph.

**Definition 2.1.6** A graph  $G$  is connected if every pair of its vertices is joined by a path.

**Definition 2.1.7** A cycle, denoted by  $C_n, n \geq 3$ , of order  $n$  is the graph consisting of the vertices  $x_1, x_2, \dots, x_n$  and edges  $x_1x_2, x_2x_3, \dots, x_nx_{n-1}, x_nx_1$ .

**Definition 2.1.8** A graph  $G$  is connected if every pair of its vertices is joined by a path.

**Definition 2.1.9** The  $k$ th power of a graph  $G$ , denoted by  $G^k$ , is the graph with  $V(G^k) = V(G)$  and whose vertices  $u$  and  $v$  are adjacent in  $G^k$  whenever  $d_G(u, v) \leq k$ .

**Illustration 2.1.10** The graphs  $P_6^3$ ,  $P_6^4$  and  $P_6^5$  are shown in Figure 1.

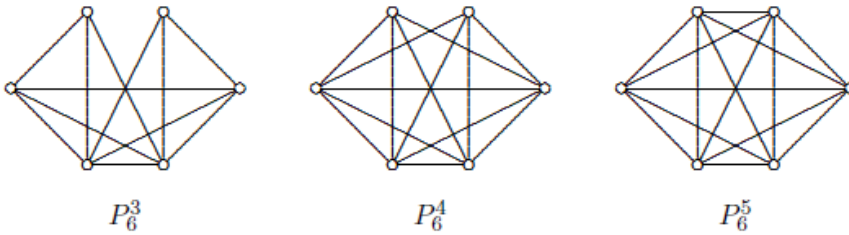


Figure 1: The graphs  $P_6^3$ ,  $P_6^4$  and  $P_6^5$

**Illustration 2.1.11** The graphs  $C_6^2$  and  $C_6^3$  are shown in Figure 2.

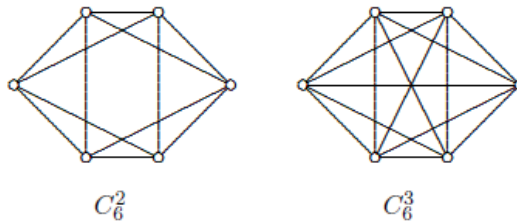


Figure 2: The graphs  $C_6^2$  and  $C_6^3$

## 2.2 Definition of Vertex Cover of Graphs

**Definition 2.2.1** Let  $G$  be a graph. A vertex in  $G$  is said to cover the edges on which it is incident. A subset  $U$  of  $V(G)$  is a vertex cover of  $G$  if for each edge  $e \in E(G)$ , there is a vertex in  $U$  which covers  $e$ . The vertex covering number of  $G$ , denoted by  $\alpha(G)$ , is given by,

$$\alpha(G) = \min\{|U| : U \text{ is a vertex cover of } G\}.$$

**Example 2.2.2** Consider the graph  $G$  shown in Figure 3.

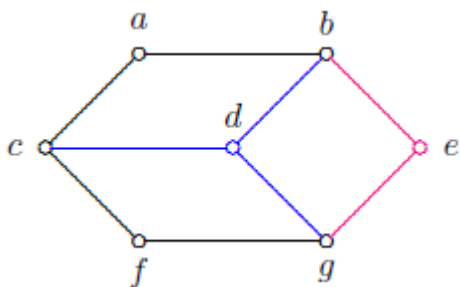


Figure 3: A graph  $G$  with  $\alpha(G) = 3$

Vertex  $d$  covers the edges  $db$ ,  $dc$  and  $dg$  while vertex  $e$  covers the edges  $be$  and  $eg$ .

The set  $\{b, c, g\}$ ,  $\{a, e, f, d\}$  and  $V(G)$  are vertex covers of  $G$  with cardinalities 3, 4 and 7, respectively. The following will show the process of examining whether the subsets of  $V(G)$  are vertex covers of  $G$  with cardinality less than 3. Consider the following subsets of  $V(G)$  below.

$\{a\}$ ,  $\{b\}$ ,  $\{c\}$ ,  $\{d\}$ ,  $\{e\}$ ,  $\{f\}$ ,  $\{g\}$ ,  $\{a, b\}$ ,  $\{a, c\}$ ,  $\{a, d\}$ ,  $\{a, e\}$ ,  $\{a, f\}$ ,

$\{a, g\}$ ,  $\{b, c\}$ ,  $\{b, d\}$ ,  $\{b, e\}$ ,  $\{b, f\}$ ,  $\{b, g\}$ ,  $\{c, d\}$ ,  $\{c, e\}$ ,  $\{c, f\}$ ,  $\{c, g\}$ ,  
 $\{d, e\}$ ,  $\{d, f\}$ ,  $\{d, g\}$ ,  $\{e, f\}$ ,  $\{e, g\}$  and  $\{f, g\}$ .

Notice that  $\{a\}$ ,  $\{e\}$  and  $\{f\}$  cover only two edges while  $\{b\}$ ,  $\{c\}$ ,  $\{d\}$  and  $\{g\}$  cover only three edges. Clearly, these singletons are not vertex covers of  $G$ . Also,  $\{a, c\}$ ,  $\{a, d\}$ ,  $\{a, f\}$ ,  $\{a, g\}$ ,  $\{c, d\}$ ,  $\{c, f\}$ ,  $\{c, g\}$ ,  $\{d, f\}$ ,  $\{d, g\}$  and  $\{g, f\}$  cannot cover the edge  $be$ ;  $\{a, b\}$ ,  $\{a, e\}$ ,  $\{b, c\}$ ,  $\{b, d\}$ ,  $\{b, e\}$ ,  $\{c, e\}$  and  $\{d, e\}$  cannot cover the edge  $fg$ ; and  $\{b, f\}$ ,  $\{b, g\}$ ,  $\{e, f\}$  and  $\{e, g\}$  cannot cover the edge  $ac$ . Hence, no subset of  $V(G)$  with cardinality 2 can cover  $G$ .

Therefore, the vertex covering number  $\alpha(G)$  is 3.

### 3. Results

#### Vertex Cover of Powers of Paths

This section gives the vertex covering number of power of paths and cycles. How to find the vertex covering number of powers of paths is demonstrated first.

**Illustration 3.1.1** Consider  $P_{10}^3$  in Figure 4.

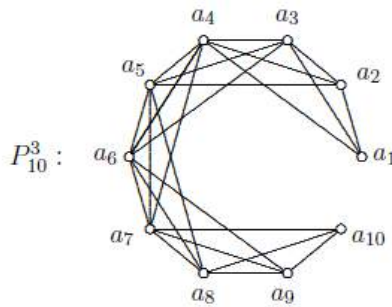


Figure 4: The graph  $P_{10}^3$

The subgraphs  $N_1$  and  $N_2$  induced by  $A_1 = \{a_1, a_2, a_3, a_4\}$  and  $A_2 = \{a_5, a_6, a_7, a_8\}$ , respectively, are disjoint complete subgraphs of order 4, while the subgraph  $N_3$  induced by the remaining vertices  $A_3 = \{a_9, a_{10}\}$  is a complete graph of order 2. Since  $A_1 \cap A_2 \cap A_3 = \emptyset$ ,  $N_1$ ,  $N_2$  and  $N_3$  are pairwise disjoint. By Theorem 1.2.7 and 1.2.8,

$$\begin{aligned} \alpha(P_{10}^3) &\geq \alpha(N_1) + \alpha(N_2) + \alpha(N_3) \\ &= 3 + 3 + 1 \\ &= 7. \end{aligned}$$

On the other hand, the sets  $B_1 = A_1 \setminus \{a_1\} = \{a_2, a_3, a_4\}$ ,  $B_2 = A_2 \setminus \{a_5\} = \{a_6, a_7, a_8\}$  and  $B_3 = A_3 \setminus \{a_{10}\} = \{a_9\}$  are vertex covers of subgraphs  $N_1$ ,  $N_2$  and  $N_3$ , respectively. The union  $B_1 \cup B_2 \cup B_3 = \{a_2, a_3, a_4, a_6, a_7, a_8, a_9\}$  covers  $N_1$ ,  $N_2$ ,  $N_3$  and the edges between them. Thus,

$$\begin{aligned} \alpha(P_{10}^3) &\leq |B_1 \cup B_2 \cup B_3| \\ &= 7. \end{aligned}$$

Combining the two resulting inequalities,  $\alpha(P_{10}^3) = 7$ .

The next theorem generalizes the discussion in Illustration 3.1.

**Theorem 3.1.2** Let  $q$  and  $r$  be the quotient and remainder, respectively, when  $n \in \mathbb{N}$  is divided by  $k+1$ . Then

$$\alpha(P_n^k) = \begin{cases} n-1 & \text{if } k \geq n-1 \\ kq & \text{if } k < n-1 \text{ and } r \leq 1, \\ kq+r+1 & \text{if } k < n-1 \text{ and } r > 1 \end{cases}$$

where  $\alpha(P_n^k)$  is the vertex covering number of the  $k$ th power of the path of length  $n$ .

Proof: Let  $P_k^n$  be the  $k$ th power of  $P_n$ , where  $V(P_n) = \{a_1, a_2, \dots, a_n\}$  and  $E(P_n) = \{a_1a_2, a_2a_3, \dots, a_{n-1}a_n\}$ . Consider the following cases:

Case 1:  $k \geq n-1$

The farthest distance of the vertices in  $P_n$  is  $n-1$ . Since  $k \geq n-1$ , every pair of vertices in  $P_k^n$ . Thus,  $P_k^n$  is a complete graph. Applying Theorem 1.2.7,  $\alpha(P_k^n) = n-1$ .

Case 2:  $k \leq n-1$

For  $1 \leq i \leq q$ , let  $N_i$  be the subgraph of  $P_k^n$  induced by

$$A_i = \{a_{(k+1)i-k}, a_{(k+1)i-(k-1)}, \dots, a_{(k+1)i}\}.$$

The following are observations.

- i. Each  $N_i$  is a complete subgraph of order  $k+1$  since the farthest distance of the vertices of  $N_i$  is  $k$  implying that every pair of vertices in  $A_i$  is adjacent. By Theorem 1.2.7,  $\alpha(N_i) = k$ .
- ii.  $N_1, N_2, \dots, N_q$  are pairwise disjoint since  $A_1, A_2, \dots, A_q$  are disjoint.
- iii. No edge joins a vertex in  $N_i$  and a vertex in  $N_j$ , whenever  $|i-j| \leq 2$ . To show this, let  $i \leq j$  and  $j-i \leq 2$ . Without loss of generality, assume  $j \leq i+2$ . Suppose

$$A_i = \{a_{(k+1)i-k}, a_{(k+1)i-(k-1)}, \dots, a_{(k+1)i}\} \text{ and}$$

$$A_j = \{a_{(k+1)j-k}, a_{(k+1)j-(k-1)}, \dots, a_{(k+1)j}\}$$

is a subset of  $V(P_n)$  that induces complete subgraphs of  $P_n^k$ . Then

$$\begin{aligned} d_G(a_{(k+1)i}, a_{(k+1)j-k}) &= d_G(a_{(k+1)i}, a_{(k+1)(i+2)-k}) \\ &= d_G(a_{(k+1)i}, a_{(k+1)i+2k+2-k}) \\ &= k+2 > k. \end{aligned}$$

Hence,  $a_{(k+1)i}$  and  $a_{(k+1)j-k}$  are not adjacent. Therefore, no edge joins a vertex in  $N_i$  and a vertex in  $N_j$  whenever  $|i-j| \geq 2$ . Furthermore, there are edges that join vertices from  $N_i$  and  $N_j$  if  $|i-j| > 2$ .

Let  $B_i = A_i \setminus \{a_{(k+1)i-k}\}$ . For  $1 \leq i \leq q$ ,  $B_i$  covers  $N_i$  and  $|B_i| = |A_i - 1| = k$ .  $B_i \cup B_{i+1}$  covers  $N_i, N_{i+1}$  and the edges between them. Extending the later relationship,  $\bigcup_{i=1}^q B_i$  covers  $N_1, N_2, \dots, N_q$  and the edges between them.

Subcase 2.1:  $r \leq 1$

Note that  $\bigcup_{i=1}^q B_i$  is a vertex cover of  $P_n^k$ . Thus,

$$\alpha(P_n^k) \leq \left| \bigcup_{i=1}^q B_i \right| = \sum_{i=1}^q |B_i| = kq.$$

Subcase 2.2:  $r > 1$

Let  $N_{q+1}$  be the subgraph of  $P_n^k$  induced by  $A_{q+1} = \{a_{(k+1)q+1}, a_{(k+1)q+2}, \dots, a_n\}$ . The distance between the vertices in  $A_{q+1}$  must be less than  $k-1$ . Then  $N_{q+1}$  is a complete graph and is disjoint with each  $N_i$ . Applying Theorem 1.2.7,  $\alpha(N_{q+1}) = r-1$ . By Theorem 3.1.2,

$$\alpha(P_n^k) \geq \sum_{i=1}^{q+1} \alpha(N_i) = kq + r - 1.$$

Let  $B_{q+1} = A_{q+1} \setminus \{a_n\}$ . Then  $\bigcup_{i=1}^q B_i$  is a vertex cover of  $P_n^k$ . Thus,

$$\alpha(P_n^k) \leq \left| \bigcup_{i=1}^q B_i \right| = \sum_{i=1}^{q+1} |N_i| = kq + r - 1.$$

Therefore,  $\alpha(P_n^k) = kq + r - 1$ .

□

The next example illustrates how to find a vertex cover for a power of cycle.

**Example 3.1.3** Consider  $C_8^2$  in Figure 5.

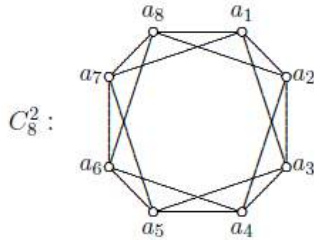


Figure 5: The graph  $C_8^2$

Let  $N_1$  and  $N_2$  be the subgraphs induced by  $A_1 = \{a_1, a_2, a_3\}$  and  $A_2 = \{a_4, a_5, a_6\}$ . The distance between vertices in  $A_1$  and the distance between vertices in  $A_2$  are less than or equal to 2. Hence, each pair of vertices in  $A_1$  and  $A_2$  are adjacent. Thus,  $N_1$  and  $N_2$  are complete subgraphs of order 3. By Theorem 1.2.7 and Theorem 1.2.8,  $\alpha(C_8^2) \leq \alpha(N_1) + \alpha(N_2) = 2 + 2 = 4$ .

Let  $B_1 = A_1 \setminus \{a_3\}$  and  $B_2 = A_2 \setminus \{a_6\}$ . Then  $B_1$  and  $B_2$  cover  $N_1$  and  $N_2$ , respectively. Furthermore,  $B_2$  covers the edges between  $N_1$  and  $N_2$ . Let  $M = \{a_7, a_8\}$ . Then  $P = M \cup B_1 \cup B_2$  is a vertex cover of  $C_8^2$ . Hence,

$$\alpha(C_8^2) \geq |P| = |M| + |B_1| + |B_2| = 2 + 2 + 2 = 6.$$

$M$  induces a complete subgraph  $N_3$  of order 2. Thus,  $\alpha(N_3) = 1$ . By Theorem 1.2.7,

$$\alpha(C_8^2) \geq \sum_{i=1}^3 \alpha(N_i) = 2 + 2 + 1 = 5.$$

Thus,  $5 \leq \alpha(C_8^2) \leq 6$ .

Suppose  $\alpha(C_8^2) = 5$ . Then only one element in  $M$  is in  $U$ .



If  $a_7 \in U$ , edge  $a_6a_8$  is not covered by  $U$ . If  $a_8 \in U$ ,  $a_7a_6$  is not covered by  $U$ . In both ways, a contradiction is found since  $U$  is a vertex cover of  $C_8^2$ . Thus,  $a_7$  and  $a_8$  must be elements of  $U$ . Therefore,  $\alpha(C_8^2) = 6$ .

The next theorem generalizes the discussion above.

**Theorem 3.1.4** Let  $q$  be the quotient when  $n \in N$  is divided by  $k+1$ . Then

$$\alpha(C_n^k) = \begin{cases} n-1 & \text{if } k \geq \left\lfloor \frac{n}{2} \right\rfloor \\ n-q & \text{if } k < \left\lfloor \frac{n}{2} \right\rfloor \end{cases}$$

where  $\alpha(C_n^k)$  is the vertex covering number of the  $k$ th power of the cycle of length  $n$ .

Proof: Let  $C_n^k$  be the  $k$ th power of cycle  $C_n$  where  $V(C_n) = \{a_1, a_2, \dots, a_n\}$  and  $E(C_n) = \{a_1a_2, a_2a_3, \dots, a_na_1\}$ .

Case 1:  $k \geq \left\lfloor \frac{n}{2} \right\rfloor$

The farthest distance of vertices in the graph  $C_n^k$  is  $\left\lfloor \frac{n}{2} \right\rfloor$ .

Since  $k \geq \left\lfloor \frac{n}{2} \right\rfloor$ , every pair of vertices is adjacent in  $C_n^k$ . Thus,  $C_n^k$  is a complete graph of order  $n$ . By Theorem 1.2.7,  $\alpha(C_n^k) = n-1$ .

Case 2:  $k < \left\lfloor \frac{n}{2} \right\rfloor$

For  $1 \leq i \leq q$ , let  $N_i$  be a subgraph of  $C_n^k$  induced by

$$A_i = \{a_{(k+1)i-k}, a_{(k+1)i-(k-1)}, \dots, a_{(k+1)i}\}.$$

Then

i. Each  $N_i$  is a complete subgraph of order  $k + 1$ , since the farthest distance of vertices in  $N_i$  is  $k$ , which implies that every vertices in the graph is adjacent. This further implies that  $\alpha(N_i) = k$  for  $i = 1, 2, \dots, q$ .

ii.  $N_1, N_2, \dots, N_q$  are pairwise disjoint since  $A_1, A_2, \dots, A_q$  are also disjoint subsets of  $V(C_n)$ .

iii. No edge of  $C_n^k$  joins a vertex in  $N_i$  and a vertex in  $N_j$ , whenever  $|i - j| \geq 2$ . To show this, let  $i \leq j$  and  $j - i \leq 2$  for  $i, j = 1, 2, \dots, q$  and  $i \neq j$ . Without loss of generality, let  $j = i + 1$ .

Suppose

$$A_i = \{a_{(k+1)i-k}, a_{(k+1)i-(k-1)}, \dots, a_{(k+1)i}\} \text{ and}$$

$$A_j = \{a_{(k+1)j-k}, a_{(k+1)j-(k-1)}, \dots, a_{(k+1)j}\}.$$

Then

$$\begin{aligned} d_{C_n^k}(a_{(k+1)i}, a_{(k+1)j-k}) &= d_{C_n^k}(a_{(k+1)i}, a_{(k+1)(i+2)-k}) \\ &= d_{C_n^k}(a_{(k+1)i}, a_{(k+1)i+2k+2-k}) \\ &= d_{C_n^k}(a_{(k+1)i}, a_{(k+1)i+(k+2)}) \\ &= k + 2 > k. \end{aligned}$$

Hence,  $a_{(k+1)i}$  and  $a_{(k+1)j-k}$  are not adjacent. Therefore, no edge of  $C_n^k$  joins  $N_i$  and  $N_j$  whenever  $|i - j| \geq 2$ .

By Theorem 1.2.8 and Theorem 1.2.7,  $\alpha(C_n^k) \geq \sum_{i=1}^q \alpha(N_i) = kq$ . For  $i = 1, 2, \dots, q$ , let  $B_i = A_i \setminus \{a_{(k+1)i}\}$ .

Then for each  $i$ ,  $B_i$  covers  $N_i$ . For  $i = 1, 2, \dots, q$ ,  $B_i$  covers the edges joining  $N_{i-1}$  and  $N_i$  and the edges between them. Let

$M = V(C_n) \setminus \bigcup_{i=1}^q A_i$ . Then  $P = M \cup \left( \bigcup_{i=1}^q B_i \right)$  is a vertex cover of  $C_n^k$ .

Thus,

$$\alpha(C_n^k) \leq |P| = |M| + \left| \bigcup_{i=1}^q B_i \right| = r + kq,$$

where  $r$  is the remainder when  $n$  is divided by  $k+1$ . It follows that  $kq \leq \alpha(C_n^k) \leq r + kq$ .

Subcase 1:  $r = 0$

Then  $\alpha(C_n^k) = kq$ . Since  $(k+1)q = kq + q = n$ ,  $\alpha(C_n^k) = kq = n - q$ .

Subcase 2:  $r = 1$

Then  $M = \{a_n\}$  and  $\alpha(C_n^k) = kq$  or  $\alpha(C_n^k) = kq + 1$ . Suppose that  $\alpha(C_n^k) = kq$  and let  $U$  be a vertex cover of  $C_n^k$  such that  $|U| = kq$ . If  $a_n \in U$ , then  $M = \{a_n \in U\} |U \cap A_i| < k$  for some  $i$ . This is not possible since  $N_i$  is a complete graph of order  $k+1$ . If  $a_n \notin U$ , then  $|U \cap A_i| = k$  for all  $i$ . To cover the edges between  $M$  and  $N_i$ , it is necessary to have  $a_1, a_2, \dots, a_k$  in  $U$ . It follows that  $a_{k+1} \notin U$ . To cover the edges between  $N_1$  and  $N_2$ , it is necessary to have  $a_{k+2}, a_{k+3}, \dots, a_{2k+1}$  in  $U$ . It follows that  $a_{2k+2} \notin U$ . Continuing this way, it can be concluded that  $a_{n-1} \notin U$ . Hence, no vertex will  $a_{n-1}a_n$ . This is not possible since  $U$  is a vertex cover of  $C_n^k$ . Therefore,  $\alpha(C_n^k) = kq + 1 = n - q$ .

Subcase 3:  $r \geq 2$

Since the farthest distance of vertices in  $M = \{a_n, a_{n-1}, \dots, a_{n-(r-1)}\}$  is  $r-1 < k$ , every pair of vertices is adjacent. Then  $M$  induces a complete subgraph  $N_{q+1}$  of  $C_n^k$  of order  $r$ . Hence,

$$\alpha(N_{q+1}) = r - 1 \text{ and}$$

$$\alpha(C_n^k) \geq \sum_{i=1}^{q+1} \alpha(N_i) = kq + (r-1).$$

It follows that  $\alpha(C_n^k) = k + r - 1$  or  $\alpha(C_n^k) = k + r$ .

Suppose that  $\alpha(C_n^k) = k + r - 1$  and  $U$  is a vertex cover of  $C_n^k$  such that  $|U| = kq + r - 1$ . Then  $|U \cap M| = r - 1$  and  $|U \cap A_i| = k$  for all  $i$ . Since  $|M| = r$ , there is only one vertex  $b \in M$  such that  $b \in U$ . Without loss of generality, let  $b = a_n$ . To cover the edges between  $a_n$  and  $N_1$ , it is necessary that  $a_1, a_2, \dots, a_k \in U$ . Since  $|U \cap A_1| = k$ , it follows that  $a_{k+1} \notin U$ . To cover the edge between  $a_{k+1}$  and  $N_2$ , it is necessary that  $a_{k+2}, a_{k+3}, \dots, a_{2k+1}$  is in  $U$ . Since  $|U \cap A_2| = k$ , it follows that  $a_{2k+2} \notin U$ . Continuing this way, it can be concluded that  $a_{(k+1)q} \notin U$ . Now, the distance between  $a_n$  and  $a_{(k+1)q}$  in  $C_n$  is  $r \leq k$ . Thus,  $a_n a_{(k+1)q}$  is an edge in  $C_n^k$  and it is not covered by  $U$ . This contradicts the assumption that  $U$  is a vertex cover of  $C_n^k$ . Therefore,  $\alpha(C_n^k) = kq + r = n - q$ .

Therefore, if  $k < \left\lfloor \frac{n}{2} \right\rfloor$ ,  $\alpha(C_n^k) = n - q$ .

□

#### 4. Summary and Recommendations

##### Summary

This section summarizes the researches results in this study.

1. Let  $q$  and  $r$  be the quotient and remainder, respectively, when  $n \in N$  is divided by  $k+1$ . Then

$$\alpha(P_n^k) = \begin{cases} n-1 & \text{if } k \geq n-1 \\ kq & \text{if } k < n-1 \text{ and } r \leq 1 \\ kq+r+1 & \text{if } k < n-1 \text{ and } r > 1 \end{cases} .$$

**Theorem 3.1.2**

2. Let  $q$  be the quotient when  $n \in N$  is divided by  $k+1$ . Then

**Theorem 3.1.4**

Recommendations

The following are for future researchers who wish to study vertex cover of graphs.

1. Work on parallel problems using the edges.
2. Determine relationship between the vertex cover of graphs and other graph-theoretic ideas such as coloring and chromatic number.
3. Find the vertex covering number of other special graphs.

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# On The Additive Infinite Groups That Are Isomorphic To Their Proper Infinite Subgroups

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## Abstract

Two groups are isomorphic if there exists an isomorphism  $\phi$  between them. Lagrange Theorem states that the order of a subgroup divides the order of the group. This implies that a finite group is not isomorphic to its proper subgroup. Some infinite groups which are isomorphic to some of their proper subgroup are illustrated in this paper. Moreover, it is shown through concepts in linear algebra that these groups really exist.

## 1. Introduction

This chapter presents the background of the study, objectives of the study, significance of the study, methodology and basic concepts in group theory.

### Background of the Study

Many of the students taking introductory abstract algebra aim to know whether a certain group is isomorphic to a proper subgroup of itself. Finite groups are not isomorphic to a proper subgroup of themselves since two groups having different cardinalities cannot be isomorphic. The additive group  $\mathbb{Z}$  of all integers is isomorphic to the subgroup  $2\mathbb{Z}$  of even integers via the map  $f : \mathbb{Z} \rightarrow 2\mathbb{Z}$  given by  $f(x) = 2x$ , for all  $n \in \mathbb{Z}$ . Also, the multiplicative group  $Q^+$  of all positive rational is isomorphic to some of its proper subgroup using the function  $f : Q^+ \rightarrow Q^+$  defined by  $f(x) = x^3$ , for all  $x \in Q^+$ . These groups show that indeed, there are infinite groups which are isomorphic to some of

their proper subgroups. But being infinite is not enough, because some infinite groups are not isomorphic to their proper subgroups. Hence, this paper characterizes some infinite groups which are isomorphic to their proper subgroup.

### Objectives of the Study

This paper investigated those infinite groups which are isomorphic to their proper subgroups. Specifically, this paper aimed to show the following:

1. The additive group  $Z$  is isomorphic to its proper subgroup  $nZ$ , where  $n \in Z/\{0,1,-1\}$ .
2. The additive group  $Q$  of all rational numbers is not isomorphic to any of its proper subgroup.
3. The additive group  $Q \oplus Z$  is isomorphic to its proper subgroup  $Q \oplus nZ$ , where  $n \in Z/\{0,1,-1\}$ .
4. Suppose that  $G$  and  $H$  are groups, one of which is isomorphic to some of its proper subgroup. Then  $G \oplus H$  is also isomorphic to some of its proper subgroup.
5. Let  $G_1, G_2, \dots, G_n$  be groups. If for some  $i \in \{1, 2, 3, \dots, n\}$ ,  $G_i$  is isomorphic to its proper subgroup then  $G_1 \oplus G_2 \oplus \dots \oplus G_n$  is also isomorphic to its proper subgroup.

### Significance of the Study

If a group is isomorphic to its proper subgroup and this subgroup has a known structure, then the structure of the group can also be determined via this isomorphism.

Also, if one group is known to be isomorphic to its proper subgroup, then any group isomorphic to this group will also be



isomorphic to its proper subgroup. Thus, this paper which involves basic concepts of group theory is of great importance to mathematics enthusiasts.

## 2. Methodology

This paper is an extension of Shaun Fallat, Chi Kwon Li, David Lutzer, and David Stanford's work entitled "On Groups That Are Isomorphic to a Proper Subgroup". The additive groups like the groups,  $\mathbb{Z}$  and  $\mathbb{Z}+\mathbb{Q}$  are considered and added some more general results. Definitions, examples and preliminary concepts are being presented in order to provide detailed proof of the main results.

### Preliminaries

This section contains definitions and preliminary concepts that are needed for further understanding of the study.

### Basic Definitions and Known Results

**Definition 1.5.1 [3]:** A function  $f : X \rightarrow Y$  is a relation between  $X$  and  $Y$  with the property that each  $x \in X$  appears as the first member of exactly one ordered pair  $(x, y) \in f$ . Such a function is called a *map* or *mapping* of  $X$  into  $Y$ .

**Definition 1.5.2 [3]:** Let  $f : X \rightarrow Y$  be a function, and let  $A$  be a subset of  $X$  and  $B$  be a subset of  $Y$ . The *image* of  $A$  in  $Y$  under  $f$  is the set  $f(A) = \{f(a) : a \in A\}$ . The set  $f(X)$  is called the *range* of  $f$ . The *inverse image* of  $B \subseteq Y$  is the set  $f^{-1}(B) = \{x \in X : f(x) \in B\}$ .

**Definition 1.5.3 [4]:** A function  $f : X \rightarrow Y$  is

- i. *well defined* if  $a = b$  implies  $f(a) = f(b)$
- ii. *injective* if  $\forall a, a' \in X$ ,  $f(a) = f(b)$  implies  $a = b$
- iii. *surjective* if for each  $b \in Y$ ,  $b = f(a)$  for some  $a \in X$

iv. *bijective* if it is both injective and surjective.

**Definition 1.5.4 [1]:** (*Principle of Mathematical Induction*): Let  $P(n)$  be a statement concerning the positive integer  $n$ . Suppose that

1.  $P(1)$  is true, and
2. If  $P(k)$  is true, then  $P(k+1)$  is true.

Then  $P(n)$  is true  $\forall n \in \mathbb{Z}^+$ .

**Definition 1.5.5 [1]:** Let  $G$  be nonempty set with a binary operation  $\cdot$ . Then  $G$  is called a

*group* if the following axioms hold:

[G1]:  $a \cdot b \in G, \forall a, b \in G$  (closure property)

[G2]:  $(a \cdot b) \cdot c = a \cdot (b \cdot c), \forall a, b, c \in G$  (associative property)

[G3]: There is an element  $e$  in  $G$  such that  $\forall a \in G, e \cdot a = a = a \cdot e$ .  
(existence of an identity element in  $G$ )

[G4]: Corresponding to each  $a \in G$ , there is an element  $a^{-1} \in G$  such that

$a \cdot a^{-1} = a^{-1} \cdot a = e$  (existence of inverses in  $G$ )

**Definition 1.5.6 [1]:** The *order* of a group  $G$ , denoted by  $|G|$ , is the number of elements in  $G$ . A group with finite order is called a *finite group*. Otherwise, it is an *infinite group*.

**Definition 1.5.7 [1]:** Let  $G$  be a group. If  $\emptyset \neq H \subseteq G$  and  $H$  is a group under the binary operation  $\bullet$  in  $G$ , then  $H$  is a *subgroup* of  $G$  written  $H \leq G$ .

**Definition 1.5.8 [1]:** If  $G$  is a group, then the subgroup consisting of  $G$  itself is called an *improper subgroup* of  $G$ . All the other subgroups of  $G$  are called *proper subgroups*.

**Definition 1.5.9 [1]:** If  $G$  is a group,  $a$  is in  $G$  and  $n \in \mathbb{N}$ , then  $a^n$  is a product of  $n$  factors each equal to  $a$ ; that is,  $a^n = a \cdot a \cdot a \cdots a$  ( $n$  - factors).

**Definition 1.5.10[1]** Let  $G$  be group. If  $a \in G$ , then  $\{a^n : n \in \mathbb{Z}\}$  is called the *cyclic subgroup* of  $G$  generated by  $a$  and will be denoted by  $\langle a \rangle$ . If  $G = \langle b \rangle$  for some  $b \in G$ , then  $G$  is said to be *cyclic*.

**Definition 1.5.11[1]:** Let  $G$  be a group and  $a \in G$ . The *order of  $a$* , denoted  $|a|$ , is the smallest positive integer  $n$  such that  $a^n = e$ . The order of the cyclic subgroup  $\langle a \rangle$  is equal to the order of  $a$ , that is,  $|\langle a \rangle| = |a|$ .

**Theorem 1.5.12 [3]:** Every infinite cyclic group is isomorphic to the additive group  $\mathbb{Z}$  and every finite cyclic group of order  $m$  is isomorphic to the additive group  $\mathbb{Z}_m$ .

**Theorem 1.5.13 [1]: Lagrange's Theorem:** Let  $H$  be a subgroup of a finite group  $G$ . Then the order of  $H$  divides the order of  $G$ . In particular, if  $a \in G$ , then  $|a|$  divides  $|G|$ .

**Definition 1.5.14 [1]:** Let  $G_1, G_2, \dots, G_n$  be groups. Consider

$$\otimes_1^n G_i = G_1 \oplus G_2 \oplus \dots \oplus G_n = \{(g_1, g_2, \dots, g_n) : g_i \in G_i\}$$

Define a binary operation on  $\otimes_1^n G_i$  by

$$(g_1, g_2, \dots, g_n) + (h_1, h_2, \dots, h_n) = (g_1 + h_1, g_2 + h_2, \dots, g_n + h_n),$$

$\forall g_i, h_i \in G_i$ . Then  $G_1 \oplus G_2 \oplus \dots \oplus G_n$  is a group called the *direct sum* of the groups

$G_i$  under the binary operation  $+$ .

**Definition 1.5.15 [1]:** Let  $G$  and  $H$  be groups. A function  $f : G \rightarrow H$  is a *homomorphism*

provided that  $f(a * b) = f(a) * f(b) \forall a, b \in G$ . If  $f$  is bijective, then  $f$  is called an *isomorphism*.

In this case,  $G$  and  $H$  are said to be *isomorphic* written  $G \cong H$ . The *kernel* of  $f$ , denoted

by  $\ker f$ , is the subgroup  $f^{-1}(\{e'\})$  where  $e'$  is the identity element of  $H$ .

**Definition 1.5.16 [4]:** Let  $n$  and  $d$  be non-zero integers. Then  $d$  *divides  $n$* , denoted by  $d|n$ , if there exists an integer  $q$  such that  $n = dq$ .

### 3. Main Results and Discussions

This chapter presents the isomorphism of group onto its proper subgroup for the case where the group is a direct sum.

#### Direct Sum of Groups

This section states when the direct sum of groups is isomorphic to some of its proper subgroup.

**Theorem 3.1.1** The additive group  $Z$  of integers is isomorphic to some of its proper subgroup  $nZ$ , where  $n \in Z \setminus \{0, 1, -1\}$ .

Proof: Let  $f : Z \rightarrow nZ$  be defined by  $f(a) = na, \forall a \in Z$ . Let  $a, b \in Z$ . If  $a = b$ , then

$f(a) = na = nb = f(b)$ . Thus,  $f$  is well-defined. Suppose  $f(a) = f(b)$ . Then,  $na = nb$

which implies that  $a = b$ . Hence,  $f$  is one-to-one. Also  $f(a + b) = n(a + b) = na + nb =$

$f(a) + f(b)$ . Hence,  $f$  is a homomorphism. Let  $b \in nZ$ . Then  $b = nm$  for some  $m \in Z$ .

Take  $a = m$ . Then  $f(a) = na = nm = b$ . So,  $f$  is onto. Therefore, the additive group  $Z$

is isomorphic to the proper subgroup  $nZ$ . □

The following corollary follows from Theorem 3.1.1 and Theorem 1.5.12.

**Corollary 3.1.2** Every infinite cyclic group is isomorphic to some of its proper subgroup.

**Theorem 3.1.3** The additive group  $Q$  of all rational numbers is not isomorphic to any of its proper subgroup.

Proof: Suppose that  $f : Q \rightarrow Q$  is a nonzero homomorphism. Note that  $1 \in Q$  and  $f(1) \in Q$ .

Claim 1:  $f(x) = f(1)x, \forall x \in Q$ , where  $f(1) \neq 0$

Let  $x \in Q$ . Then  $x = \frac{a}{b}$  for some  $a, b \in Z, b \neq 0$ . Observe that

$$\begin{aligned}
bf(x) &= bf\left(\frac{a}{b}\right) = f\left(\frac{a}{b}\right) + \dots + f\left(\frac{a}{b}\right) \\
&= f\left(\frac{a}{b} + \dots + \frac{a}{b}\right) \\
&= f\left(b\frac{a}{b}\right) \\
&= f(a) \\
&= f(a\mathbb{1}) \\
&= f(1 + \dots + 1) \\
&= f(1) + f(1) + \dots + f(1) \\
&= af(1) \\
&= f(1)a
\end{aligned}$$

Thus,  $f(x) = f(1)\frac{a}{b} = f(1)x$ .

Moreover,

$f(1) \neq 0$  since  $f$  is a nonzero homomorphism.

Claim 2:  $f$  is one-to-one

Let  $a, b \in Q$  with  $f(a) = f(b)$ . Then  $f(1)a = f(1)b$  by Claim 1.

Since  $f(1) \neq 0$  and  $f(Q)$

is a subgroup of  $Q$ , cancellation holds, that is,  $a = b$ . Hence,  $f$  is one-to-one.

Claim 3:  $f$  is onto

Let  $x \in Q$ . Then  $x = \frac{a}{b}$  with  $a, b \in Z, b \neq 0$ . Since  $0 \neq f(1) \in Q$ , there

exist nonzero integers  $c$  and  $d$  such that  $f(1) = \frac{c}{d}$ . This implies that

$bc \neq 0$  since  $b \neq 0$  and  $c \neq 0$ .

Let  $t = \frac{ad}{bc}$ . Then  $t \in Q$  and  $f(t) = f(1)t = \left(\frac{c}{d}\right)\left(\frac{ad}{bc}\right) = \frac{a}{b} = x$ . Thus,

$f$  is onto.

Therefore,  $f$  is an isomorphism. This means that every homomorphism  $f: Q \rightarrow Q$  is an isomorphism. Thus,  $Q$  is not isomorphic to any of its proper subgroup.  $\square$

Observe that the additive group  $Z$  of integers is isomorphic to some of its proper subgroup but the additive group  $Q$  of rational numbers is not. What can be said about  $Q \oplus Z$  ?

**Theorem 3.1.4** The additive group  $Q \oplus Z$  is isomorphic to some of its proper subgroup  $Q \oplus nZ$ , where  $n \in Z \setminus \{0, 1, -1\}$ .

Proof: Note that  $Q \oplus nZ$  is a proper subgroup of  $Q \oplus Z$  since  $(1, 1) \in Q \oplus Z$  but  $(1, 1) \notin Q \oplus nZ$ . Let  $f: Q \oplus Z \rightarrow Q \oplus nZ$  be defined

$$\text{by } f((s, a)) = (s, na).$$

Let  $(s, a)$  and  $(t, b)$  be in  $Q \oplus Z$  with  $(s, a) = (t, b)$ . Then

$s = t$  and  $a = b$ . Now  $f((s, a)) = (s, na) = (t, nb) = f((t, b))$ . Thus  $f$  is well-defined. Suppose that  $f((s, a)) = f((t, b))$ . Then,  $(s, na) = (t, nb)$  implies that  $s = t$  and  $a = b$ . This shows that  $(s, a) = (t, b)$  and  $f$  is one-to-one. Let  $x \in Q \oplus nZ$ . Then,  $x = (s, na)$  for some  $s \in Q, n, a \in Z$ .

Take  $(s, a) \in Q \oplus Z$ . Then,  $f((s, a)) = (s, na) \in Q \oplus nZ$  implying that  $f$  is onto. Therefore,  $Q \oplus Z$  is isomorphic to its proper subgroup  $Q \oplus nZ$ .  $\square$

Theorem 3.1.4 is generalized in the following theorem.

**Theorem 3.1.5** Suppose that  $G$  and  $H$  are groups, one of which is isomorphic to some of its proper subgroup. Then  $G \oplus H$  is also isomorphic to its proper subgroup.

Proof: Let  $G_1 < G$  such that  $\exists$  an isomorphism  $\phi: G \rightarrow G_1$ .

Since  $G_1$  and  $H$  are groups, it follows that the identity elements say  $e_{G_1} \in G_1$  and  $e_H \in H$  exist. Thus,  $(e_{G_1}, e_H) \in G_1 \oplus H$  and

so  $G_1 \oplus H \neq \emptyset$ . Let  $(g_1, h_1), (g_2, h_2) \in G_1 \oplus H$ . Now,  $(g_1, h_1) + (g_2, h_2) = (g_1 + g_2, h_1 + h_2) \in G_1 \oplus H$  since  $G$  and  $H$  are closed under addition. Thus,  $G_1 \oplus H$  is also closed under  $+$ . Note that

$$(g_1, h_1) + (e_{G_1}, e_H) = (g_1 + e_{G_1}, h_1 + e_H) = (g_1, h_1).$$

Thus  $(e_{G_1}, e_H)$  is the identity element in  $G_1 \oplus H$ . Also,

$$(e_{G_1}, e_H) = (g_1, h_1) + (g_2, h_2) = (g_1 + g_2, h_1 + h_2)$$

implies that  $g_1 + g_2 = e_{G_1}$  and  $h_1 + h_2 = e_H$ . Thus

$$g_2 = e_{G_1} - g_1 = -g_1 \text{ and } h_2 = e_H - h_1 = -h_1. \quad \text{Hence}$$

$$(g_2, h_2) = (-g_1, -h_1) \in G_1 \oplus H \text{ is the inverse of } (g_1, h_1) \in G_1 \oplus H.$$

Thus,  $G_1 \oplus H$  is a subgroup of  $G \oplus H$ . Consider the function  $\varphi: G \oplus H \rightarrow G_1 \oplus H$  defined by

$$\varphi((g, h)) = (\phi(g), h), \forall (g, h) \in G \oplus H. \quad \text{Let } (g, h), (g', h') \in G \oplus H.$$

If  $(g, h) = (g', h')$ ,

then  $g = g'$  and  $h = h'$ . So,

$$\varphi((g, h)) = (\phi(g), h) = (\phi(g'), h') = \varphi((g', h')). \text{ Thus } \varphi \text{ well-defined.}$$

Observe that,

$$\begin{aligned} \varphi((g, h) + (g', h')) &= \varphi((g + g', h + h')) \\ &= (\phi(g + g'), h + h') \\ &= (\phi(g) + \phi(g'), h + h') \\ &= (\phi(g), h) + (\phi(g'), h') \\ &= \varphi((g, h)) + \varphi((g', h')) \end{aligned}$$

Thus,  $\varphi$  is a homomorphism. Now, if  $\varphi((g, h)) = \varphi((g', h'))$ , then  $(\phi(g), h) = (\phi(g'), h')$  so that  $\phi(g) = \phi(g')$  and  $h = h'$ . Since  $\phi$  is one-to-one,  $g = g'$ . Thus,  $(g, h) = (g', h')$  and  $\varphi$  is one-to-one.

Let  $(g_1, h) \in G_1 \oplus H$ . Since  $g_1 \in G_1$  and  $\phi$  is onto,  $\exists g \in G$  such that  $\phi(g) = g_1$ . Consider  $(g, h) \in G \oplus H$ . Then,

$$\varphi((g, h)) = (\phi(g), h) = (g_1, h). \text{ Thus, } \varphi \text{ is an isomorphism and}$$

$G \oplus H$  is isomorphic to its proper subgroup  $G_1 \oplus H$ .

□

**Corollary 3.1.6** Let  $G_1, G_2, \dots, G_n$  be groups. If for some  $i \in \{1, 2, \dots, n\}$ ,  $G_i$  is isomorphic to some of its proper subgroups, then  $G_1 \oplus G_2 \oplus \dots \oplus G_n$  is also isomorphic to its proper subgroup.

Proof: If one of  $G_1$  or  $G_2$  is isomorphic to its proper subgroup, then by Theorem 3.1.5,  $G_1 \oplus G_2$  is isomorphic to its proper subgroup. Assume that  $G_1 \oplus G_2 \oplus \dots \oplus G_k$  is isomorphic to its proper subgroup for all  $k > 1$ . Then by Theorem 3.1.5,

$$G_1 \oplus G_2 \oplus \dots \oplus G_{k+1} = (G_1 \oplus G_2 \oplus \dots \oplus G_k) \oplus G_{k+1}$$

is isomorphic to some of its proper subgroups. Therefore, by *PMI*,  $G_1 \oplus G_2 \oplus \dots \oplus G_n$  is also isomorphic to some of its proper subgroups. □

#### 4. Summary and Recommendations

This chapter summarizes the results being studied in this paper and presents some recommendations for further inquiries.

##### Summary and Conclusion

This paper obtained the following results on groups which are isomorphic to some of their proper subgroups:

1. The additive group  $Z$  of integers is isomorphic to some of its proper subgroups  $nZ$ , where  $n \in Z \setminus \{0, 1, -1\}$ .

##### (Theorem 3.1.1)

2. Every infinite cyclic group is isomorphic to some of its proper subgroups.

##### (Corollary 3.1.2)



3. The additive group  $Q$  of all rational numbers is not isomorphic to any of its proper subgroup. **(Theorem 3.1.3)**

4. The additive group  $Q \oplus Z$  is isomorphic to some of its proper subgroup  $Q \oplus nZ$ , where  $n \in Z \setminus \{0, 1, -1\}$ .

**(Theorem 3.1.4)**

5. Suppose that  $G$  and  $H$  are groups, one of which is isomorphic to some of its proper subgroup. Then  $G \oplus H$  is also isomorphic to its proper subgroup. **(Theorem 3.1.5)**

6. Let  $G_1, G_2, \dots, G_n$  be groups. If for some  $i \in \{1, 2, \dots, n\}$ ,  $G_i$  is isomorphic to some of its proper subgroup, then  $G_1 \oplus G_2 \oplus \dots \oplus G_n$  is also isomorphic to its proper subgroup.

**(Theorem 3.1.6)**

### Recommendations

The author recommends the following questions for further investigation.

1. If  $G \oplus H$  is isomorphic to some of its proper subgroup, will it follow that  $G$  or  $H$  is isomorphic to some of its proper subgroup?
2. How many homomorphism and isomorphism exist from the additive group  $R$  and into itself?
3. One can show that the usual fields  $Q$  and  $R$  are not isomorphic to proper subfields of themselves but there are fields lying between  $Q$  and  $R$  that are isomorphic to proper subfields of themselves. Which fields are field isomorphic to proper subfields of themselves?

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## List of Notations

$H \leq G$	$H$ is a subgroup of $G$
$H < G$	$H$ is a proper subgroup of $G$
$\forall$	for all
$\exists$	there exists
$\emptyset$	empty set
$A \oplus B$	Direct sum of sets $A$ and $B$
$N$	set of natural number
$Z$	group of integers
$2Z$	group of even integers
$Q$	group of rational numbers
$R$	group of real numbers
$Z_n$	group of integers modulo $n$
$\cong$	isomorphic to

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