**UNIVERSITY OF KWA-ZULU NATAL**

# Investigating the impact of mathematical skills development provided to manufacturing staff by Optimum Learning Technologies.

**By**

**Elianorah Nokubonga Mkhize**

**Student Number: 213570589**

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**Graduate School of Business & Leadership**

**College of Law and Management Studies**

**Supervisor: Dr R. Sibanda**

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## DECLARATION

I, **Elianorah Nokubonga Mkhize**, do hereby declare that this dissertation is the result of my investigation and research and that this has not been submitted in part or full for any degree or for any other degree to any other University.

______________________________ ______________________________

**Elianorah Nokubonga Mkhize** **Date**

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## ABSRACT


Although there has been a considerable amount of research relating to measures of schooling years, qualifications, or training spells to workers' labour market success, there has been very little assessment of the role of more basic literacy and numeracy skills, largely due to problems with measurement and data availability. Yet it is obviously crucial, in an era of apparently rising demand for skills, that we have evidence on the labour market value of the full range of worker skills, including basic literacy and numeracy. The study was conducted to Investigating the impact of mathematical skills development provided to manufacturing staff by Optimum Learning Technologies. The research took a quantitative approach by which a probability sampling was done using stratified random sampling method to select the samples. Data were collected using a self-administered questionnaire. The findings of the study revealed that although the numeracy skills are adapted to specific strategies for each industry, they tend to be based on an underpinning of skills developed through a range of prior learning experiences and, in many cases, transferred between workplaces and life situations. Numeracy is not a skill or fixed entity that can be earned. Instead, people’s skills are situated along a continuum of different purposes and levels of accomplishment with numbers. There is need for senior management to show commitment for the programme, monitoring and evaluation of the programme, strengthening communication, creating a learning culture among employees as well as providing incentives for participating in the programme.



**Keywords:** Numeracy; Optimum Learning Technologies; Mathematical skills; manufacturing employees

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| | |
|---|---|
| OLT | Optimum Learning Technologies |
| FMCG | Fast-Moving Consumer Goods |
| USA | United States of America |
| UKZN | University of Kwazulu Natal |
| SPSS | Statistical Package for Social Sciences |
| UK | United Kingdom |

# CHAPTER 1: INTRODUCTION

## 1.1 Introduction

Increasingly, employers have been discovering that their workforces need skills that seem to be in short supply, skills over and above the basic academic triumvirate of reading, writing, and computation. The skills that employers are looking for include problem solving, personal management, and interpersonal skills as well as the abilities to conceptualize, organize, and verbalise thoughts; to resolve conflicts; and to work in teams all of these skills are critical but often lacking.

Basic workplace skills are of interest because rapid technological change, participative management, just-in-time production, and other workplace innovations have created a demand for more flexibility, adaptability, and a higher "base" level of skills from all workers, including those at the nonsupervisory level. While it is recognised that a percentage of workers have always done well in the workplace despite skills deficiencies, it is increasingly apparent that such success in the future will be illusory for many workers if they continue to be ill equipped in a broad spectrum of basic workplace skills.

The international research literature distinguishes between numeracy and mathematics, yet maintains that mathematical skill underpins, but does not equate to numeracy. Steen (2011) makes a distinction, arguing that mathematics requires a distancing from context. Numeracy (quantitative literacy), on the other hand, is anchored in real data which reflect engagement with life’s diverse contexts and situations. Numeracy offers solutions to problems about real situations.

There is a growing understanding of how mathematical knowledge is used in real situations of life and work, to which the present research is a contribution. Following Bernstein (2014), it is argued that the use of common sense—of relatively little value in formal mathematics—is essential in numeracy.

## 1.2 Background of the Study

Observations of workplace numeracy practices indicate that knowledge is embedded in ongoing practices. Such knowledge is ‘directed towards specific, immediate goals, highly relevant to the acquirer in the context of his/her life’ (Bernstein 2014), and is usually learned face to face and, if necessary, repeated until the particular competence is fully acquired. Just as there are fundamental differences between mathematics and numeracy, workplace numeracy education requires a fundamentally different curriculum and teaching/learning strategies from those required for teaching school mathematics. However, these would need to encompass underpinning mathematical knowledge and skills in ways that enable the generation of ‘new’ knowledge in order to solve problems which cannot always be known in advance.

Optimum Learning Technologies is an accredited training institution that provides training to the manufacturing sector especially FMCG and Automotive. The organisation specialise on outcome-based education rather than the content based education (OLT, 2017). Their subsidiary company, Learning Cubed is specializing in the training and assessment of mathematics. All students enrolling with them has to go through numeracy assessment and training before they do other modules of the qualification. The main purpose of this kind of training is to develop people who are already in the workplace, experienced but most of them do not have qualification.

Individuals and employers have viewed basic workplace skills differently. For workers, competency in basic workplace skills has always been important because sound basic skills leverage earnings and opportunities (Wegner, 2012). Employers world over have seen competency in workplace basics as a prerequisite for hiring and viewed the accumulation of such skills as solely the responsibility of the individual worker. The employer's interest has focused on measuring the skills of prospective employees and screening out those who are most suitable for hiring. However, times are changing. Employers are beginning to see that they must assist their current and future workers to achieve competency in workplace basics if they are to be competitive (Moser and Kalton, 2013). This sense of shared responsibility is grounded in economic realities and is compelling employers to invest in workplace basics training programs.

Technology creates both opportunities and problems for employers. Its very transferability has levelled the worldwide playing field. An employer's competitive edge is increasingly reliant upon how effectively and efficiently workers and machines are integrated and move through the production cycle. Successful integration is dependent upon how quickly veteran workers accumulate new skills. In addition, acquisition of new skills is facilitated when a worker has a solid grounding in the numeracy basics.

## 1.3 The Research Problem

The workplace is continuously changing with ushering of new technology, participative management, sophisticated statistical quality controls, customer service, and just-in-time production. By ripple effect, the skills that employees must have should also change in order to keep up the pace of the ever-changing environment. Many employees, however, do not have basics essential for acquiring more sophisticated technical skills. While deficiencies in basic workplace skills are not a new problem, they are a growing one. A challenge is emerging from a volatile mix of demographic, economic, and technical forces. Combined, these forces are driving the nation toward a human capital deficit among both new and experienced workers that threatens the competitiveness of economic institutions and acts as a barrier to the individual opportunity of all South Africans.

Internationally, adult literacy and numeracy are in general recognized as cultural techniques. However, the two competences and their development are contested among politicians and researchers. Numeracy is often subsumed under literacy and/or described in isolation from the situational context. Adult numeracy at work is often described unproblematically as transfer from school to workplace. With reference to theoretical framework by Bernstein (2014), adult numeracy on the labour market is a horizontal discourse, in contrast to the vertical discourse of mathematics. It is therefore against this backdrop that this study seeks to investigate on the impact of mathematical literacy on outcome-based education rather than the content based education.

## 1.4 Aim of the Study

The study aims to investigate the impact of statistical skills development provided to manufacturing staff by Optimum Learning Technologies.

**2.5 Objectives of the Study**

2.3.1 To assess whether mathematics training improves learner's ability to interpret statistical information

2.3.2 To ascertain the influence of mathematical literacy on workplace performance by learners

2.3.3 To evaluate the ease of knowledge/skills conversion into practicality/application to real work environment after numeracy learning

2.3.4 To make recommendations for optimal training services by Optimum Learning Technologies (OLT)

**2.6 Research Questions**

2.4.1 Does mathematics training improve learners' ability to interpret statistical information?

2.4.2 Is mathematics training influential enough to affect the learners' performance on respective workplace?

2.4.3 How easy is conversion of learnt skills into practicality/application given real workplace environment for improved organizational performance by learners after training?

2.4.4 How best can Optimum Learning Technologies (OLT) optimise training services?

**1.7 Significance of the Study**

The study is important for several reasons. Firstly, the study seeks to improve the workplace numeracy in the manufacturing industry, therefore the recommendations provided could optimise training services Optimum Learning Technologies (OLT). Secondly this could improve OLT business strategies such as collaboration (the work team concept), exemplary customer service, and emphasis on quality demand teamwork, listening skills, the ability to set goals, creativity, and problem-solving skills. Coupled with the movement toward more participative management and employers aggressively driving workers toward decision making at the point of production or point of sale, it is easy to see that new skills must be applied if employees and their employers are to succeed in the marketplace. Moreover, this could also be a source of motivation to the entire workforce as working for a better performing organisation in itself creates motivation. Lastly, the study may contribute to the existing body of knowledge on electricity business models.

## 1.8 Limitations of the study

Time and resource constraints limited the sample size selected for this study. Optimum Learning Technologies (OLT) is only one of many employee training and development centres in South Africa. The results of this dissertation are unlikely to be generalizable to all learners and their employers in the country.

## 1.9 Summary of literature Review

According to Wedege (2004), the term numeracy is contested, and the burgeoning corpus of relevant research conducted in workplaces utilises the terms numeracy, mathematics, or even mathematics literacy — according to the orientation of the particular researcher/s. However few reports address the issue of how such competences may be learned on-site. Wake and Williams (2011) links workplace learning and school-based learning, but it does not address learning in the workplace per se. Up to this point, in Australia at least, several manuals have been produced to support numeracy teaching for the workplace, and in formal workplace training sessions. In Denmark, the term used in Adult Vocational Training is “professional arithmetic”. However, these tend to replicate the traditional school texts with what Fitzsimons (2012) describes as pseudo-contextualisations and which reflect few if any of the complexities of industrial and other workplaces.

Lindenskov and Wedege (2011) propose that numeracy in the workplace can be perceived as skills and understandings charged with media, context and intention, interwoven with other competences and qualifications, interacting with the organisation of work. An instance would be the counting of items in a work situation: One does not simply count. There is a work-related aim in counting, and a certain precision is demanded. There are certain limits to the time consumption. Often one already knows the items that are to be counted. Often the shape of the items and the arrangement of the workplace will call for a special way of counting. Finally it is the organisation of work that determines who counts, controls and documents, whether it takes place individually or in co-operation, and who can suggest changes. Counting in a work context is not only counting. Wedege (2014) identifies four inter-related analytical dimensions of numeracy in the labour market: the situation context (where), personal intention (why), mathematical knowledge and activity (how), and media and data (what). However, the same author notes that the translation from qualifications in the workplace into qualification in school and vice versa is not straightforward.

### 1.10 Brief outline of research methodology and design

According to Neuman (2013: 142), it is necessary to determine if problems investigated are in fact valid ones. Once this is established, the research can begin in earnest. This research is not an historical review examining developments and improvements over time but rather a methodological and contextual review. The research has identified which aspects of workplace training have been key factors to effective training in order to make recommendations which may assist in fledgling businesses to avoid the pitfalls and have a better chance of success.

The research tool that was used to investigate the perceived problems and to elicit primary data was a structured questionnaire, based on a Likert scale. A few open-ended questions were added at the end to ensure depth to the research. Questionnaire responses were analysed using inferential and descriptive data analysis by use of Statistical Package for Social Sciences (SPSS) software. Inferential statistics help to create the relationship between variables and come up with conclusions (Sekaran & Bougie, 2013:126). Descriptive statistics is described as the statistics that provide descriptive information about a set of data. Graphs and charts were used to present the data findings.

### 1.11 Organisation of the Study

The study is presented in five chapters briefly described below:

**Chapter One – Introduction**

This chapter, known as the introduction chapter will introduce the study by providing background to the study followed by problem statement, objectives, questions, aims, significance of the study and the overall study structure.

**Chapter Two – Literature Review**

This chapter reviews literature related to the study. In particular, the literature commence by defining key concepts in the field of learning and development as well as numeric literacy.

**Chapter Three – Research Methodology**

This chapter provides the research design for the study. Key sections discussed in this chapter includes the research design, methods, sampling and sampling strategy, research instrument, pilot study, validity and reliability and ethical considerations

**Chapter Four - Presentation of results, discussion and interpretation**

This chapter will present results of the study, following by analysis and interpretation with literature linked to the findings

**Chapter Five – Conclusions and Recommendations**

This chapter will provide the conclusions and recommendations for the study.

## 1.12 Conclusion

The chapter outlined the introduction to the study, background thereto, research problem against the objective and the significance of the study. The chapter ends by outlining the structure of this thesis. The next chapter focuses on review of literature relevant to this quantitative study.

# CHAPTER 2: LITERATURE REVIEW

## 2.1 Introduction

In the previous chapter, the background information to the study was presented, followed by the development of objectives and the problem statement. This chapter presents the existing literature on the topic of study. The discussion will be guided by the objectives of the research, hence focus will be on assessment of whether mathematics training improves learner's ability to interpret statistical information, ascertaining the influence of mathematical literacy on workplace performance by learners, and evaluation of the ease of knowledge/skills conversion into practicality/application to real work environment after numeracy learning.

## 2.2 Learning

Wals (2010) argues that training institutions have a fundamental role in enhancing learners to develop skills so that they can contribute to viable solutions in terms of reliable and productive decision-making. The author further emphasises the need to strengthen sustainability and competence in learners and faculty, and the possibility of facing that challenge when there are places in the curriculum that can help engaging the students in a process of transformative learning towards statistical numeracy. Based on O'Sullivan's (2013) studies, transformative learning refers to a shift to a new way of being and seeing, and applied learning refers to learning by mirroring one's own ideas, views, values, and perspectives with those of others (Wals, 2010:385).

This learning process can happen when students are called upon to question everyday events, revisiting ways of thinking and acting. Pluralism and heterogeneity, which are part of university environment, favour the creation of necessary conditions so that they may generate creative solutions for the resolution of complex social and environmental problems. To sum up, transformative applied learning involves learning for being, knowing and doing; consequently, it should incorporate counter-hegemonic thinking (Wals & Bawden 2009).

Chabay (2011:5) adds that it is important to link the interconnectedness of learning with other dimensions of sustainability. In this sense, according to Lotz-Sisitka (2011), the twenty-first century has being characterised as a risk society, and therefore, researchers have been confronted with education and participation practices – how and what to teach in multiple and integrative forms. Experiences, such as water and energy scarcity, loss of biodiversity and diseases permeate education and demand a new language, teaching new forms of social-ecological resilience, adaptation and social change. According to Chabay (2011), numeracy learning processes differ from earlier education and participation practices, and have implications for learning and social change; curriculum development; learning interactions; epistemological foundations of education; pedagogy, and socio-ecological resilience building.

Regarding the corporations' viewpoint, Haugh and Talwar (2010) recommend integrating Mathematical numeracy in the long-term strategy of the organisation in continuous cycles of social learning that expand their knowledge systems. To do so, large organisations need to create spaces for initiatives of training and employee development, targeted at rethinking policies and practices of quantitative decision making, such as reviewing the supply chain. Mathematical learning aims to instil the calling for sustainability in daily organisational actions.

Shrivastava (2011), draws attention to cognitive understanding alone not being sufficient to solve the problems and challenges of sustainable management. It is necessary to adopt an approach that encourages critical thinking among learners. This requires not only an identification of multiple demands relevant to sustainable development (economic, environmental, social, political and cultural), but also the involvement and interest of the different social actors (companies, government, non-governmental organisations and representatives of civil society). Numeracy learning, therefore, requires interaction among multiple knowledge and different subject areas to achieve sustainable behaviours that balance interests. This can be observed, for example, in projects related to the management of natural resources, which, according to Bouwen and Taillieu (2014), are almost all interdisciplinary. These projects involve the collaboration of experts and skilled professionals (practitioners), as well as the combination of experimental and theoretical knowledge of the many fields related to sustainable development, to deal with and balance the many interests.

Sterling (2014), asserts that such discussion between higher education and mathematical numeracy often centres on the practical aspect, which may be called education for change. However, it is necessary to sufficiently emphasise the provision aspect, which concerns change in education as policy. Given the complexity of this challenge, it is necessary to adopt a systemic perspective that leverages policies and practices that lead to learning and transformative change. According to Sterling (2014), mathematical numeracy does not simply require an add-on to existing structures and curricula, but implies a change of fundamental epistemology in our culture and hence also in our educational thinking and practice. Seen in this light, mathematics is not just another issue to be added to an overcrowded curriculum, but a gateway to a different view of curriculum, of pedagogy, of organizational change, of policy and particularly of ethos.

### 2.2.1 Learning Models

Winataputra in Sugiyanto (2008) suggests that the learning model is a conceptual framework that describes a systematic procedure in organizing learning experiences to achieve specific learning objectives and serves as a guide for learning and the crier proclaimed and teachers in implementing the learning activities.

Sugiyanto (2008) suggests that there are many learning model developed by experts in an effort to optimize student learning outcomes. The learning model is comprised of:

- **Contextual Learning Model**
  Contextual learning model is the concept of learning that encourages teachers to link between the material being taught to the students real-world situations. This study also encourages students make connections between knowledge and its application in their daily lives. Knowledge and skills gained from the efforts of students to construct their own knowledge and skills as students learn.

- **Cooperative Learning Model**
  Model of cooperative learning is a learning approach that focuses on the use of small groups of students to work together in maximizing the learning conditions for achieving learning objectives.

- **Quantum Learning Model**

Quantum Learning model is an assembly of various theories or views of cognitive psychology and neurology that much programming already exist.

- **Integrated Learning Model**
  An integrated learning model of learning that allows students both individually and in groups of actively searching, digging, and found the concepts and principles of holistic. Learning is a model that tried to integrate several subjects.

- **Model Problem Based Learning (PBL)**
  Model of problem-based learning (PBL) is a cognitive psychology of learning that takes as its theoretical support. The focus is not much on what is being worked on students but on what students think as long as they do. Enabling teachers themselves as mentors and facilitators so that students can learn to think and solve their own problems.

**2.2.2 Training defined**

Training has been defined as "The systematic development of the knowledge, skills and attitudes required by an individual to perform adequately a given task or job". Training has also been defined in the Glossary of Training Terms (Manpower Services Commission, U.K.) as "a planned process to modify attitude, knowledge or skill behaviour through learning experience to achieve effective performance in an activity or range of activities. Its purpose in the work situation is to develop the abilities of the individual and to satisfy current and future manpower needs of the organisation". It clearly implies that the role of training is to improve the overall performance of the organisation. The term 'performance' is, therefore, interwoven with training.

The trainer has a wide range of training methods to choose from. A judicious mix of one or more methods should be adopted to suit each training programme. Some of the important training methods are enlisted below:

Lecture; Discussion; Case study; Role play; Sensitivity training; Syndicate; Brain storming; Computer assisted learning; Exercise Business games; In-Basket; On the job training; Project work; and Programmed learning.

The training objective and the outcome an event seeks to achieve determine the choice of training method. For example, if the objective is to develop technical skill, then there is need for practical exercises; if conceptual skill, then case study could be a method. If attitudinal orientation is intended, then role-play is an appropriate method. Balanced content A training programme should not be too heavy, so as to leave no time for the trainee to absorb the inputs. Neither should it be so light as to convey the impression that the training programme is not a serious endeavour. The programme should be stimulating enough, but must leave time and opportunity for reflection.

While imparting training in precursor control, the training content must be tailored to the specific duties, roles and responsibilities of the trainees in a particular group. For instance, the content designed for enforcement officers will vary somewhat from the content for trainers or for chemists. In each case, the content should be devised so as to achieve the purpose of training effectively and efficiently.

### 2.3 Mathematics/Numeracy in the Workplace.

In the literature, adult numeracy is in various ways linked with mathematics, often synonymously. At the ninth international conference on adults learning mathematics, O'Donoghue (2011) discussed the difference between mathematics and numeracy and highlighted that the two phenomena are technically varied. A possible interpretation is that adult numeracy and mathematics may be distinguished with reference to Bernstein's (2012) concepts of vertical discourse and horizontal discourse.

Bernstein (2012:157) distinguishes between two fundamental forms of discourse. In the educational field they are known as school(ed) vs everyday common-sense knowledge, or 'official' vs 'local' knowledge. Common sense knowledge is likely to be "oral, local, context dependent and specific, tacit, multi-layered, and contradictory across but not within contexts". Mathematics is an example of a *vertical* discourse because of its coherent, explicit, and systematically principled structure.

By contrast, the knowledge of horizontal discourses is embedded in on-going practices, usually with strong affective loading, and directed towards specific, immediate goals, highly relevant to the acquirer in the context of his/her life. Fitzsimons (2014) has argued that the construct of numeracy is an example of a horizontal discourse. Bernstein notes that whereas in mathematics, there is a well-known hierarchy between so-called common sense and so-called uncommon sense, with numeracy common sense is of the essence. Numeracy is not necessarily explicit or precise, and its capacity for generating formal models may be limited to the context at hand rather than generalisable.

According to Bernstein (2012:160), the pedagogy of horizontal discourses is usually carried out face-to-face. It may be transmitted by modelling, by showing, or by explicit means. If necessary, the pedagogy is repeated until the particular competence is acquired. Bernstein continues that from the point of view of any one individual, there is not necessarily one and only one correct strategy relevant to a particular context. The author concludes that horizontal discourse facilitates the development of a repertoire of strategies activated in contexts whose reading is unproblematic. The observations of workplace numeracy practices resonate strongly with Bernstein's concept of horizontal discourse and its associated pedagogy.

Lindenskov and Wedege (2011:5) proposed a two-pronged general definition of numeracy describing it as a mathematics-containing everyday competence that everyone, in principle, needs in any society at any given time:

- Numeracy consists of functional mathematical skills and understanding that in principle all people need to have.
- Numeracy changes in time and space along with social change and technological development.

Lindenskov and Wedege(2011) continue that: Whereas ethno-mathematics, folk mathematics, street mathematics and the like are analytically descriptive concepts of competence, numeracy can be both descriptive (what is actually used) and normative (what is desirable), like other concrete concepts of competence (cultural competence, communication competence, social competence, etc.), which involve judgements and estimations based on values and norms. As noted above, the term numeracy is contested, and the burgeoning corpus of relevant research conducted in workplaces utilises the terms numeracy, mathematics, or even mathematics literacy — according to the orientation of the particular researcher/s. However, few reports address the issue of how such competences may be learned on-site. Wake and Williams (2012) links workplace learning and school-based learning, but it does not address learning in the workplace per se. Up to this point, in Australia at least, several manuals have been produced to support numeracy teaching for the workplace, and in formal workplace training sessions. In Denmark, the term used in Adult Vocational Training is professional arithmetic. However, these tend to replicate the traditional school texts with what Fitzsimons (2012) describes as pseudo-contextualisations and which reflect few if any of the complexities of industrial and other workplaces (see also Wedege, 2014).

Lindenskov and Wedege (2013) propose that: Numeracy in the workplace can be perceived as skills and understandings charged with media, context and intention, interwoven with other competences and qualifications, interacting with the organisation of work. An instance would be the counting of items in a work situation:
One does not simply count. There is a work-related aim in counting, and a certain precision is demanded. There are certain limits to the time consumption. Often one already knows the items that are to be counted. Often the shape of the items and the arrangement of the workplace will call for a special way of counting. Finally it is the organisation of work that determines who counts, controls and documents, whether it takes place individually or in co-operation, and who can suggest changes. Counting in a work context is not only counting.

Wedege (2014:114) identifies four inter-related analytical dimensions of numeracy in the labour market: the situation context (where), personal intention (why), mathematical knowledge and activity (how), and media and data (what). However, she notes that “the translation from qualifications in the workplace into qualification in school and vice versa is not straightforward”.

There have been many definitions of numeracy in relation to adults education. In recent years, the most appropriate is the specific context of teaching and learning numeracy on the job in the manufacturing industry (Simons: 2010). To be numerate means to be competent, confident, and comfortable with one’s judgements on whether to use mathematics in a particular situation and if so, what mathematics to use, how to do it, what degree of accuracy is appropriate, and what the answer means in relation to the context (Coben, 2013). This definition is consistent with a seminal work on relationships between mathematics, society and technology in relation to school mathematics education, by Keitel, Kotzmann, and Skovsmose (2013).

**2.4 Adult and workplace numeracy**

The present research has the capacity to contribute to emerging perspectives on the use of mathematical knowledge in practical situations of life and work that do not necessarily reflect the practices of the traditional mathematics classroom (Willis and Rosen, 2014). Misconceived attempts to recollect imperfectly remembered classroom practices are a frequent cause of mistakes in the workplace and can lead to the suppression of common sense instincts. On the other hand, all recent surveys stress the importance of a foundation of mathematical knowledge (Murnane *et a*l., 2012).

There is a distinctions between mathematics and numeracy. Following the work of Bernstein (2010), it could be said that, while in mathematics there is a well-known hierarchy between common sense and its opposite (the strict, increasingly abstract rules of the discipline of mathematics), common sense is the essence of numeracy. The high-level abstractions of formal mathematics alone are insufficient and may even prove counter-productive in the workplace. Observations of workplace numeracy practices indicate that knowledge is embedded in ongoing practices. Such knowledge is 'directed towards specific, immediate goals, highly relevant to the acquirer in the context of his/her life' (Bernstein 2010:159) and is usually learned face to face and, if necessary, repeated until the particular competence is fully acquired.

Current research positions numeracy as a social and cultural–historical process—to use terms drawn from activity theory (Engeström 2011). This approach recognises that humans pass on tools and procedures for their use to the next generation. As an activity, work is a collective process, dependent on interaction and communication, using artefacts, such as tools, written materials, tables and charts, as an integral part of the process.

Mathematical work in manufacturing and the agriculture/horticulture industries is highly dependent on the tools, machinery and equipment used in the workplace. Numbers and computations come from measuring physical quantities that really matter in production. Workers need to understand conceptual qualities such as averages in cases of problematic data. Assembly and operative work does not require more mathematics, but mathematics that is used and interpreted in context (Grogger & Eide, 2013).

In summary, reports of workplace numeracy/mathematics suggest that the skills required are not necessarily found high up in school curricula; rather they are often regarded as ‘basic’ or lower high school level, but are applied in complex ways to ill-defined and ever-evolving problems which themselves may not be inherently mathematical. Clearly, mathematical skills and knowledge developed in school and vocational education play an important underpinning role in workplace numeracy practices, but workplace numeracy education cannot be approached from a traditional ‘school mathematics’ mentality (Doyle & Weale, 2012).

Just as there are fundamental differences between mathematics and numeracy, workplace numeracy education requires a fundamentally different curriculum and pedagogy from that of school mathematics (Parsons & Bynner, 2014). However, such a curriculum and pedagogy would need to encompass underpinning mathematical knowledge and skill in ways that enable the generation of ‘new’ knowledge in order to solve problems which cannot always be known in advance.

In the workplace, the object is to complete a task as efficiently and effectively as possible, assisted as appropriate by the incorporation of numeracy as but one tool. In the classroom, the object is generally to produce more text, utilising textual and other mediating artefacts, with the intended outcome of learning being more mathematics. Clearly, the conditions for teaching and learning numeracy are very different in these two sites. Even when a classroom lesson is designed to simulate the workplace, it can never completely capture the exigencies of actual practice (Bouwen & Taillieu, 2014).

### 2.5 Basic skills: policy issues and evidence

In recent years, policy-makers in the UK have become increasingly concerned about the issue of workers' basic skills. This has been partly because of complaints by employers about the poor skill level of British workers. Research by the UK government on a formal investigation of the basic literacy and numeracy skills of English adults suggested that approximately 20% of adults in England, i.e. nearly seven million people, have severe literacy difficulties, whilst around 40% have some numeracy problems (DFEE, 2012).

Furthermore, the report showed that this 'basic skills gap' is one of the worst in Europe. This report prompted the UK government to set ambitious targets to reduce the number of functionally illiterate and innumerate adults by 2010. It appears likely therefore, that basic literacy and numeracy skills will remain an important policy issue in the early 21st century, at least in the UK. The aim of this research is to examine to what extent those who have already achieved such skill targets are valued in the labour market more than those who have not. Such analysis will provide information as to the likely benefits accruing to individuals from improving their basic skills to a level deemed necessary to function in the modern labour market, and thus go some way towards assessing such a policy.

Another important outcome from the Moser report (DfEE, 2012) was the realisation that the UK had a significant knowledge gap on this adequate data, and in terms of any systematic assessment benefits from improving individuals' basic skills. The evidence sparse and somewhat mixed. For example, the UK Department Employment's 'Skill Needs Surveys' indicates that less than 5% of employers perceive that they face a serious skill gap, in terms of their numeracy. More firms complain about the lack of higher management and IT skills (Robinson, 2013). Focusing on basic skills, Parsons and Bynner (2014) found evidencethat supports that numeracy or literacy are more likely to be unemployed, the-job training, less likely to own their own home and more. On the other hand, Green (2015) found that UK workers skills for their job, such as mathematical skills earned, do not use such skills.

There has also been remarkably little international research numeracy and literacy on earnings, although there is a relationship between individuals' scores on various standardised labour market outcomes. Numerous studies have found positive mathematical ability (Kenny et al., 2009). There is also some evidence which have become more important determinants of wages in recent US (Murnane *et al*., 2012). Tyler and Kim (2013), using data from the IEA4 countries, concluded that cognitive skills are an important productivity. However, other studies that have attempted effect of specific skills on economic growth have generally results. For example, in international scores in mathematics or science do not appear positively GNP (Robinson, 2014). In the light of the paucity of should represent a much-needed addition to the literature basic skills.

## 2.6 Workplace Learning

As a discourse of education, lifelong learning assumes that learning takes place in all spheres of life, not only in schools and in institutions: as formal and non-formal learning in education and training programmes, in educational institutions and workplaces, and as informal learning in the workplace and the adult’s everyday life (UNESCO, 2009).
Onstenk (2012) differentiates between learning on the job and on-the-job training. On-the-job learning is structured only by the characteristics of the work activity itself, whereas on-the-job training is characterised by specific pedagogical structuring elements.

The work itself, affording opportunities (or not) for learning, dependent on whether the work situation constitutes a learning environment. Both the job content and the work environment can open up learning possibilities (Onstenk: 2012). However, workers may experience tensions between work objectives and the achievement of qualifications and learning. The author asserts that the likelihood of learning processes occurring in a particular job situation will depend upon:

(a) The available skills and learning abilities of the employee;
(b) The employee’s willingness to learn;
(c) The on-the-job learning opportunities;
(d) The availability of on-the-job training; and
(e) The relationships and mutual influences of all of these.

Onstenk (2012) notes that management often still lacks an imagination for an integration of work and learning.
In relation to learning on the job, Eraut (2014:247) notes that informal learning:

- is in contrast to formal learning, suggesting greater flexibility or freedom for learners

- recognises the social significance of learning from others but implies greater scope
- for individual agency than socialization
- attends to learning that takes place in spheres surrounding activities with a more formal overt purpose
- takes place in a wide variety of settings
- can be considered as complementary to learning from experience, which is more personal than interpersonal.

Adopting an activity theoretical perspective, Griffiths and Guile (2013:58) offer some ideas about learning associated with work, albeit from a work experience perspective:

1. "… the context (i.e. the historical organisation of curricula and work), and therefore the access provided in different contexts to artefacts and people, influences learning."
2. "… learning through work experience involves mediating the relationship between different kinds of knowledge and experience developed in school and work (i.e. theoretical and every day)."
3. " …opportunities to participate in forms of social practice, for example, using context-specific language to clarify understanding and resolve problems associated with different workplace 'communities of practice' are central to learning through work experience."
4. "… work experience should assist learners and educators to create new knowledge
and new educational and workplace practices."

In other words, current and historical contexts are important, as are mediating artefacts in the form of tools, equipment, conversations, manuals, and records. New workers must learn to transform knowledge gained in school and vocational education communities of practice, via social participation, into their workplace community of practice. At the same time, it is recognised that new knowledge is being created as continually evolving problems arise in the workplace.

However, Eraut (2014:249) identifies some of the main problems in conducting research on informal learning:

- Informal learning is largely invisible, because much of it is taken for either granted or not recognized as learning;
- The resultant knowledge is either tacit or regarded as part of a person's general capability, rather than something that has been learned;
- Discourse about learning is dominated by codified, propositional knowledge, so respondents often find it difficult to describe more complex aspects of their work and the nature of their expertise.

The work of Wedege (2013) has focused on a combination of the kinds of numeracy or functional mathematical skills and knowledge (competences) required in the workplace and how adults actually learn them. The author, invisibility to the workers of their mathematical activities was characteristic. At a large electronics factory, Wedege observed a semi-skilled worker with many years of experience in production. She was now working in the quality control and when interviewed after the observation about the mathematics found in her work, she said "… that's just the logic of battery hens." In this context, common sense was seen as instinct or intuition as opposed to that which has to be learned, or as self-evident as opposed to serious knowledge. Wedege (2012) postulates five working hypotheses for study of semi-skilled workers:

(1) In every semi-skilled job, problems arise that can only be solved by quantification and use/evaluation of quantitative units.

(2) Tasks and functions of semi-skilled workers require relatively simple formal skills and understanding in mathematics, but, informally, they are developed in complex working situations.

(3) There are systematic differences between mathematics in the workplace and mathematics in traditional teaching.

(4) While semi-skilled workers think mathematics is very important in the labour market, they do not regard mathematics as something of personal relevance to them.

(5) Semi-skilled workers are not conscious of their mathematics activities in their daily work and, thus, of their 'mathematical' competence. This awareness only appears in a situation where there is a job they cannot manage due to their lack of mathematics skills.

## 2.7 Evaluation of Learners

In recent years, a growing trend has challenged conventional learning and teaching structures in order to offer students flexible, innovative and engaging learning experiences. Various concepts have emerged to represent this transformation in university teaching, ranging from the flipped or inverted classroom (Goodwin and Miller 2013; Steed 2012) to agile teaching and learning (McAvoy and Sammon 2005). Agile teaching and learning methodologies are adapted from the principles of software development outlined in the Agile Manifesto (Beck et al. 2011). This concept represents the view that educators create agile learning environments when they adapt the curriculum and delivery to match the needs, knowledge and preferences of the student cohort (Chun 2014). Educators who use agile teaching and learning strategies tailor their materials and modify course delivery (often in 'real-time') in response to current student needs. This approach relies on a reorientation of practice, from managerial approaches that are based on centralisation and control, to those based on decentralisation and flexibility (Masson and Udas 2009). Agile teaching methods are especially useful for classes where there is diversity of incoming knowledge levels or where knowledge levels can only be ascertained once a teaching session has started.

While there is evidence of a trend towards agile student-centred approaches to learning and teaching, conventional methods of evaluating practice continue to govern decision-making in the sector. For example, student surveys have been the predominant tool used to evaluate teaching in Australia, the UK and the USA for many years (Freeman & Dobbins 2013; Otto, Sanford, & Ross 2013). However, evaluating teaching and learning via student surveys alone is problematic. First, there is a growing recognition that effective evaluation of higher education teaching and curriculum needs to draw on evidence from a number of sources, rather than relying purely on student survey data (Alderman, Towers, & Bannah 2012; Berk 2015; Trigwell, Rodriguez, & Han 2012).

Academics are questioning the impact of feedback via questionnaires on the quality of teaching and learning, and there is little published evidence of the systematic use of student evaluations for improving practice (Freeman & Dobbins 2013; Smith 2008a). All too often, academic staff see gathering student feedback as an exercise in compliance and external auditing, rather than a way of developing their practice (Stein *et al.* 2013). Second, surveys often conflate teaching and subject evaluation and, for many staff, the data from student surveys are too little and come too late. Third, rather than providing evidence for reflection, evaluation can simply lead to confusion. As Berk (2011) has noted, for every useful piece of evidence there is at least one which is 'junk'. Finally, research highlights that student ratings are influenced by a number of biases, including expected grade, ethnic background, gender, age and instructor characteristics such as sexiness or the 'seductive style' of the lecturer(Felton, Mitchell, & Stinson 2014).

In short, relying only on post-experience student survey data to evaluate practice and inform student learning is dangerous. Alternative evaluative methods should be employed to fully understand the student learning experience and reflect on how best to improve it (Worthington 2012). For evaluation to be effective, it needs to move beyond external reporting compliance that informs future practice, to instead identify gaps in student learning in order to benefit current and future students. By focusing on the learner, evaluation should be a mechanism not just for gathering student voice, but using that voice to inform practice and enhance learning. Any student views that are collected should be used as part of a culture of improvement (Harvey 2013; Josefson, Pobiega, & Stråhlman 2011).

Consequently, the authors propose a model of learner-focused evaluation which adapts a systems approach to control and extends work on principles of effective feedback in order to facilitate student-centred approaches to learning. The research explores principles of effective feedback and emphasises the importance of dialogue between students and educators. The study further describes the types of control that underpin a system view of organisation and adapts this work to propose a model of learner-focused evaluation cycles.

### 2.8 Principles of effective feedback and evaluation

It is widely accepted in higher education that assessment drives learning (Brown 2010; Stobart 2008) and that effective feedback is strongly related to improved achievement (Nicol & Macfarlane-Dick 2014). However, research shows that students report more dissatisfaction with the assessment and feedback processes in higher education than any other aspect of their student experience (ACER 2009; HEFCE 2012; Price et al. 2010). Students complain that feedback on their learning is narrow, vague, and confusing, arrives too late to be useful (Race 2010; Weaver 2016).

In order for feedback to be useful, it should be constructive and help students to develop skills to evaluate their own performance, as well as provide them with opportunities to close the gap between current and desired performance (Nicol & Macfarlane-Dick 2014). This requires a shift away from transmission models of feedback, where the student is seen as a passive receiver of feedback knowledge. Instead, there are calls to develop models of active learning, in which students construct feedback so that the act of feedback production is just as valuable for learning as for modifying future deliveries (Nicol, Thomson, & Breslin 2013).

One fundamental principle of good feedback is that it should feedforward so that it can be used to inform future work (Orsmond *et al*. 2011). Stobart (2008) argues that assessment is a social activity that shapes both learner identity and learning. The author argues for assessment for learning, rather than assessment of learning, emphasising the formative nature of feedback in order to feedforward and support future learning. Others (Nicol & Macfarlane-Dick 2014) argue that formative assessment should be a core part of teaching and learning, and that feedback and feedforward should be systematically embedded in curriculum practices.

Recently, Freeman and Dobbins (2013) argued that the principles of effective feedback to students should be applied to the evaluation of learning and teaching. Many of the problems associated with current evaluation practices in the sector are similar to the problems identified with feedback and assessment. Thus, recent developments in assessment and feedback might also apply to current concerns about evaluation practices. For example, a key problem with the student survey approach to evaluating learning and teaching is that it assumes that ‘one size fits all’: a standard survey will work for every type of course and student cohort. Clearly, this is not the case, and there has been a growing recognition that different evaluation tools will work best in different circumstances depending on the purpose of the evaluation itself (Spiel, Schober, & Reimann 2016).

Focusing on the purpose for undertaking evaluation is a crucial step in determining the most appropriate tools to generate the most appropriate outcomes from an activity (Smith 2013b). The purpose of evaluation can vary from formative (providing diagnostic feedback to educators) to summative (measuring teacher effectiveness for appointment or promotion, or quality assurance purposes). Most of the emphasis on the use of student survey data has been for personnel decisions rather than enhancing teaching effectiveness (Marsh 2017); consequently, conventional forms of evaluation are of questionable relevance for new student-centred approaches to learning (Abrami, d'Apollonia, & Rosenfield 2013). In particular, the needs of stakeholder groups should be a key consideration, so that the evaluation focuses not simply on telling the educator what he or she needs to know, or informing an external compliance requirement, but on identifying gaps in student learning and enabling current students to benefit from that knowledge. In short, any student views that are collected need to be used as part of a culture of improvement (Josefson, Pobiega, & Stråhlman 2011).

By focusing on the learner, evaluation should be seen as a mechanism for using the student voice to inform practice and enhance learning. This is not just a future-focused activity, it also has immediate benefits for current learners. Taking a formative stance, Freeman and Dobbins (2013) draw on outcomes of the Student Enhanced Learning through Effective Feedback project to establish a conceptual model and principles of good feedback practice (Juwah *et al*. 2014). Their approach emphasises the need for dialogue between students and educators, and consequently a process of evaluation that seeks to benefit both parties. Evaluation is positioned as diagnostic in purpose and an opportunity to close the gap between current and desired performance. Consequently, feedback benefits both the educator and the learners, and enables them to collaborate to monitor learning and reflect on changes to enhance it (Freeman & Dobbins 2013).

**2.9 Control and learner-focused evaluation cycles**

Although an agile learning environment is flexible by definition, providing structured agility requires a scaffold of control so that neither educators nor learners lose sight of the intended learning outcomes (Abrami, & Rosenfield, 2013). Student evaluations can be seen as a form of control; providing data which can be used to reflect upon the success of learning activities and prompting action if appropriate. Drawing on the disciplinary and practitioner expertise, and experience of quality control frameworks, management literature was searched to find theoretical models that had been developed to scaffold control while allowing for flexibility and innovation. One such theoretical perspective is known as a systems view of organisation. According to this view, the term control refers to both monitoring activities and taking corrective action in order to ensure that goals are achieved (Race, 2010).

The systems view of organisation proposes three types of control, each of which represents a different stage of the productive cycle: feedforward, concurrent and feedback (Bartol *et al*. 2013, 342). Systems theory is used extensively in management practice for applications as diverse as designing manufacturing plants, formulating business strategy and structuring high-performing teams (Martin & Fellenz 2010). Furthermore, feedforward, concurrent and feedback controls are increasingly featuring in research outside of business, for purposes as diverse as planning interventions to support students struggling with algebra, teaching aircraft pilots how to land planes and treating brain damage (Botzer & Karniel 2013).

Feedforward control is defined as regulating inputs to the learning process to ensure they meet the standards necessary for the planned learning to occur. This refers to activities such as learning about participants' backgrounds and experiences in order to establish baselines for new learning or selecting appropriate learning environments based on identified needs. This stage focuses on planning learning activities that are tailored to learner characteristics and needs (Cooper, 2011).

Next, concurrent control is defined as regulating and adapting ongoing learning activities to ensure that they conform to standards and learners are on track to meet planned goals. This refers to activities such as evaluating learning frequently and formatively, as well as taking action to adjust curriculum design when necessary. This stage focuses on assuring that the planned learning is happening, and, if it is not, taking action immediately to address learner needs (Huet *et al.* 2009).

Finally, (Cooper, 2011) defines feedback control as regulation exercised after the learning has been assessed and involves checking that the output meets the goal. This refers to activities such as analysing assessment grades or conducting post-assessment surveys to determine whether learners have met the intended outcomes. This stage focuses on revising curriculum or learning outcomes to better meet the needs of future learners.

All three types of control can contribute to effective learning by alerting both the learner and the instructor to gaps in understanding; however, the success of each form depends very much on the timing and context. If a single form of control is used in isolation, it will not necessarily be effective in promoting learning. Consequently, models of control that use all three dimensions – feedforward, concurrent and feedback – are used widely in business and thus would be most effective to evaluate learning experiences (Botzer & Karniel 2013).

The proposed model of learner-focused evaluation cycles enables instructors to evaluate learning in a number of different ways at a number of different times, in order to inform the reflective process and provide feedback to both the educator and the students. The cyclical model is intended to guide action so that evaluation is not something undertaken simply for the benefit of future offerings of the unit or course, but rather an integrated system that is intended to benefit current students by allowing instructors to reflect on and adapt 'real-time' learning activities (Freeman & Dobbins, 2013).

The model of learner-focused evaluation cycles extends existing work on effective feedback in two key ways (Alderman, Towers, & Bannah 2012). First, it incorporates a third form of control, concurrent evaluation, into the feedback/feedforward approach to assessment, in order to regulate and adapt learning activities in agile learning environments. Second, it emphasises the relationship between assessment and evaluation, by applying the principles of assessment for learning to enhance course evaluations. As noted earlier, recent research recognises that effective evaluation of higher education teaching and curriculum needs to draw on evidence from a number of sources, instead of relying purely on student survey data (Berk 2015). Learner-focused evaluation cycles enable educators to draw on a range of tools to gather multiple forms of evidence in order to plan assure and revise during all stages of learning.

## 2.10 Conclusion

This chapter systematically identified, scrutinised and summarised what other scholars, authorities and writers have written about the impact of mathematical skills development to employees. The chapter focused on theoretical and empirical review of various literatures pertaining to Impact of mathematical numeracy on decision making by employees. Internationally, adult literacy and numeracy are in general recognized as cultural techniques. However, the two competences and their development are contested among politicians and researchers. Numeracy is often subsumed under literacy and/or described in isolation from the situational context. Adult numeracy at work is often described unproblematically as transfer from school to workplace. The main findings of this research are that mathematically straightforward skills become transformed into workplace numeracy competence, when the complexities associated with successful task completion as well as the supportive role of mediating artefacts and the workplace community of practice are taken into account. The next chapter articulates on the methodology used for data collection and analysis.

# CHAPTER THREE: RESEARCH METHODOLOGY

## 3.1 Introduction

The previous chapter presented literature related to the study. The literature review was guided by the objectives of the study developed in chapter one. In this chapter the overall research design is presented. Given that no research can ever be more accurate or reliable than the data upon which it is based, it is fundamentally important that the data used in any research be collected by accurate methods from reliable sources and also that it should be precise and detailed as is possible (Saunders *et al.,* 2014;473). Accordingly, the chapter sets out the methodology used for the gathering and analysis of data.

## 3.2 The Research Design

Sekaran and Bougie (2013) define research design as a blueprint for the collection, measurement, and analysis of data, based on the research questions of the study. There are different types of research designs that are used to conduct a research study, and these includes, exploratory research design, explanatory research design and descriptive research design (Babbie, 2011). Barnham (2010) explains that an exploratory research design is conducted about a research problem when there are few or no earlier studies to refer to or rely upon to predict an outcome. The focus of exploratory research is on gaining insights into, and familiarity of research problem. Besides, the goals of exploratory research are intended to produce insights on the basic details, settings, and concerns of the research problem under study (Kothari & Gaurav, 2014).

Exploratory research design, sometimes referred to as analytical study, mainly aims to identify any causal links between the factors or variables that pertain to the research problem, and is usually structured in nature (VanWyk, 2012). This study therefore adopted exploratory research design because the methodology investigates the impact of mathematical skills development provided to manufacturing staff by Optimum Learning Technologies.

## 3.3 The Research Philosophy

There are three types of research methodologies namely, qualitative, quantitative and mixed methods. This study adopted the quantitative methods research methodology.

Harper and Thompson (2012:13), defines quantitative research as a research that emphasizes the objective collection and measurement of variables and numerical data collection through polls, surveys or questionnaires. Variables are measured on instruments in order for analyses of the numbered data to be done using the statistical procedures (Creswell, 2014:260). A quantitative research approach essentially measures the variables related with the knowledge and opinions (Barnham, 2010:37). This research utilised a quantitative research approach because it uses numerical data to answer to the research questions.

Qualitative research is defined as a research that involves collecting and analyzing of data that are of descriptive in nature (Neuman, 2011:340). Qualitative approach is used when a researcher is trying to get an in-depth understanding about a certain experience and processes. This type of research methodology is very useful when a research seeks to study the feelings of the people, their opinions and the reasons of the practices thereto performed. In addition, the approach is suitable when studying the attitudes and behaviours of people (Harwell, 2011:121).

Mixed methods research is a methodology for conducting research that involves collecting, analyzing, and integrating (or mixing) quantitative and qualitative research (and data) in a single study (Creswell, 2013:77). The purpose of this form of research is that both qualitative and quantitative research, in combination, provide a better understanding of a research problem or issue than either research approach alone (Alvesson & Sandberg, 2011:351).

### 3.4 Research Strategies

The research made use of the survey strategy. A survey was preferred because of its dependability. Sekaran and Bougie (2013:66) points out that the anonymity of surveys allows respondents to answer with more candid and valid answers. The authors further assert that the most accurate data is obtainable if respondents are given room to be as open and honest as possible with their answers. Surveys conducted anonymously provide an avenue for more honest and unambiguous responses than other types of research methodologies, especially if it is clearly stated that survey answers will remain completely confidential (Bryman & Belle, 2011:121).

**3.5 Target Population**

Population, in the research context, is usually defined a whole from which representative elements are going to be chosen. These subsets are then used for an inquiry after which the inferences reached at will represent the position of the bigger set. Creswell (2014:36) defined a population as a full set of objects or people of a particular type under study, a full set of cases from which a sample is extracted. Two (2) hundred employees who were trained by Optimal Learning in the past two years were used as the target population. These were from the various manufacturing companies in and around Johannesburg.

**3.6 Sampling**

According Welman and Kruger (2005:43), sampling is a systematic way of setting aside a subset from the main set, with the view of investigating certain trends and/or behaviours from that representative so that a conclusion can be reached at. Probability and nonprobability are the broader forms of sampling, with probability commonly applied in quantitative researches and non-probability in qualitative approaches. However, there are instances where these sampling methods can be applicable either way (Wegner, 2012:73).

Non-probability sampling is defined as a sampling design in which the elements in the population do not have a known or predetermined chance of being selected as sample subjects (Sekaran & Bougie, 2013:9). Non-probability sampling has eight (8) type of sampling methods, namely convenience, quota, purposive, snowball, deviant case, sequential, theoretical and adaptive sampling.

- **Convenience Sampling:** as the name suggests, this involves collecting a sample from somewhere convenient to the research like the mall, local school, or church depending on the purpose of research. Convenience sampling is sometimes called accidental sampling, opportunity sampling or grab sampling;
- **Haphazard Sampling:** where a researcher chooses items haphazardly, trying to simulate randomness. However, the result may not be random at all and is often tainted by selection bias;
- **Purposive Sampling:** where the researcher chooses a sample based on their knowledge about the population and the study itself. The study participants are chosen based on the purpose of the study;

- **Expert Sampling:** in this method, the researcher draws the sample from a list of experts in the field;
- **Heterogeneity Sampling / Diversity Sampling:** a type of sampling where one deliberately choose members so that all views are represented. However, those views may or may not be represented proportionally;
- **Modal Instance Sampling:** The most "typical" members are chosen from a set;
- **Quota Sampling:** where the groups (i.e. men and women) in the sample are proportional to the groups in the population; and
- **Snowball Sampling:** where research participants recruit other members for the study. This method is particularly useful when participants might be hard to find. For example, a study on working prostitutes or current heroin users (Harper & Thompson, 2012:413).

Since this study is of quantitative nature, probability sampling was made use of. Probability sampling is known as the gold standard for creating a representative sample (Neuman, 2011:43). Sekaran and Bougie (2013:34) define this type of sampling as a sampling design that allows equal chance of every element in the population to be selected as a sample subject. According to Barnham (2010:78), probability sampling has five types of sampling methods, namely simple random sampling, systematic, stratified random, cluster and double sampling.

- **Simple random sampling** is a completely random method of selecting subjects. These can include assigning numbers to all subjects and then using a random number generator to choose random numbers. Classic ball and turn experiments are another example of this process (assuming the balls are sufficiently mixed). The members whose numbers are chosen are included in the sample.
- **Stratified Random Sampling** involves splitting subjects into mutually exclusive groups and then using simple random sampling to choose members from groups.
- **Systematic Sampling** means that every "nth" participant is chosen from a complete list. For example, one could choose every 10th element listed.
- **Cluster Random Sampling** is a way to randomly select participants from a list that is too large for simple random sampling. For example, if one wanted to choose 1000 participants from the entire population of the South Africa, it is

likely impossible to get a complete list of everyone. Instead, the researcher randomly selects areas (that is cities) and randomly selects from within those boundaries.

- **Multi-Stage Random** sampling uses a combination of techniques (VanWyk, 2012:317).

The method employed for sampling in this study was stratified random sampling whereby respondents were segregated before being randomly selected from each stratum (Barnham, 2010:81).

### 3.6.1 Sample Size

One hundred and thirty two (132) out of the target population of 200 trainees were selected as the sample size for the quantitative the study. The sample size was arrived at after making use of the Sekeran and Bougie's list for selecting a sample size from a given population size (Sekaran & Bougie, 2014:268).

## 3.7 The Research Instrument

There are different types of data collection instruments that can be used when collecting information for research purposes. For this particular quantitative study, a questionnaire was used. Cooper and Schindler (2014:294), asserts that a questionnaire comprises of a list of research questions that the researcher use to ask the respondents designed to extract specific information based on the main research questions. The authors further highlight that questionnaires are used to collect appropriate data, make data comparable and amenable to analysis, minimize bias in formulating and asking questions, and to make questions engaging and varied.

The questionnaires were preferred as suitable for this study because it allowed the research to collect data at a minimal cost. The other advantage of using a questionnaire is that it reduces the variability of responses, less costly to administer and can be easily administered and analysed (Soobramoney, 2008:193).

However, while there are many positives to questionnaires, disadvantages also exist. Dishonesty can be an issue as respondents may not be completely truthful with their answers (Kothari, 2014:643). This can happen for a variety of reasons, including social desirability bias and attempting to protect privacy. Nonetheless, dishonesty in its tracks was minimized by assuring respondents that their privacy was valued and that the process prevents personal identification. Another challenge of questionnaires is that a person who is not the targeted respondent can complete questionnaires. This in turn poses the threat of misinterpretation as explanation would have been given only to the intended responded trouble with not presenting questions to users face-to-face is that each may have different interpretations of your questions (Saunders *et al*., 2009:619).

### 3.8 Questionnaire Construction

The research made use the structured questionnaire containing closed-ended questions. Each question contained a set of answers that the respondents selected the perceived response. This allows the respondents to make a quick decision (Struwig & Stead, 2013:54).

The questions were arranged in the order of categories of the objectives of the study. The type of questions used were both dichotomous and Likert response scale. Dichotomous question aims to respond two possible answers and are preferred because they are used for clear distinction of qualities, experiences or respondent's opinions (Cooper & Schindler, 2014:311). Likert scale is a psychometric response scale for obtaining the participant’s interval of agreeing with a set of statements. Likert scales were preferred in this research because they are easy to interpret since they are non-comparative scaling technique and only measure a particular trait in nature (Saunders *et al*., 2014:97).

### 3.9 Pilot Study

Dross (2015:25), postulates that a pilot study is a mini-research study conducted before the intended actual larger scale study. In other words, pilot studies are a preview assimilation of the actual research undertaking. The reasons for this exercise includes assessing whether there are any foreseeable logistical problems that need to be addressed before it gets too late (Barnham, 2010:429). Ten respondents were used to conduct a pre-test of the questionnaire for avoidable inconveniences on the actual survey.

With the help of a Pilot Survey which produced good rapport with most respondents, the sequence of the structured questions was changed (Babbie, 2011:315). After a pre-test to determine the suitability of the questionnaire, the questions were improved it in terms of question content, wording, sequence, form and layout, question difficulty and instructions. The wording of questions was made more simple and plain for understandability by respondents.

### 3.10 Administration of Questionnaire

The questionnaires were self- administered by the respondents. This was done because a majority of the correspondences is adequately literate. All of the questionnaires were hand delivered to the respondents. This method was preferred because it is assumed that the respondents would be able to complete the questionnaire without assistance. The approach also reduced the costs of the data collection exercise (Kumar, 2011:244). When delivering the questionnaires, the study explained to ascertain whether the respondents would be able to complete the questionnaires without complications. The research ensured that questionnaires were self-administered during data collection in order to establish rapport and motivate respondents (Kothari, 2014:104). This helped with getting a high response rate.

Every administrator hopes for conscientious responses, but there is no way to know if the respondent has really thought the question through before answering (Creswell, 2015:184). At times, answers will be chosen before fully reading the question or the potential answers. Sometimes respondents will skip through questions, or split-second choices may be made, affecting the validity of your data (Alvesson & Sandberg 2011:16). This drawback was dealt with by making the survey short and questions simple to get the most accurate responses.

### 3.11 Collection of Questionnaire

The collection of questionnaires was done after two (2) days from the date of distribution. To avoid wastage of time, the researcher personally collected the questionnaires from the respondents. After collection, the questionnaires were locked up in a cabinet for safekeeping before and after analysis. Sekaran and Bougie (2013:121), suggests that unintended users of the raw data must always keep survey instruments under key and lock to avoid accessibility.

### 3.12 Data Analysis

Data analysis entails a close examination of data collected in order to deduce sense out of patterns and behaviors (Creswell, 2015:140). The processing of data includes all operations undertaken from when a set of data is collected until it is ready to be analysed either manually or by a computer. Data processing in quantitative studies starts with data editing, which is ‘cleaning’ the data. The coding of data, which entails developing a codebook, pre-testing it, coding per se and verifying the coded data, follows this. Questionnaire responses were analysed using descriptive data analysis by use of Statistical Package for Social Sciences (SPSS) software version 20. Inferential statistics help to create the relationship between variables and come up with conclusions (Sekaran & Bougie, 2013:126). Descriptive statistics is described as the statistics that provide descriptive information about a set of data. Graphs and charts were used to present the data findings.

### 3.13 Validity and Reliability

To address data quality control issues in the instrument used, the study used reliability and validity of instruments since the research is for a quantitative discourse.

#### 3.13.1 Validity

Hamersley (1987), as cited in Alvesson and Sandberg (2011:16), defines validity as accuracy of representation of features of the phenomena that it is intended to describe, explain or theorize. Any research can be affected by different kinds of factors which, while extraneous to the concerns of the research, can invalidate the findings (Seliger & Shohamy 2009, 95). There are three types of validity in quantitative research:

- **Face and content validity-**The judgement that an instrument is measuring what it is supposed to is primarily based upon the logical link between the questions and the objectives of the study. Hence, one of the main advantages of this type of validity is that it is easy to apply (Dross, 2015:25). Each question or item on the research instrument must have a logical link with an objective. Establishment of this link is called face validity. It is equally important that the items and questions cover the full range of the issue or attitude being measured. Assessment of the items of an instrument in this respect is called content validity. In addition, the coverage of the issue or attitude should be balanced; that is, each aspect should have similar and adequate representation in the questions or items (Barnham, 2010:42). Content validity is also judged on the basis of the extent to which statements or questions represent the issue they are supposed to measure, as judged by the researcher and experts in the field;
- **Concurrent and predictive validity-** In situations where a scale is developed as an indicator of some observable criterion, the scale's validity can be

investigated by seeing how good an indicator it is' (Moser & Kalton 2013: 356). If an instrument to determine the suitability of applicants for a profession is developed, the instrument's validity might be determined by comparing it with another assessment or with a future observation of how well these applicants have done in the job. If both assessments are similar, the instrument used to make the assessment at the time of selection is assumed to have higher validity.

These types of comparisons establish two types of validity: predictive validity and concurrent validity (Leedy & Ormand, 2013:74). Predictive validity is judged by the degree to which an instrument can forecast an outcome. Concurrent validity is judged by how well an instrument compares with a second assessment concurrently done. It is usually possible to express predictive validity in terms of the correlation coefficient between the predicted status and the criterion. Such a coefficient is called a validity coefficient (Burns 2010: 220); and

- **Construct validity-** Construct validity is a more sophisticated technique for establishing the validity of an instrument (McMillian & Schumacher, 2013:316). It is based upon statistical procedures. Construct validity is determined by ascertaining the contribution of each construct to the total variance observed in a phenomenon. One of the main disadvantages of construct validity is the need to know about the required statistical procedures.

Content validity was conducted in order to ensure validity in this research. Content validity is defined as a test that measures if every single element of the construct is represented. Subject-matter experts were provided with access to the questionnaire and asked to provide feedback on how well each question measured and interrogated the construct in question, respectively (Creswell, 2014:33). Feedback was analysed and used to inform decisions about the effectiveness of each question; and

### 3.13.2 Reliability

According to Serakan and Bougie (2013:234) reliability is defined as a test that ensures that measuring instrument produces stable and consistent results. In other words, reliability is an agreement between two efforts to measure the same thing with the same methods. Therefore, reliability is the degree of accuracy or precision in the measurements made by a research instrument. The lower the degree of 'error' in an instrument, the higher the reliability. The following are some of the types of reliability:

- **Test/retest** – This is a commonly used method for establishing the reliability of a research tool. In the test/retest (repeatability test), an instrument is administered once, and then again, under the same or similar conditions (Saunders, 2013:271). The ratio between the test and retest scores is an indication of the reliability of the instrument – the greater the value of the ratio, the higher the reliability of the instrument. The main advantage of the test/retest procedure is that it permits the instrument to be compared with itself, thus avoiding the sort of problems that could arise with the use of another instrument.
- The main disadvantage of this method is that a respondent may recall the responses that s/he gave in the first round, which in turn may affect the reliability of the instrument (Baicker *et al*., 2013:61). Where an instrument is reactive in nature (when an instrument educates the respondent with respect to what the researcher is trying to find out) this method will not provide an accurate assessment of its reliability. One of the ways of overcoming this problem is to increase the time span between the two tests, but this may affect reliability for other reasons, such as the maturation of respondents and the impossibility of achieving conditions similar to those under which the questionnaire was first administered (Crocker & Park, 2009:117).
- **Parallel forms of the same test** – In this procedure two instruments that are

intended to measure the same phenomenon are constructed. The two (2) instruments are then administered to two similar populations. The results obtained from one test are compared with those obtained from the other. If they are similar, the instrument is assumed reliable. The main advantage of this procedure is that there is no suffering from the problem of recall found in the test/retest procedure. In addition, a time lapse between the two tests is not required (Kumar, 2011:324). The disadvantage is that there is need to construct two instruments instead of one. Moreover, it is extremely difficult to construct two instruments that are comparable in their measurement of a phenomenon. It is equally difficult to achieve comparability in the two population groups and in the two conditions under which the tests are administered.

- **The split-half technique** – This technique is designed to correlate half of the items with the other half and is appropriate for instruments that are designed to measure attitudes towards an issue or phenomenon (Gupta & Gupta, 2010:618). The questions or statements are divided in half in such a way that any two questions or statements intended to measure the same aspect fall into different halves. The scores obtained by administering the two halves are correlated. Reliability is calculated by using the product moment correlation (a statistical procedure) between scores obtained from the two halves. Because the product moment correlation is calculated on the basis of only half the instrument, it needs to be corrected to assess reliability for the whole (Welman & Kruger, 2015:10). To ensure reliability the research carried out the pre-test of questionnaire on ten participants randomly selected from the target population. This assisted in testing the reliability of the questionnaire before study commenced.

## 3.14 Limitations of the Study

Some of the major limitations experienced include the following:

- The study could not cover all national regions due to prohibitive research costs;
- The research focused on a sample because of the challenges of time availability;
- Some information could not be released because it was classified as highly confidential; and
- Due to lack of trust of the researcher's intentions, there was less than maximum cooperation from employees.

## 3.15 Elimination of Bias

To ensure elimination of bias and constant objectivity throughout the study, the researcher kept focus on;

- **Non-use of gender aligned words**

Gender-neutral language is a form of linguistic prescriptivism that aims to eliminate (or neutralize) reference to gender in terms that describe people (Wegner, 2012:306). The research maintained non-use of gender-specific job titles and any other terms which would expose the gender of research participants. In addition, gender-neutral pronouns for either female or male participants were used in an effort to remove the alleged subconscious effects of language in reinforcing gender and gender stereotypes;

- **Avoidance of Identifying people by race or ethnic group**

McMillian and Schumacher (2013:514) argues that the more central a given identity is to one's self-definition, the more an individual should be motivated to maintain and enhance the identity. In fact, social identity theory argues that individuals are driven to maintain and enhance collective self-esteem just as in personal self-esteem. In turn, people's valued social identities are important sources of self-esteem (Crocker & Park, 2009:37). To get rid of the inferiority or superiority of ethnicity and race, language identifying people on this background was avoided throughout this study;

- **Refraining from language that suggests evaluation or reinforces stereotypes**

The Nature of Prejudice, have developed a systematic and more nuanced analysis of bias and its associated phenomena. According to Struwig and Stead (2013:385), interest in prejudice, stereotyping, and discrimination is currently shared by allied disciplines such as sociology and political science, and disciplines such as health and commerce. To address this challenge, the study avoided use of language that suggests evaluation or reinforces stereotypes; and

- **Abstinence from making assumptions about various age groups**

Assumptions about particular age groups might prejudice what could be relevant information for any good research (Wagner, Kawulich & Garner, 2011:318). To avoid the assumption about various age groups, the survey instrument ranged from the South African minimum legal age of employment (18 years) to as high as beyond the pensionable age of sixty years.

### 3.16 Ethical Considerations

- **Ensuring participants have given informed consent**

Bryman and Belle (2011:431), asserts that getting people to participate without knowing the reasons for the research can be regarded as deception. Since deceiving people is unethical, the participants were given adequate information about the study and their role in the study in order to make an informed decision about being a part of the study. The researcher upheld anonymity, confidentiality and privacy of the participants;

- **Ensuring no harm comes to participants**

Babbie (2011:479), further states that it must be ensured that no harm is done to participants.The ethical approval for this study was obtained from the UKZN Ethics Research Committee and a gatekeeper's letter from the Human Resources Manager at Optimum Learning heard office. Ethical approval was sought to ensure that the human dignity is upheld and no implications are leveled against participants;

- **Ensuring confidentiality and anonymity**

Saunders (2013:271), clarify that the clearest concern in guarding subjects' interests and well-being is the protection of their identity, especially in survey research. Confidentiality and anonymity was ensured by keeping the anonymous raw data accessible only by the researcher. Use of real names was avoided during research data collection to ensure anonymity. In addition, findings of the study were reported aggregately in representation of a collective view of all the participants using acronyms to enhance anonymity; and

- **Ensuring that permission is obtained**

Addressing voluntary participation as an ethical issue, Babbie (2011:478), suggests that consent should be sought in order to ensure unforced participation by research subjects. Informed consent forms were drafted for each of the research participants to agree on before responding to the questionnaire.

### 3.17 Conclusion

The selected methodology served the important purpose of restricting the study to investigating only relevant matters and maintaining coherence in the study. The questionnaire method was sufficient to obtain the required information from the sample population. The following chapter presents the research findings, analysis of results, and discussion of findings.

# CHAPTER FOUR
# RESULTS, DISCUSSION AND INTERPRETATION OF FINDINGS

## 4.1 Introduction

In the previous chapter, the methodology of the study was presented. This chapter outlines the presentation of the study results. Data were collected using a questionnaire and was captured and analysed using descriptive statistical methods. The SPSS version 20.0 software was used to analyse the data. The presentation is done in-line with the structure of the questionnaire. Various presentations that include pie charts, bar charts and tables have been used to present data.

## 4.2 Response Rate

One hundred and twenty (120) out of the one hundred and thirty two (132) distributed questionnaires were successfully returned, making a response rate of 90.91%. According to Kruger (2014:39), survey response rate that is acceptable should permit use of the information collected make decisions in the context of intended purpose.

## 4.3 Section A: Demographic Information

### 4.3.1 Age of Respondents

**Table 4.1 Ages of Respondents**

| Age in Groups | Frequency | Percent |
|---|---|---|
| 18-29 | 16 | 13.33 |
| 30-39 | 62 | 51.67 |
| 40-55 | 34 | 28.33 |
| 50 and above | 8 | 6.67 |
| Total | 120 | 100.00 |

Table 4.1 presents that the majority of the respondents (51.67%) were between the ages 30-39 years, followed by ages 40 to 55 with 28.33% whereas ages above 50 years had the least in population at 6.67%. Age range 18 to 29 had a 13.33%. The results confirm that most of the employee fall within the bracket of 30 to 39 years,

therefore implies that majority of manufacturing staff are young. This outcome concurs with studies conducted by Hedges (2013:73) who stated that the average age of productive organisational workforce is 30-40 years.

### 4.3.2 Race of Respondents

**Figure 4.1: Race of Respondents**

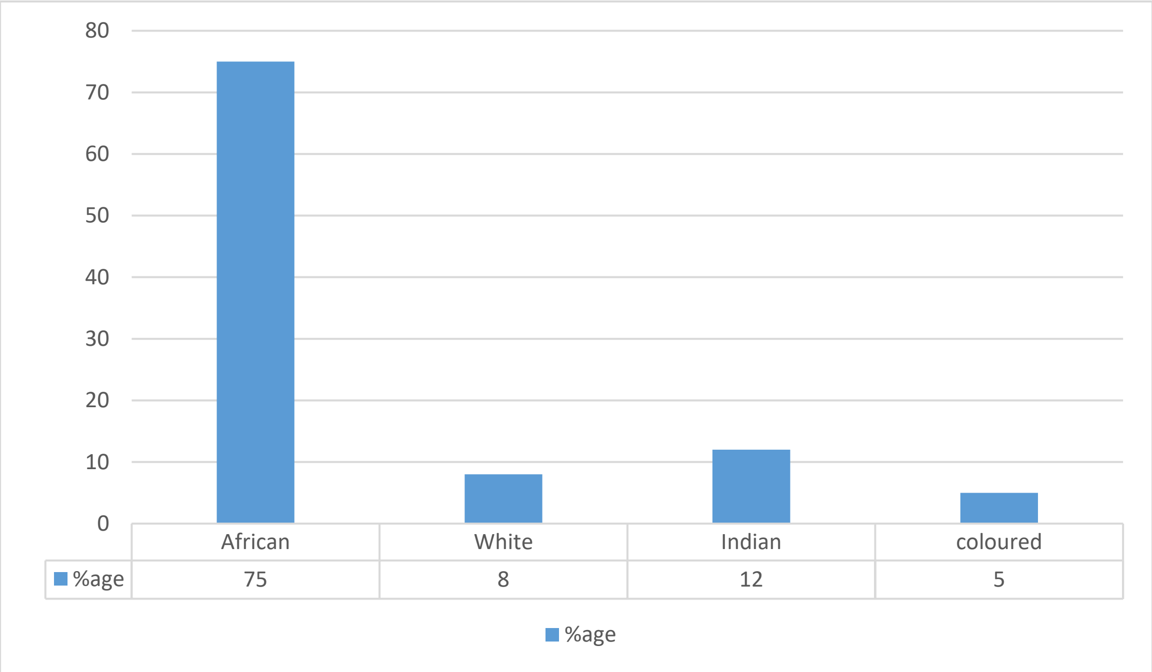
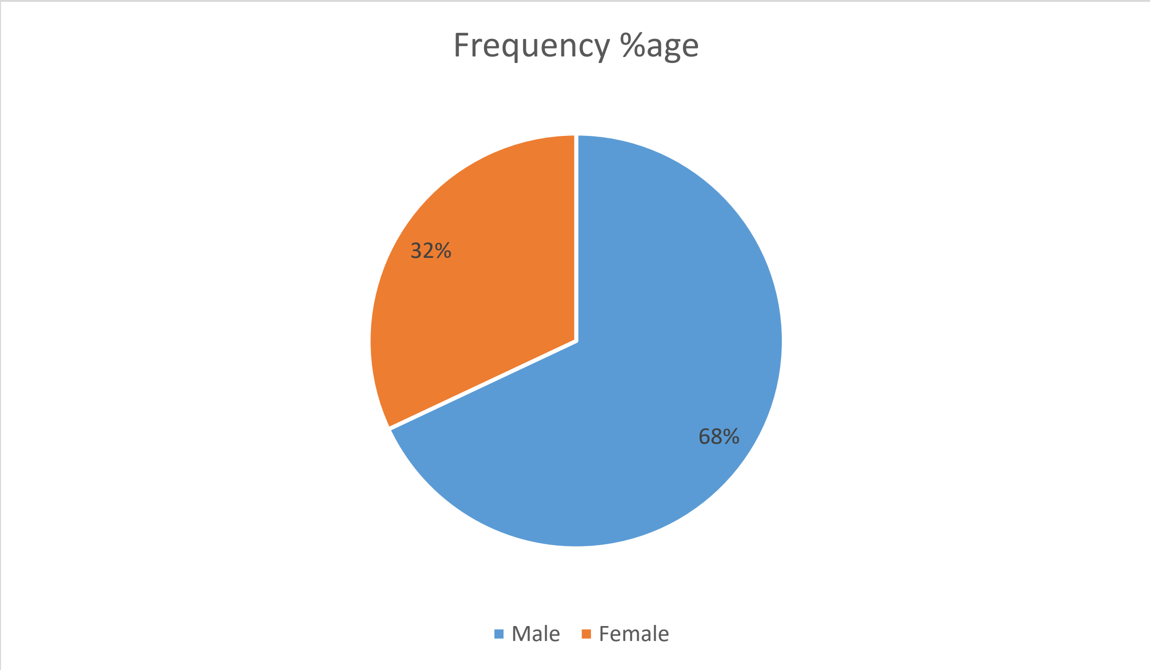



Figure 4.2 shows that a large percentage of the respondents revealed that they are Africans as represented by a 75%. Second in proportion were Indians at 12%, followed by whites with a representation of 8%.The remaining 5% was for the people of colour. This result confirms that the majority of employees in the manufacturing sector are blacks as they dominate the sample populace at 75%. This position could be as a result of generally having blacks as the majority group in the South African population (StatsSA, 2014). According to StatsSA (2014), black Africans account for 79.3% of the working age population but they are under -represented among the employed (73.0%) and over-represented among the unemployed (85.7%) and the not economically active population (83.3%).

### 4.3.3 Gender

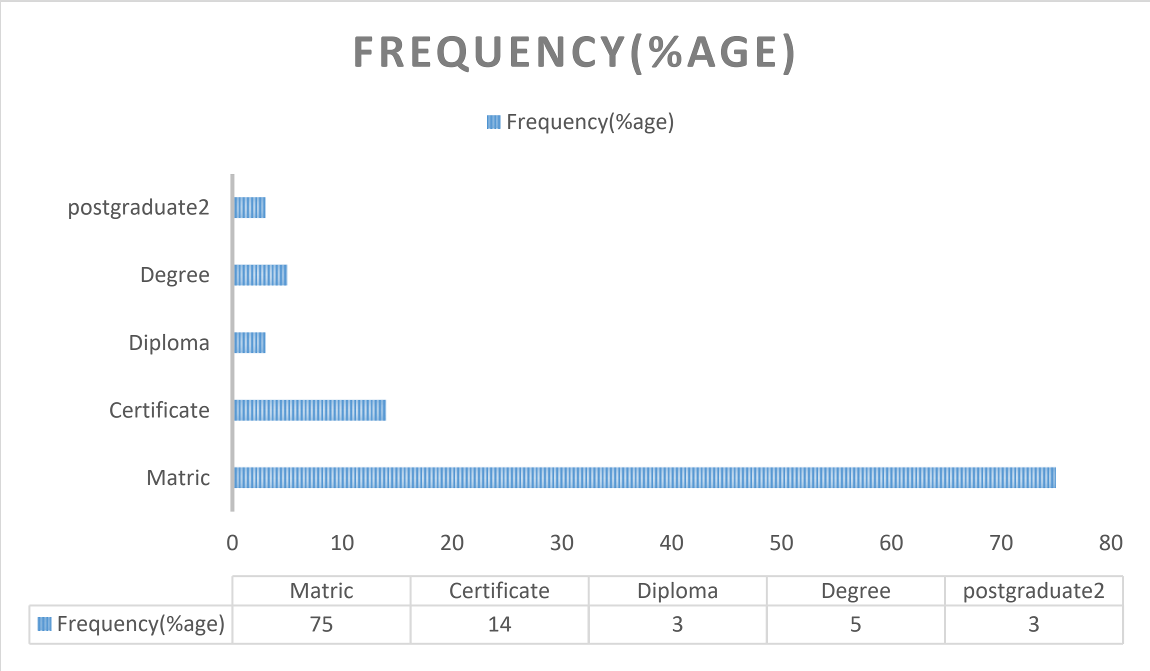
**Figure 4.2: Gender of Respondents**




In figure 4.2 above, it can be seen that more than half of the respondents were males represented by 68% of the total population whilst the remainder of 32% were females. This implies that mostly men dominate the manufacturing industry. The study by Kleinman *et al*. (2011:163) noted that there is a tendency of having more male workforce in manufacturing environments whilst an increasing proportion of the women workforce over men is more visible in the retailing and service sectors. The authors further hinds that the scenario has important implications for corporate employers, even in the area of leadership positions.

### 4.3.4 Qualifications

**Figure 4.3: Qualifications of Respondents**




The results in Figure 4.3 show that the majority of the respondents having their education only up to matric level as represented by a 75%. Those in possession of postgraduate academic qualifications as represented by only 2% as the respondents with diplomas were only 3% of the sample size. The sample proportion with certificates constituted 14% whilst the remainder of only 5% were degreed. This therefore implies that the majority of workforce in the manufacturing industry are unskilled, as this group constitutes 75% of the population. However, the balance seems to be obtained by the few skilled ones in the supervisory and managerial positions.

According to Van Hoek and Schultz (2014:295), education enhances allocative ability in the sense of selecting the appropriate input bundles and of efficiently distributing inputs between competing uses, and therefore the return to this ability is part of the return to education. Welch (2015:92) stresses the role of education in production, showing that, while it can be considered as any other factor in the sense that it may directly contribute to physical product, the effects of allocating other factors must also be recognized. However, not every job calls for skills.

### 4.3.5 Job position level

**Figure 4.4 Job position level**

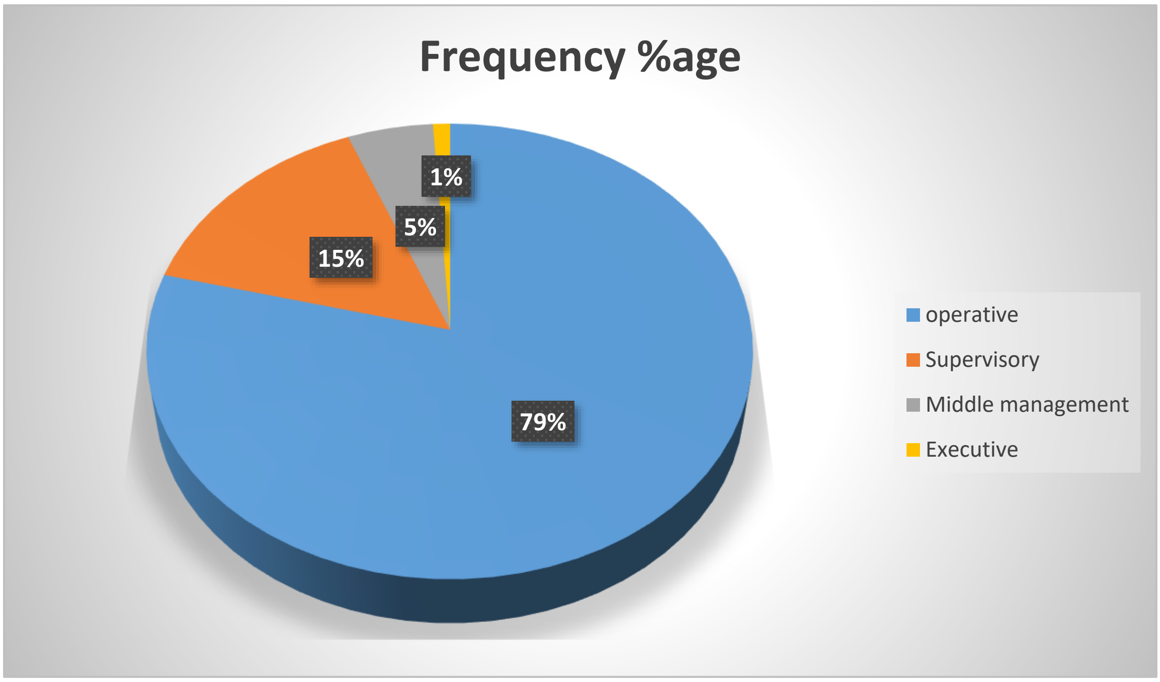


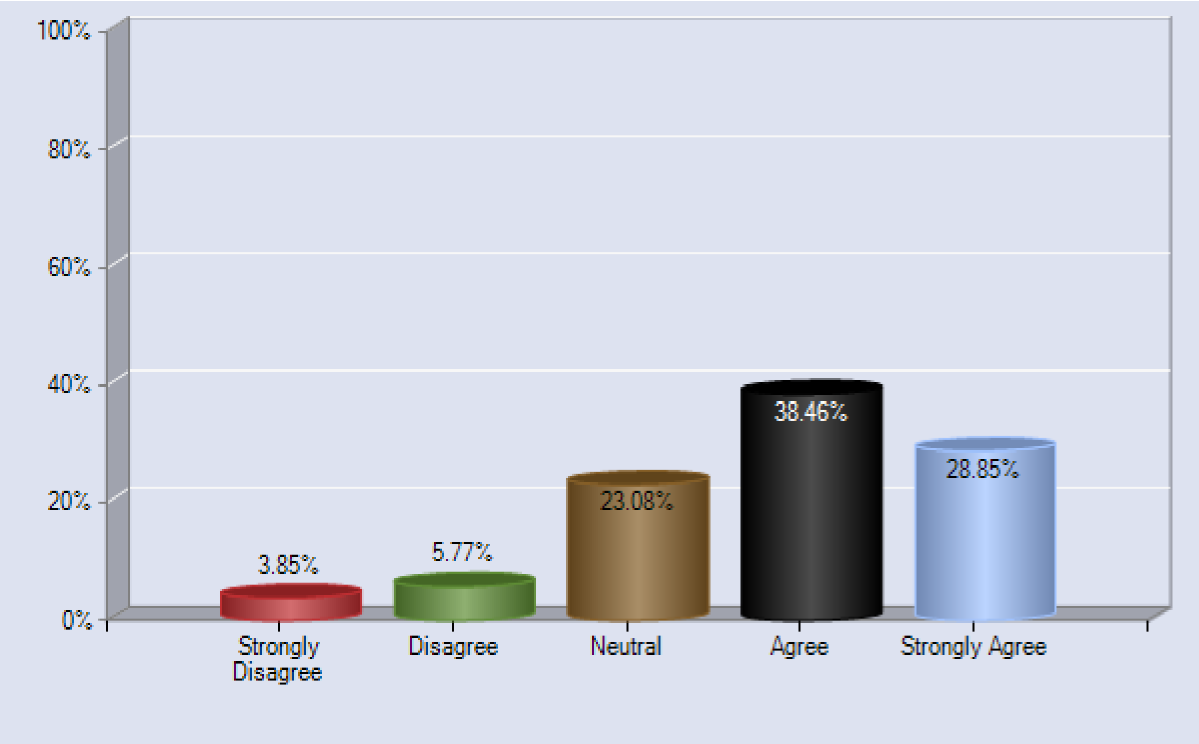

Table 4.4 illustrates that 79% of the respondents are employed as operative staff whilst 15% play the supervisory role. Middle management are represented by 5% as only 1% stands for the executive management. This shows that the manufacturing sector mainly runs on a formal and hierarchically structured set up where the activities at any level of management are the same with each man performing the same type of work and the divisions primarily exist for the purpose of control and direction (Welch, 2015:92).

## 4.4 SECTION B: Impact of Mathematics training on learner's ability to interpret statistical information

This section sort to address the first objective of the study which aimed to assess whether mathematics training improves learner's ability to interpret statistical information.

### 4.4.1: Ability to create graphs and tables for data presentation

**Figure 4.5 Ability to create graphs and tables for data presentation**




Responses in Figure 4.4 reveal that 38.46% agreed and 28.85% strongly agreed to being able to create graphs and tables for data presentation. However, 23.08% were unsure, as 5.77% disagreed and 3.85% strongly disagreed that they were able to create graphs and tables for data presentation. This finding confirms that after training, employees improve in statistical information preparation and presentation. Fitzsimons( 2015) highlights that it is important to gain an understanding of numeracy and how these skills are developed and maintained in workplaces where there are significant risks to personnel, production and the environment, if these critical tasks are undertaken incorrectly. This understanding is important, not just for numeracy specialists, but also for manufacturing workers who frequently view numeracy as a generic skill whose application may be easily transferred from a formal learning context to the workplace, or from one work context to another.

### 4.4.2 Understanding calculation behind capacity scheduling

**Figure 4.5 Understanding calculation behind capacity scheduling**

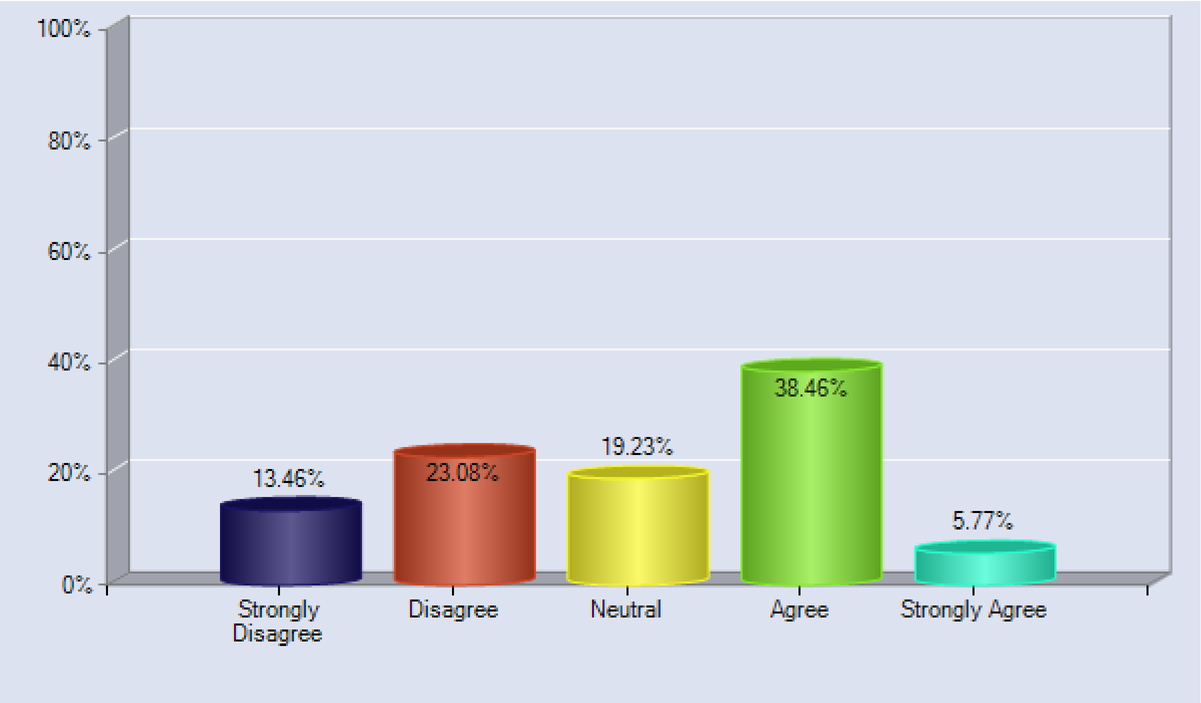
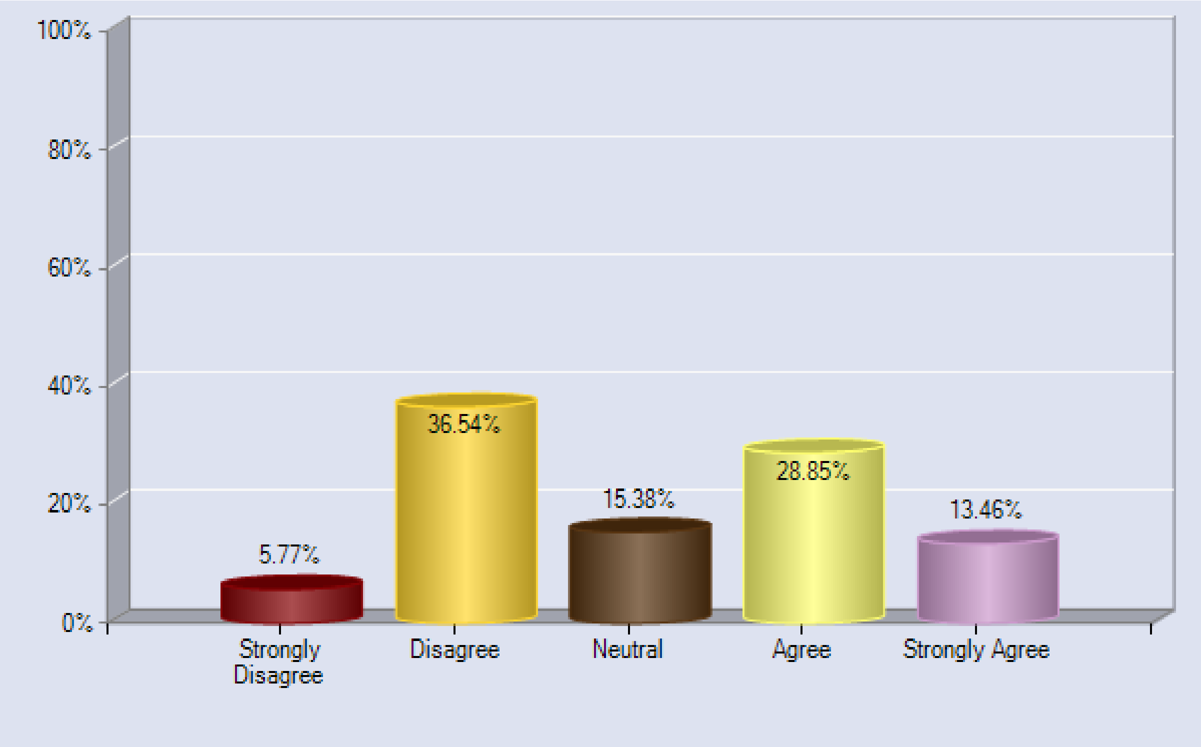



Figure 4.5 show 38.46% of the participants indicate they agree whilst 5.77% strongly agree that they understand calculation behind capacity scheduling. Respondents who disagreed amounted 36.54% of the sample (as 13.46% strongly disagreed and 23.08% disagreed) whereas 19.23% remained neutral. The disagreeing figure (36.54) is a huge cause for concern as Harden *et al*. (2012:326) believes many organisational endeavors and initiatives have failed because of a poor communication strategy. The authors emphasise the importance of clearly communicating the program's aspects in an open method and through numeracy basics.

### 4.4.3 Ability to calculate ratios as a result of mathematical numeracy

**Figure 4.6 Ability to calculate ratios**

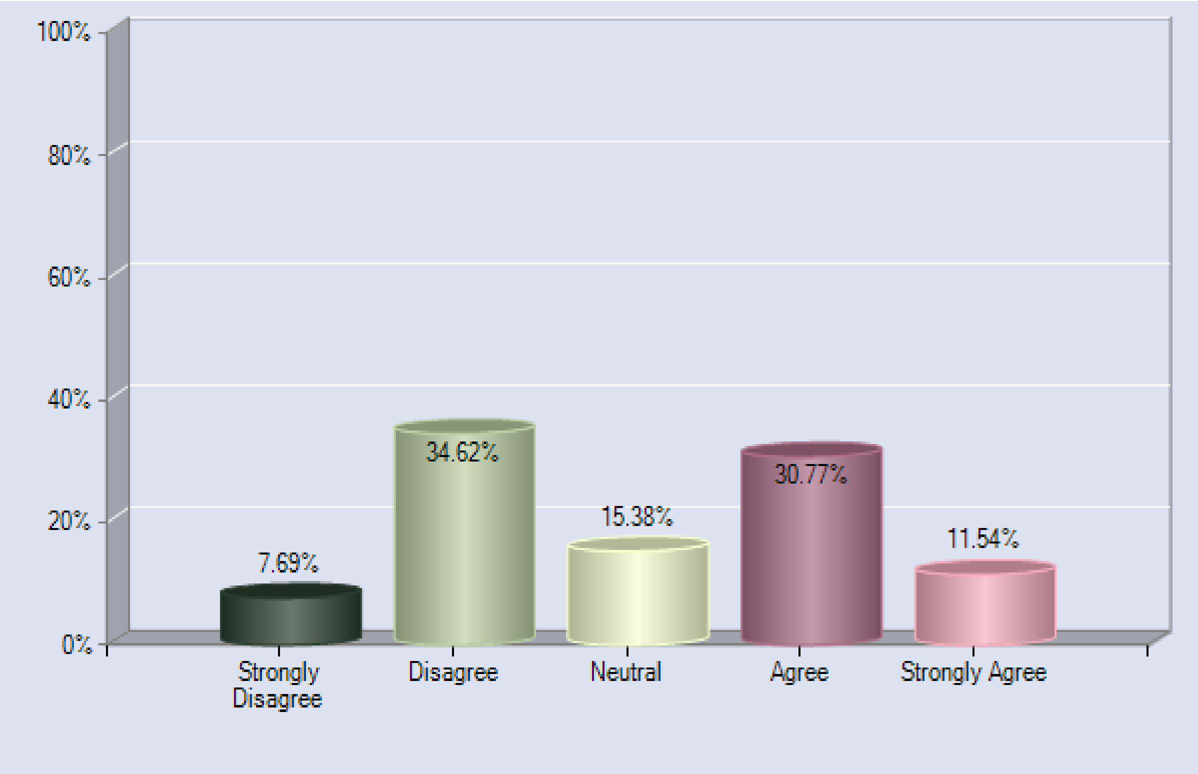



As depicted in Figure 4.6 above, most of the participants (36.54% disagreeing and 5.77% strongly disagreeing) did not agree to their ability to calculate ratios as a result of mathematical numeracy. The participants who agreed that mathematical numeracy enabled them to calculate ratios were 28.85% (agreeing) and 13.46 (strongly agreeing), summing up to 42.31%. Those who remained neutral were 15.38%. This outcome therefore suggests that majority of the trainees are indifferent about the relationship between numeracy and ratio calculation and analysis.

Steen (2001) suggests that emphasis should be put on numeracy than mathematic by drawing a distinction, arguing that mathematics requires a distancing from context. Numeracy (quantitative literacy), on the other hand, is anchored in real data which reflect engagement with life's diverse contexts and situations. Numeracy offers solutions to problems about real situations. There is a growing understanding of how mathematical knowledge is used in real situations of life and work, to which the present research is a contribution. Following Bernstein (2000), it is argued that the use of common sense, of relatively little value in formal mathematics, is essential in numeracy.

**4.4.4 I am able to collect, interpret and present the data clearly.**

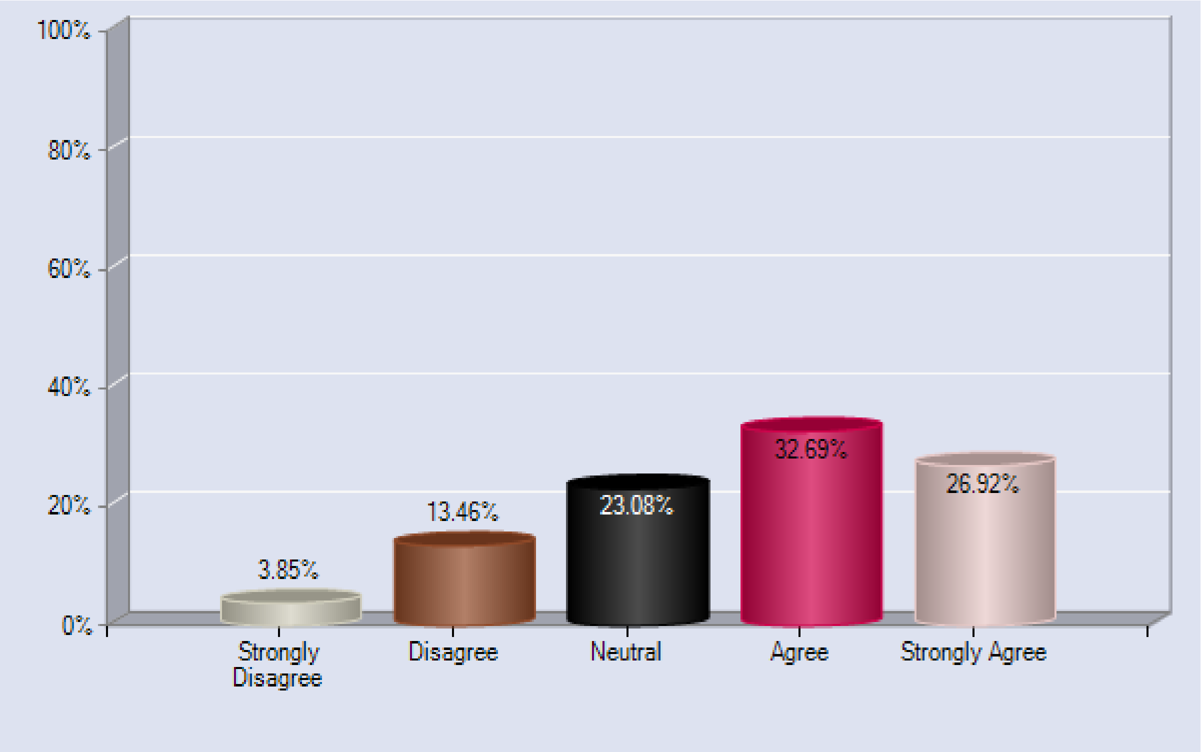
**Figure 4.7 Ability to collect, interpret and present the data clearly**




As seen from figure 4.8 above, 42.31% respondents agreed (34.62% and 7.69%) that they are able to collect, interpret and present the data clearly. Out of the balance, 15.38% did not say as the other 42.31% agreed that they are able to collect, interpret and present the data clearly. Again, it can be further noted that collection, interpretation and presentation of data remains a critical component in the manufacturing sector. Kataria and Garg (2013:67), highlight that internal statistical communication serves as a catalyst for production/manufacturing firms to reach their goals and objectives by creating a communication culture within the business. This is characterised by a two-way flow of information that moves information from the top to the bottom and then moves feedback back up to the top (Bockerman & Laukkenen, 2010:27).

### 4.4.5 I have the ability to choose the correct method to present my data

**Figure 4.8 I have the ability to choose the correct method to present my data**




According to Figure 4.8 above, 26, 92% strongly agreed as 32.69% just agreed to the assertion that they have the ability to choose the correct method to present data. However, 23.08% maintained neutral whilst only 17.31% did not agree to the assertion. This outcome therefore leads to the conclusion that most of the employees become able to choose the appropriate method of data presentation after mathematical training facilitated by Optimal Learning.

## 4.5 Section C: Influence of mathematical literacy on workplace performance by learners

This section sort to address the second objective of the study which sought to ascertain the influence of mathematical literacy on workplace performance by learners.

### 4.5.1 My time management and timetables preparation has improved.

**Figure 4.9 Improvement of time management and timetables preparation**

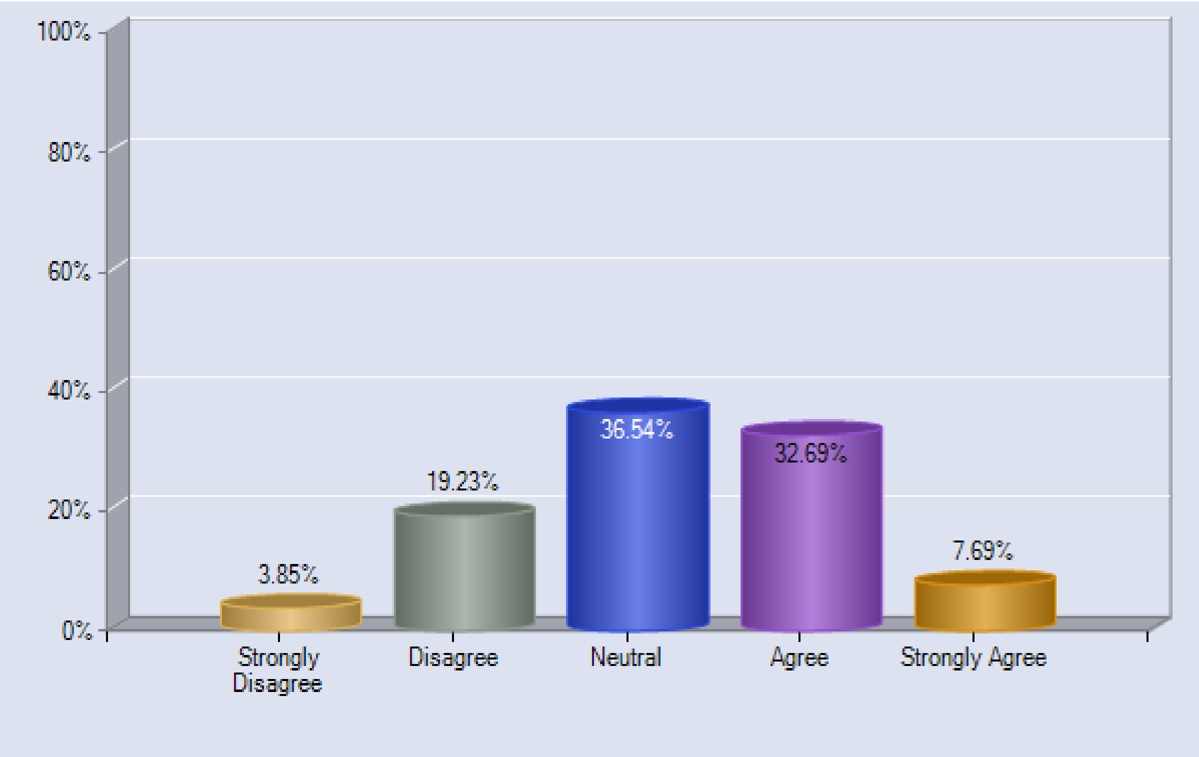
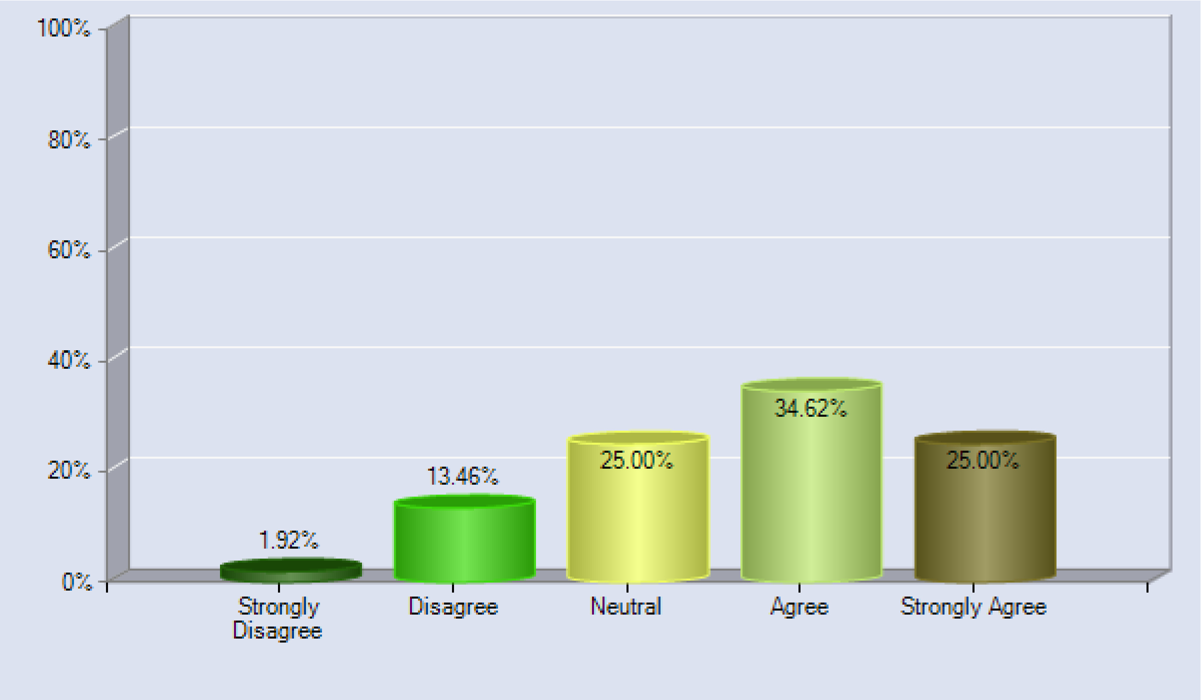



Figure 4.9 above shows the improvement of time management and timetables preparation after mathematical literacy training. The largest percentage of respondents (40.38%) agreed that the mathematical training services provided within the work context has significantly improved their management of time. Wellness Program are relevant to needs and expectations of employees. Only 3.85 and 19.23% strongly disagreed and disagreed respectively to the statement of time management improvement whilst 36.54% remained neutral over the matter. This position of outcome implies that most of manufacturing employees improve in time management after some mathematical literacy training offered by Optimum Training.

**4.5.2 My monthly reports preparation time has improved.**

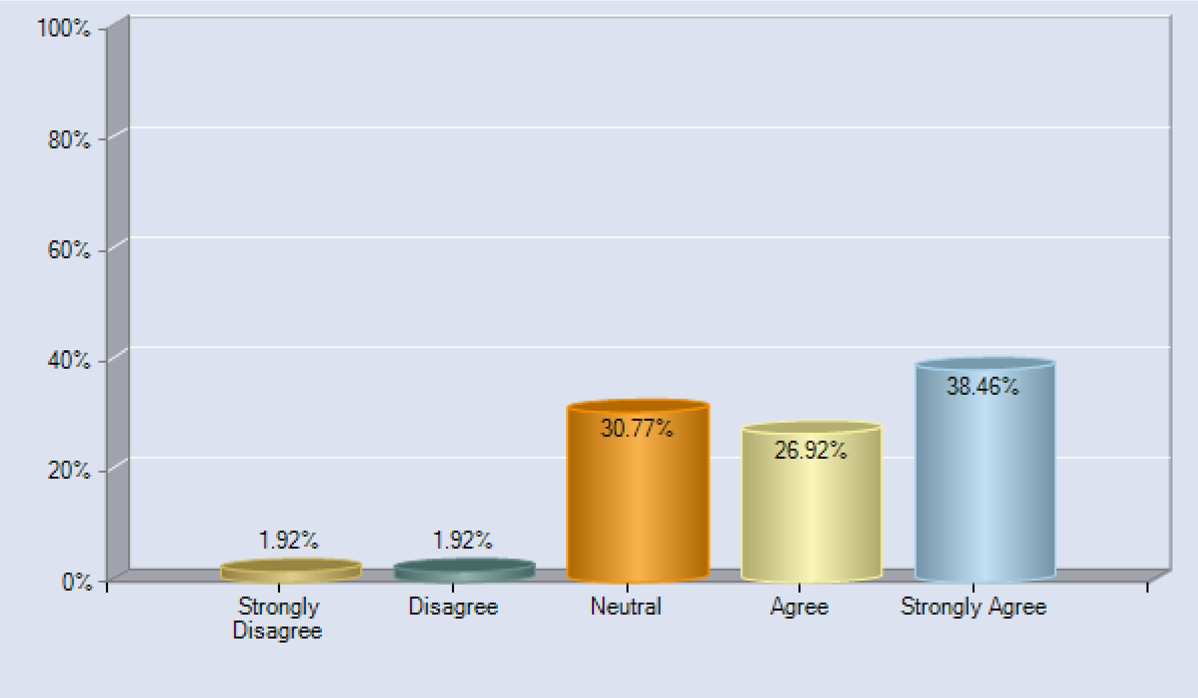
**Figure 4.10 Improvement of monthly reports**




The quality of monthly reports and the preparation time required rating as indicated in figure 4.10 above shows that 34.68% agreed whilst 25% strongly agreed, hence 59.62% in aggregate. However, 25% of the respondents remained neutral about their rating as the remaining 1.92% and 13.46% strongly disagreed and agreed respectively. However, Guqaba (2012:18) warns against complacency on an achieved point as it is the role of leadership to persuade strategic learning as part of encouraging the people and of course the organisation to deal with tensions that could prevent or constrain effective alignment between strategy and the environment, strategy and the organisation, leadership and the organisation, and between key people in the organisation. In situations where the external environment is rapidly changing, organisations must be able to adapt their strategies and alignment, exhibiting organisational fitness, based on leadership-inspired strategic learning to rejuvenate the organisation by reshaping its design, culture, and political landscape (Cascio & Boudreau, 2010:297).

### 4.5.3 Understanding calculation behind the set target helped in achieving it all the time.

**Figure 4.11 Understanding calculation behind the set target**

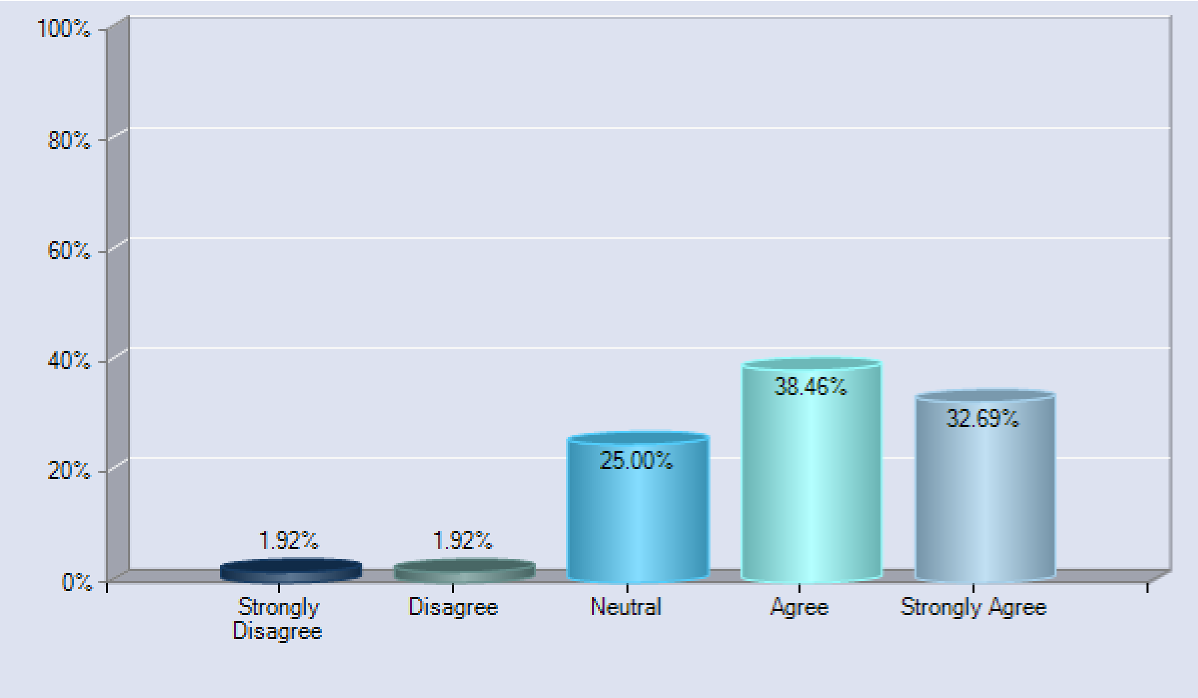



This question aimed at establishing respondents' perception on whether understanding the calculations behind the set target helped in achieving desired outcome all the time. As shown on Figure 4.11, the results depict 65.38% (26.92% agreed and 38.46% strongly agreed) of the respondents agreed that the understanding the calculations behind the set target helped in achieving desired outcome all the time. A significant 30.77% of the respondents decided to be neutral as a uniform 1.92% disagreed and disagreed to the assertion.

This result is in keeping with Preedy (2012:168-169), believes that it is significant for employees to be supported by management at all levels. Senior managers must operationalize the program by implementing strategies such as facilitating employees to have basic numeracy trainings and periodic workshops. Chartier (2011:43) adds on by stating that it is essential that all management levels show the importance of the training and upgrading programs.

**4.5.4: I am able to convert sales forecast to production/operations plan within reasonable time to get required resources for implementation**

**Figure 4.12 conversion of sales forecast to production/operations plan within reasonable time.**



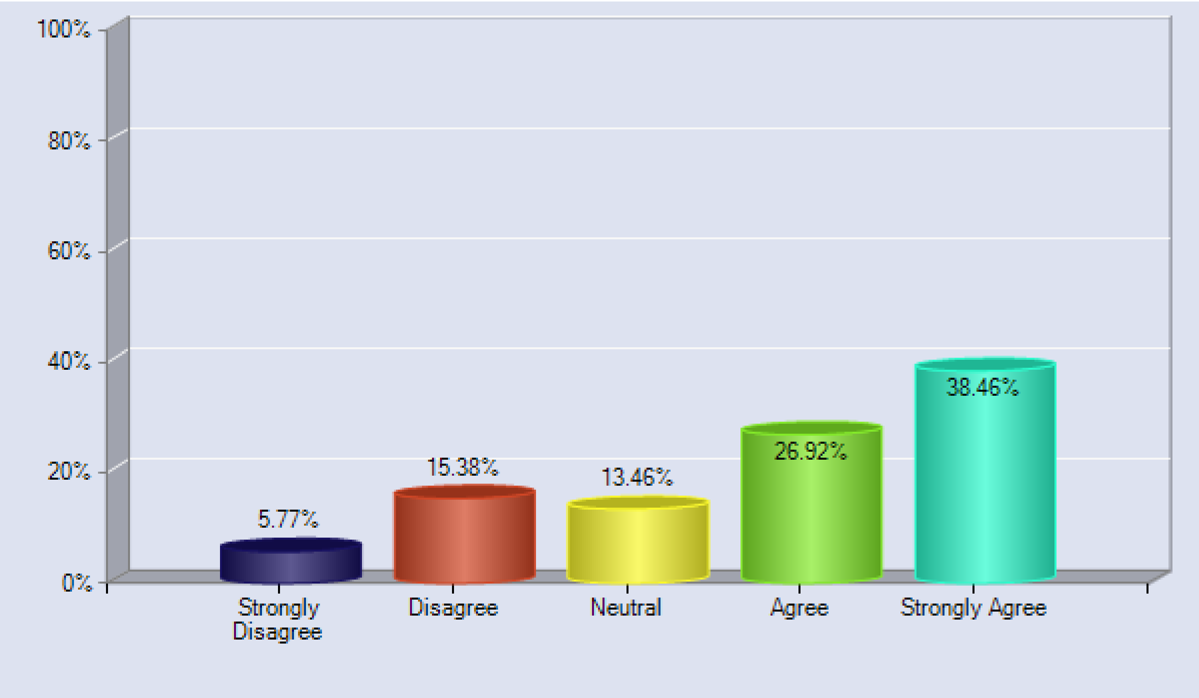

This question sought to establish whether the manufacturing industry employees are able to convert sales forecast to production/operations plan within reasonable time to get required resources for implementation. Figure 4.12 indicates 38.46% agreed as 32.69% strongly agreed, giving an aggregate 71.15% of respondents who agreed to the statement. One quota (25%) of the respondents chose to be neutral whilst only approximately 4% disagreed to the statement. This is a clear indication that the training of mathematical literacy increase employee ability to convert sales forecast to production/operations plan within reasonable time to get required resources for implementation (Powell, 2014:42)..

### 4.6 Section D: Ease of knowledge/skills conversion into practicality/application to real work environment after numeracy learning

In this section, the third objective was addressed. The objective aimed to evaluate the ease of knowledge/skills conversion into practicality/application to real work environment after numeracy learning.

#### 4.6.1 Mathematics training/course is applicable to my workplace

**Figure 4.13 Mathematics training/course is applicability to workplace**




The findings in Figure 4.13 shows a total of 26.92% agreed and 38.46% strongly agreed that mathematical training knowledge/skills learned are applicable to the concerned workplace environment after numeracy learning. A total of respondents 5.77% strongly disagreed while 15.38% (aggregating 21.15%) disagreed to the assertion. 13.46% were neutral in their responses. This is evident that mathematics training/course is easily applicable to workplace by training recipients.

The study by Henke *et al*. (2011:19) supports this outcome by mentioning that an expanded purview requires training and development competencies for developing and supporting the organization's human resource strategy. These involve acquiring and deploying talent and assuring that it supports the organization ' s general strategy, identifying system-wide performance gaps, deploying integrated learning systems, and evaluation of learning impacts to address key business drivers via organizational metrics (Arnesen et al., 2013 ).

**4.6.2 Mathematics training/course is influential enough that I can be able to transfer knowledge and skills gained into my respective workplace.**

**Figure 4.14 KNOWLEDGE TRANSFEREBILITY**

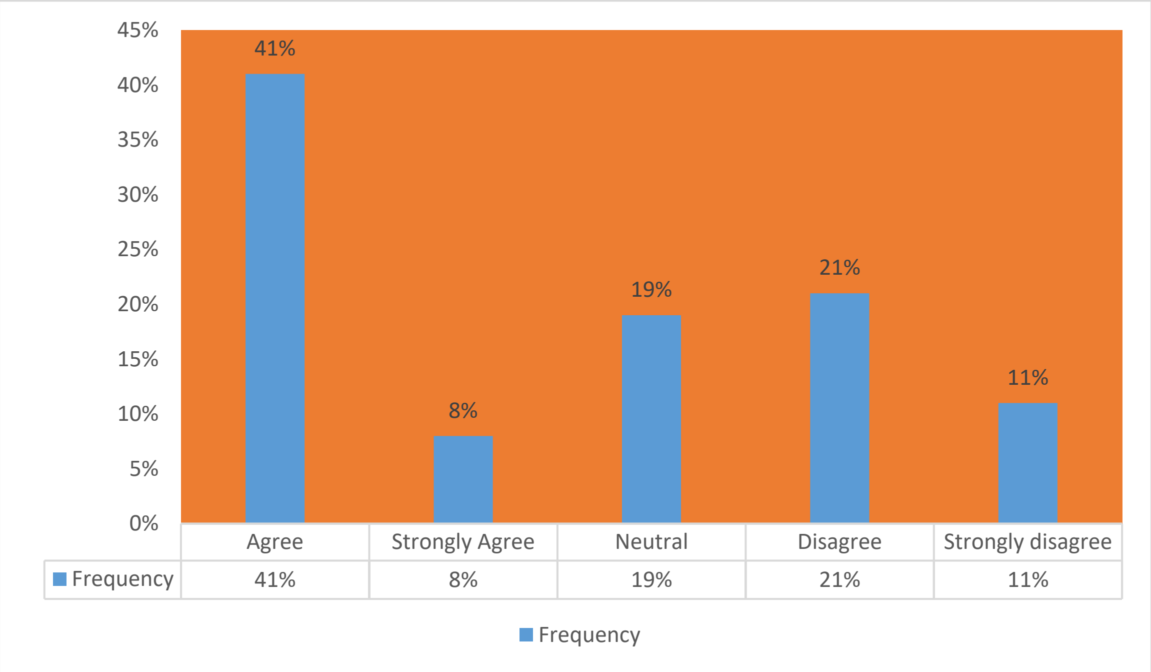



Figure 4.14 highlights that 41% agreed whilst 8% agreed with the statement that mathematics training/course is influential enough that I can be able to transfer knowledge and skills gained into my respective workplace. About 21% of the respondents disagreed as the remaining 11% strongly disagreed to mathematics training/course as being influential enough that one can be able to transfer knowledge and skills gained into respective workplace. Almost another 19% of the respondents neither agreed nor disagreed.

The literature by Bother (2015) suggests that while the ability to read documents, extract information, communicate in writing, and perform basic numerical operations are clearly required, as a minimum, in non-manual 'office jobs', they are increasingly also required in manual jobs with which employees work becomes more complex, and workers autonomy to make their own decisions. While more specific certain particular jobs but not in others, the need to have a reasonable the basic skills of literacy and numeracy has become ubiquitous (Bother, 2015:25).

### 4.6.3 Mathematics has contributed on workplace productivity improvement and personal development

### Table 4.2: Mathematics contribution on productivity improvement and employee development

| **Barrier** | | Agree | Strongly agree | Uncertain | Disagree | Strongly Disagree |
|---|---|---|---|---|---|---|
| Numeracy is the knowledge and skills required to effectively manage and respond to the mathematical demands of diverse situations. | Frequency | 51 | 26 | 19 | 32 | 4 |
| | %age | 36.64 | 20.63 | 14.39 | 24.24 | 3.03 |
| Poor numeracy imposes difficulties for functioning in all areas of life and represents a problem in the modern working world | frequency | 41 | 37 | 16 | 33 | 5 |
| | %age | 31.06 | 28.03 | 12.12 | 25 | 3.79 |
| Addressing the training needs of employees with literacy and numeracy difficulties is daunting | Frequency | 62 | 35 | 9 | 15 | 11 |
| | %age | 46.97 | 26.52 | 6.82 | 11.36 | 8.33 |
| The inability to interpret numerical information can be financially costly | Frequency | 43 | 24 | 4 | 21 | 40 |
| | %age | 32.58 | 18.18 | 3.03 | 15.91 | 30.30 |
| In the workplace, it is the ability of the individual to manage a situation or solve a problem in a real-life context using mathematics | Frequency | 29 | 43 | 8 | 32 | 20 |
| | %age | 21.97 | 32.58 | 6.06 | 24.24 | 15.15 |
| The cost of innumeracy to workplace and society in terms of bad decisions made on the basis of misunderstood math and misinterpreted risk is great | Frequency | 17 | 53 | 6 | 28 | 28 |
| | %age | 12.88 | 40.15 | 4.55 | 22.76 | 22.76 |
| Workplace numeracy, literacy and employability skills are often used in conjunction with one another | frequency | 33 | 57 | 11 | 26 | 5 |
| | %age | 25 | 43.18 | 8.33 | 19.70 | 3.79 |

Table 4.2 highlights 36.64% of respondents agreeing and 20.63% strongly agreeing to the assertion that numeracy is regarded as the knowledge and skills required to effectively manage and respond to the mathematical demands of diverse situations. However, 14.39% of the respondents were neutral as 24.24% and 3.03% disagreed and strongly disagreed respectively.

Regarding the point of poor numeracy imposing difficulties for functioning in all areas of life and representing a problem in the modern working world, 31.06% agreed as 28.03% strongly agreed. 12.12% were neutral whilst 25% and 3.79% respectively disagreed and strongly disagreed.

The third assertion sought to establish the extend of difficulties involved in addressing the training needs of employees with literacy and numeracy. As shown in table 4.2 above 46.97% agreed that the process is daunting. This was further supported by 26.52% who strongly agreed that indeed the process is straining. Only 6.82%were neutral while 11.36% disagreed. The remaining 8.33% strongly disagreed.

Next was the statement which sought to ascertain the respondents view on how costly the inability to interpret numerical information can be financially. The findings indicate that 32.58% agreeing and 18.18% strongly agreeing that the inability to interpret numerical information can be financially costly. Out of the remainder, only 3.03% were indifferent as 15.91% disagreed and 30.30%strongly disagreed.

The survey also intended to rate the opinions of respondents regarding the ability of the individual to manage a situation or solve a problem in a real-life context using mathematics at workplace. The findings presented in table 4.3 above show 21.97% agreeing and 32.58% strongly agreeing, with 6.06% lying in-between with a neutral stance. The balance of 39.39% was split as 24.24% disagreeing and 15.15% strongly disagreeing.

The sixth item established whether the cost of innumeracy to workplace and society in terms of bad decisions made based on misunderstood math and misinterpreted risk is great. Findings in table 4.3 above highlight that 12.88%and 40.15% agreed and strongly agreed in the order given. However, some 22.76% disagreed and another 22.76% strongly disagreed, as only 4.55% remained neutral.

The last element of the research instrument surveyed whether workplace numeracy, literacy and employability skills are often used in conjunction with one another. As depicted in table 4.2 above, 25% agreed and 43.18% strongly agreed that workplace numeracy, literacy and employability skills are often used in conjunction with one another. Some 8.33% disagreed as 19.70% strongly disagreed to the statement of linking workplace numeracy, literacy and employability skills. The remaining 3.79% were neutral. This leads to the conclusion that workplace numeracy, literacy and employability skills are often used in conjunction with one another as the majority (68.18%) affirmed so.

### 4.7 Conclusion

This chapter presented the results of the study findings. The results reveal that a majority of the respondents acknowledge the positive impact mathematics training has on learner's ability to interpret statistical information. The study also indicate that the influence of mathematical literacy on workplace performance by learners is significant. The study also reveal that majority of the respondents believe that Optimum Training should further contextualize their training to work environments for ease of knowledge/skills conversion into practicality/application to real work environment after numeracy learning. The next chapter will presents the conclusions and recommendations of the study.

# CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

## 5.1 Introduction

This chapter summarises the research findings. The chapter also discusses the conclusions, which will be based on the problem statement, aim of the research, research objectives and questions. The chapter will also outline recommendation on how strategies that can be considered and adopted by Optimum learning in order to improve mathematical numeracy for improved productivity.

## 5.2 Findings from the Study

### 5.2.1 Findings from the Literature Review

The cost of innumeracy to society in terms of bad decisions made on the basis of misunderstood mathematics and misinterpreted risk is great. A 2005 study by Sackney et al (2012), found that 42% of adult Canadians have literacy and numeracy skills below the level necessary to succeed in society and economy, exerting a negative influence on the overall GDP per capita. Higher levels of literacy and numeracy, on the other hand, can increase employment while cutting debt and dependence on welfare and public health services. Statistics Canada estimates that a 1% increase in average literacy and numeracy skills would raise GDP per capita by 1.5%, and labour productivity by 2.5%. A lack of employee literacy and numeracy skills is also of particular concern for businesses, costing employers $4 billion per year and $10 billion for the nation as a whole.

Societies inherently reward higher literacy. The assumption that better educated people have superior literacy and numeracy skills garners little disagreement. In fact, there is an expectation by employers that higher education graduates will possess high literacy and numeracy skills along with a high level of academic achievement. Those who are marginal to the labour market, however, such as the longer term unemployed, tend to have more significant problems in these areas.

At each level of competency an average employee can expect to earn more than someone the next step down the ladder. On the other hand, poor numeracy can reduce employment opportunities, affect career progress and equity and cause overdependence on experts and professionals. Productivity is also affected when employees are unwilling or slow to take on new tasks or to get involved in training either because of a lack of understanding or fear of math-related skills required. These related inequalities do not only affect earnings but can heavily influence work related and personal spending and investment decisions.

## 5.3 Findings from the Primary Data

The first research question sort to address whether mathematics training improve learners' ability to interpret statistical information. The findings confirm that indeed mathematical training improves the ability of learners as highlighted by enhanced ability to create graphs and tables for data presentation; improved understanding capacity scheduling; ratio analysis and interpretation; and ability to choose the correct method of data presentation.

This concurs with literature where authors like Steen (2001) suggests that quantitative literacy (numeracy), offers solutions to problems about real situations. Kataria and Garg (2013:67), highlight that internal statistical communication serves as a catalyst for production/manufacturing firms to reach their goals and objectives by creating a communication culture within the business.

The second research question deliberated on whether mathematics training is influential enough to affect the learners' performance on respective workplace. Again the research findings indicate a positive outcome that mathematics training is influential enough to affect the learners' performance on respective workplace. However, Guqaba (2012:18) warns against complacency on an achieved point as it is the role of leadership to persuade strategic learning as part of encouraging the people and of course the organisation to deal with tensions that could prevent or constrain effective alignment between strategy and the environment, strategy and the organisation, leadership and the organisation, and between key people in the organisation.

The third research question addressed the easy is conversion of learnt skills into practicality/application given real workplace environment for improved organizational performance by learners after training. General findings show that employees gain increased ability of the individual to manage a situation or solve a problem in a real-life context using mathematics at workplace.

### 5.4 Conclusions

The study evaluated the impact of mathematical skills development provided to manufacturing staff by Optimum Learning Technologies in order to establish whether the programs offered by the organisation are adequate and precise to implementation concerning the influence of mathematical literacy on workplace performance by learners/employees. This included investigating into the challenges facing the organisation concerning the employee's numeracy learning curve and to determine the impact of these challenges to provide probable practical recommendations on ways to which effectiveness of mathematical skills training programs can be accomplished. Many issues that affect the effectiveness of training and learning are unique to the developing world. Training managers in developing countries like SA therefore have to develop strategies that take into account the macro-environmental factors. Below is a summary of the conclusion of this study;

- Rapidly growing technological advances are making the need for numeracy skills more critical within the workplace. With greater numbers of workers engaging in more sophisticated tasks, numeracy is recognised as an essential employability skill. Also, it has been acknowledged as a potential employment equity issue, as adults with poor numeracy skills are more likely to have relatively low work positions with fewer promotion prospects and lower wages.

- Numeracy is the knowledge and skills required to effectively manage and respond to the mathematical demands of diverse situations. It involves developing confidence and competence with logic and reasoning, and requires an understanding of how data are gathered and presented in diagrams, graphs, tables and charts.

- While numeracy involves all dimensions of mathematics and is the type of skill needed to function in everyday life, it is more than just numbers. Innumeracy is considered the mathematical counterpart of illiteracy and is a socially based activity, as it requires the ability to integrate math and communication skills. It is intricately linked to language, as words are the tools for translating numerical code and giving it meaning.

- In the workplace, it is the ability of the individual to manage a situation or solve a problem in a real-life context using mathematics. The consequences of innumeracy are not as visible or obvious as those of illiteracy are, and appear more socially acceptable and tolerated. Innumeracy tends to affect people who are both intelligent and well educated unlike illiteracy which mostly affects the uneducated.

- Workplace numeracy, literacy and employability skills are often used in conjunction with one another. The required skills often overlap and are necessary for any task, for example, completing a job might entail gathering and analysing information; using number or mathematical skills; reporting; using computers; working within a team setting; and possibly demonstrating some initiative.

- Many occupations use numeracy that requires accuracy in the actual job tasks and capability in the language, by use of appropriate terminology and industry-related jargon. Explanation, elaboration and analysis, for example, are frequently presented along with numbers. As such, there is a language challenge that needs to be considered in numeracy tasks. Other numeracy issues that arise in the workplace can include too much reliance on calculators for simple mathematical tasks, inappropriate language used in email correspondence and fear of giving presentations due to a lack of communication skills. A very small part of the mathematical activities in workplaces actually count as visible numeracy.

- The inability to interpret numerical information can be financially costly, can limit full citizen or employee participation and result in economic manipulation. Like people with low levels of literacy, those lacking numeracy skills sometimes manage to avoid using math, relying on social support networks and coping tricks adapted to their environment. With modern technology, being saturated by numbers and advancing exponentially, the mathematical skills and understanding needed to fulfil a job function has become more invisible. But although technology has allowed organizational demands for mathematical skills to decrease, the importance and need for mathematical understanding is increasing.

- Although the numeracy skills are adapted to specific strategies for each industry, they tend to be based on an underpinning of skills developed through a range of prior learning experiences and, in many cases, transferred between workplaces and life situations. Numeracy is not a skill or fixed entity that can be earned. Instead, people's skills are situated along a continuum of different purposes and levels of accomplishment with numbers.

- While poor numeracy imposes difficulties for functioning in all areas of life and represents a problem in the modern working world, targeting these skills is likely to be a particularly important solution to the risk of employability. Employees need to be proficient in the basics of numeracy to be able to fully participate in the workforce and further education and training opportunities. Raising the levels of these skills are vital and will lead to a more flexible, skilled and adaptable workforce, increased productivity and a competitive edge for businesses. Workplace projects will have a very positive effect by improving communication, and employees' ability to complete workplace documentation, as well as reduced workplace errors and absenteeism, and improved staff retention and quality.

## 5.5 Recommendations

- In light of the rapidly growing technological advances which are making the need for numeracy skills more critical within the workplace, it is suggested that Optimum Learning must introduce continuous training programs where they make follow up refresher and upgrading training workshops in order to match up with technological changes. Focus must be put on reengagements of prior trainees that just concentrating on first timer trainees.

- Since numeracy involves developing confidence and competence with logic and reasoning, it is recommended that Optimum Training should prepare the training material and content in a context which promotes creative and inductive critical thinking than just a numeric answer orienting approach. The skills imparted to the trainees should be generalizable to every problem requiring solution in the real world set up skills required to effectively manage and respond to the mathematical demands of diverse situations. .

- While numeracy involves all dimensions of mathematics and is the type of skill needed to function in everyday life, it is more than just numbers. Innumeracy is considered the mathematical counterpart of illiteracy and is a socially based activity, as it requires the ability to integrate math and communication skills. It is intricately linked to language, as words are the tools for translating numerical code and giving it meaning. Therefore, it is recommended that Optimum learning should consider synchronisation of mumeric,communicative and managerial elements in the mathematical training numeracy

- It is also recommended that optimum Learning launch numeracy awareness campaigns in collaboration with institutions of higher learning like universities so as to close the gap of literate graduates who are not numerate since numeracy is the ability of the individual to manage a situation or solve a problem in a real-life context using mathematics.

- In view of the collaboration between workplace numeracy, literacy and employability skills, it is hereby recommended that Optimal learning do blend the mathematical aspect with other commercial modules such as business analysis and informatics as business cycle processes often overlap and are necessary for any task which compliments the other.

- In light of the growing importance and need for mathematical understanding, Optimum Learning is to expand its geographical sphere to other parts of the country than just one province of such a big nation like South Africa. This allows for reduced financial cost emanating from ignorance and genuine unawareness to the presence of innumeracy.

- It is also recommended that optimum learning design their curricula in a way inclined to industrial attachment than conventional schooling. Although the numeracy skills are adapted to specific strategies for each industry, they tend to be based on an underpinning of skills developed through a range of prior learning experiences and, in many cases, transferred between workplaces and life situations. Numeracy is not a skill or fixed entity that can be earned. Instead, people's skills are situated along a continuum of different purposes and levels of accomplishment with numbers.

### 5.6 Area(s) for further Research

This research on learning numeracy in the workplace has identified a gap in the literature, which needs further development. The literature review identified research on mathematical/numerical skills used on the workplace, how it might be taught in formal educational institutions, and general literature on workplace learning. However, there has been little attention until now focused on how numeracy is learned in the workplace, taking into account the complex issues which surround apparently simple calculations, and the importance of social, cultural, and historical contexts. Similarly, research is also needed for the further development of vocational teacher/training education in relation to workplace numeracy.

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## Appendix A: PERMISSION LETTER

**Mike Davies**
To
Nokubonga Mkhize
Apr 21 at 2:51 PM

***To whom it may concern***

*I hereby give permission to Nokubonga Mkhize to use and have access to the learners and relevant data as required by her thesis of Optimum Learning Technologies.*

*Yours faithfully*

*Michael J. Davies*
*Director*

**MICHAEL DAVIES** | Director

Unit 3A, 41 Brand Road, Glenwood, Durban, 4001
**C:** (083) 309 0572 **T:** (031) 202 9436 **F:** (086) 660 0941

## Appendix B: LETTER TO THE PARTICIPANTS

**UNIVERSITY OF KWAZULU-NATAL**
**GRADUATE SCHOOL OF BUSINESS AND LEADERSHIP**

Dear Respondent,

**MBA Research Project**
**Researcher**: Nokubonga Mkhize (0794940743)
**Supervisor**: Dr Rosemary Sibanda (031-2601479)
**Research Office**: Ms P Ximba 031-2603587

I, Nokubonga Mkhize an MBA student, at the Graduate School of Business and Leadership, of the University of KwaZulu Natal invites you to participate in a research project entitled **"Investigating the impact of mathematical skills development provided to manufacturing staff by Optimum Learning Technologies"**. The aim of this study is to assess numeracy literate level of the learners and measure the results based on daily activities.

Through your participation, I hope to understand the impact of mathematical skills development within manufacturing environment. The results of the survey are intended to contribute to gap identification, which will lead to counter-measures to ensure the positive contribution of the outcome based/ adult learning mathematics.

Your participation in this project is voluntary. You may refuse to participate or withdraw from the project at any time with no negative consequence. There will be no monetary gain from participating in this survey. Confidentiality and anonymity of records identifying you as a participant will be maintained by the Graduate School of Business and Leadership, UKZN.

If you have any questions or concerns about completing the questionnaire or about participating in this study, you may contact me or my supervisor at the numbers listed above.

The survey should take you about 10 minutes to complete. I hope you will take the time to complete this survey.

Sincerely

Investigator's signature___________________________________
Date_________________

**CONSENT FORM**

I…………………………………………………………………………… (full names of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project.
I understand that I am at liberty to withdraw from the project at any time, should I so desire.

SIGNATURE OF PARTICIPANT DATE

…………………………………………………………………………………………………

## Appendix C: RESEARCH INSTRUMENT

**Research Questionnaire**

**Investigating the impact of mathematical skills development provided to manufacturing staff by Optimum Learning Technologies.**

Please note that your information is and will remain anonymous

Please indicate your choice by ticking in the correct box

| **Section A Biographical data** | |
|---|---|
| Age | |
| 18-29 | |
| 30-39 | |
| 40-55 | |
| > 50 | |
| Race | |
| African | |
| White | |
| Indian | |
| Coloured | |
| Gender | |
| Male | |
| Female | |
| Qualification | |
| Metric | |
| Certificate | |
| Diploma | |
| Degree | |
| Postgraduate Diploma/Degree | |
| Position held in the organisational hierarchy | |
| Operative | |
| Supervisory | |

| | |
|---|---|
| Middle management | |
| Executive management | |

**Section B: Mathematics training improves learner's ability to interpret statistical information**

| | Strongly Agree (5) | Agree (4) | Neutral (3) | Disagree (2) | Strongly Disagree (1) |
|---|---|---|---|---|---|
| I am able to create graphs and tables for data presentation | | | | | |
| I understand calculation behind capacity scheduling | | | | | |
| I am able to calculate ratios | | | | | |
| I am able to collect, interpret and present the data clearly. | | | | | |
| I have the ability to choose the correct method to present my data | | | | | |

**Section C: influence of mathematical literacy on workplace performance by learners**

| | Strongly Agree (5) | Agree (4) | Neutral (3) | Disagree (2) | Strongly Disagree (1) |
|---|---|---|---|---|---|
| My time management and timetables preparation has improved. | | | | | |
| My monthly reports preparation time has improved. | | | | | |
| Understanding calculation behind the set target helped in achieving it all the time. | | | | | |
| I am able to convert sales forecast to production/operations plan within reasonable time to get required resources for implementation. | | | | | |

**Section D: Ease of knowledge/skills conversion into practicality/application to real work environment after numeracy learning**

| | Strongly Agree (5) | Agree (4) | Neutral (3) | Disagree (2) | Strongly Disagree (1) |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| Mathematics training/course is applicable to my workplace. | | | | | |
| Mathematics training/course is influential enough that I can be able to transfer knowledge and skills gained into my respective workplace. | | | | | |
| Mathematics has contributed on productivity improvement in my workplace. | | | | | |
| I have used statistical data in my workplace to make decisions. | | | | | |
| Meeting time for my team have been reduced since some or all of us attended mathematics training. | | | | | |
| I am able to read performance graphs and tables and take action where necessary | | | | | |

Thank you for participating.

Please do let me know if I still need to put more effort on this