

CHAPTER 7

SUMMARY OF THE RESULTS OF THE EMPIRICAL INVESTIGATION, CONCLUSIONS, RECOMMENDATIONS AND IMPLICATIONS

7.1 INTRODUCTION

For the reader to keep in mind what this work intends achieving, it should be remembered that the main aim of the investigation is to determine how the learning of the life sciences is facilitated (mediated) in special schools for visually impaired learners and to establish how the lessons learnt from this experience could be implemented to the advantage of these learners in the Senior Phase and Further Education and Training Band and in Outcomes-based education settings.

The purpose of this chapter is in the first place to summarise for the reader the main findings that emerged from the literature survey and the empirical investigation. This is followed by the recommendations which apply to the investigation as well as the implication of such recommendations to theory and practice. The limitations of the investigation as well as possible future research are also listed in this chapter.

To achieve the aim listed above, the following objectives were envisaged for the study, as outlined in paragraph 1.4.2, chapter one of this thesis.

- ❑ To determine how their lack of visual ability during the learning mediation of biology and other life sciences impacts on blind learners, life science educators, special schools and Outcomes-based education itself.
- ❑ To assess whether the present teaching of blind learners in special schools is in line with the Outcomes-based Education policy and to determine whether educators are achieving the learning outcomes specified for the teaching of the life sciences.
- ❑ To determine (assess) the outcomes specified for the teaching of the life sciences/biology in secondary schools in terms of the revised national curriculum statements.
- ❑ To examine the characteristics (substance and syntax) of the life sciences/biology as a subject and to use these characteristics as criteria for the selection of appropriate learning mediation strategies.
- ❑ To evaluate existing learning mediation strategies and methods for the life sciences against the outlined national curriculum statements and to determine to what extent these strategies and methods are being met by educators in special schools.
- ❑ To determine whether and how visually impaired learners achieve the learning outcomes specified for the life sciences/biology and establish which variables restrict effective teaching and learning in the life sciences/biology classroom.
- ❑ To apply and assess the findings regarding the mediation of the life sciences/biology in special schools to the practices and strategies proposed for the mediation of learning in the life sciences/biology in inclusive educational settings.

From the data collected and analysed, it appears that the mediation of life sciences to blind learners in special schools is difficult regardless of the resources available and the varied expertise their educators may have. One's motivation for this claim will be justified in the paragraphs to follow. Placing blind learners at inclusive schools presently has serious implications for the teaching/learning environment. Perhaps these implications could be an option to be considered in future, after the socio-economic impact of the policy has been tested and taken into consideration. The problem of not effectively mediating learning to blind learners and the failure in not rendering adequate services could be attributed to the fact, as Yoken (1979:iii) puts it, "...(t)hat we have barely scratched the surface in serving disabled individuals". Blind learners in South Africa who are studying life sciences are marginalised from many educational activities and will remain in this position unless and until something to correct the existing trend is done to alleviate their plight. The problem is further complicated by the fact that not enough research into the mediation of life sciences to blind learners is conducted.

To bring a halt to the unfavourable learning mediation conditions that blind learners experience, and to their marginalisation from the life sciences, proper solutions are urgently required. Governmental and non-governmental organisations need to expand their efforts in these and other areas discussed in this report:

- ❑ Research;
- ❑ Educational services;
- ❑ Employment services/opportunities; and
- ❑ Public awareness.

7.2 SYNOPSIS OF THE STUDY

In this study, the researcher elucidated the roles of special schools regarding the mediation of life sciences and lessons learnt towards establishing an inclusive education policy for the Outcomes-based classroom. The study further considered how the researcher intended addressing the problem of properly mediating and accommodating blind learners in biology learning mediation classes.

The research provided a framework for developing, facilitating and providing a qualitative, accommodative and supportive education system. Such a system will only become possible when all stakeholders take into consideration the guidelines proposed in this study and the suggested techniques or strategies for accommodating and mediating learning to blind learners. Proposed guidelines and listed techniques and strategies are essential for improving education settings and the curriculum.

The study has investigated the learning mediation of biology to blind and visually impaired learners, and made recommendations regarding aspects of the mediation and adaptation of biology as a subject. The learning mediation strategies for the blind and visually impaired learners have been dealt with in chapter four of this thesis. A report on the findings of this work is presented and entails advice, mediation challenges, curriculum challenges, adaptation challenges, needs and concerns.

This investigation was guided by the following research hypotheses, as outlined in paragraph 1.5 (chapter 1), which the researcher believes to be verifiable because the data collected and analyses supports them.

1. The mediators of the life sciences/biology to visually impaired learners in secondary special schools are well-acquainted with the envisaged learning outcomes to be achieved in science classrooms but rely heavily on the transmission of information as delivery mode, as opposed to investigative and inquiry teaching strategies, mainly because of the lack of visual ability of learners and inadequate resources.
2. Visually impaired life sciences/biology learners rely heavily on instructional support mechanisms as principles for effective teaching and learning in the science classroom but these conditions are not met because of the lack of resources and of the necessary financial and logistical support in special and inclusive schools.
3. Life science and biology educators apply creative and innovative learning mediation strategies in special schools for the blind and visually impaired learners.
4. Educators responsible for the mediation of biology and life sciences in special schools for the blind are fully equipped to optimise the potential of their learners in terms of the requirements put forward by the outcomes for biology and the life sciences in an Outcomes-based learning environment.

Furthermore, the study by means of qualitative data collection techniques and strategies sought for a better understanding of whether life sciences possess the potential to improve the quality of learning for blind learners. The researcher further verified that everyone (blind and visually impaired learners included) enjoys the right to education, which the State through reasonable measures should make progressively available and accessible.

The “truths” sought, include the question whether the four learning outcomes discussed in chapters 5 and 6 are achievable by blind learners. The Education White Paper 6 (2001:30) depicts education as accommodative, flexible and accessible to all learners, regardless of the nature of their learning needs. The study revealed that the biology curriculum created the most significant barrier to learning in terms of the exclusion of many blind and visually impaired learners, especially regarding experiments/observations, tabulations, acquisition of science process skills in the absence of visual ability and adapted equipment, acquisition of information in the absence of accessible learning mediation materials, et cetera.

Additional barriers to the learning mediation of biology seem to be stemming from each of the following:

- The content of the learning mediation programmes;
- Poor management or organisation of learning mediation classes;
- Negative perceptions that some educators still hold towards the blind and visually impaired: that they cannot cope with biology since they lack visual ability;
- Inappropriate mediation style and pace of educators;
- Rigid timeframes for the completion of the biology syllabus;
- Inadequate methods and techniques of assessment; and so on.

One further observed that certain barriers arose from the facts that:

- ❑ Blind and visually impaired learners experience difficulties in applying science process skills because of their lack of vision, of confidence, and a lack of motivation from among educators, and so forth.
- ❑ Tabulation remains a problem to blind learners and during the investigation, it was revealed that learners were given “ready made” material and not taught how to draw.
- ❑ Many educators engage their blind learners very seldom in practical work, field trips or related activities. This observation is supported by some educators who participated in the focus group interviews.
- ❑ One gained the impression that the practical activities in which blind learners were involved were limited to very simple and elementary exercises that called for minimal intellectual challenges or few advanced problem solving skills.
- ❑ In his conversations with learners, the researcher formed the impression that very few of them had access to subject-related information, with specific reference to computers, encyclopedias and recent publications. This was confirmed during the follow up interviews.
- ❑ Many educators indicated that they adapted the traditional facilitation strategies (such as demonstrations) to enhance learning for the blind learners. The learners, on the other hand, indicated that many of the activities relied heavily on a “tell and talk” strategy.
- ❑ It seems educators at special schools do not attend, or are not invited to, workshops where the developments in adapted learning facilitation mechanisms are shared.
- ❑ At some schools, learners did not follow a cooperative learning strategy because the totally blind and partially sighted learners were in separate classes.
- ❑ The researcher also gained the impression that not much is done by educators to stimulate and develop the senses of blind learners during the teaching of the life sciences.
- ❑ Finally, he further observed that certain barriers arose from the physical and the psycho-social environments within which mediation of learning occurs.

7.2.1 FINDINGS EXTRACTED FROM THE LITERATURE REVIEW

(a) Learning of biology and/or life sciences (chapter four)

Authors such as Mwamwenda (1990); Drinkwater and Niewoudt (1999); Van Wagner (1994); Fraser *et al.*, (1996); Pauw (1984a, 1990b and 1991c); Engelbrecht *et al.*, (1999); Feuerstein (2001) revealed, as discussed in chapter four (subsections 4.1.1-4.1.3), that learning is governed by the law of effect, readiness and exercise (doing/practice/experiment). When all learners learn, they successfully make or unmake connections on the basis of the subsequent results.

Various authors further argued that for learning to be effective in all respects, educators should possess competences that will encourage them to mediate knowledge and truth. As a result, all learners should be able to learn when educators present to them teachable, understandable and learnable information. Neibaur, Day and Sebastian (2002:103) argued that education is broader than the distribution of reading and study

materials. For learning to occur, there must be more than this. Communication is the part of the “more”. Learning is supported by dialoguing with the teacher and with other students.

(b) Subjects or learning areas (chapter three)

Van Aswegen *et al.*, (1993) argued, as shown in the literature reviewed (chapter three subsection 3.2), that subjects/learning areas are not complete when no substantial effort is made regarding the development of some appreciation of the structure of subjects/learning areas themselves, as these structures relate to learning mediation. The structure of the life sciences is one that is characterised by an active field of inquiry complemented by experimentation, based on principles and concepts that are subjected to modification and adaptation.

(c) Exploration, experimentation and explanation (chapters three, five and six)

The researcher found during the literature review that extensive and intensive testing, observation, evaluation, assessing, discovering, et cetera are important during the learning mediation of life sciences and must be carried out.

According to the literature reviewed, learners should possess cognitive skills so that they are able to explore, experiment, explain, infer, classify, attach meaning to information, as well as to associate various types of information with each other.

When learners are able to carry out these tasks, this will reveal to the educator an idea of:

- The basic science process skills the learner possesses;
- The learner’s interests towards the subject;
- The learner’s general attention;
- How the learner can be evaluated or assessed; and
- The progress the learner makes in that subject.

(d) Learning environments (chapter four)

It became clear from the literature reviewed that for proper, accessible, effective and accommodative learning to take place, the social and psychosocial environments have to be conducive (please refer to chapter four subsection 4.1.3). Authors such as Friend and Bursuck (1999) and Pauw (1984a, 1990b and 1991c) support this notion. Fraser *et al.*, (1996) argued that the best way to learn is when someone is aware of the demands of the task. This implies that one knows exactly what is expected of him or her. Therefore, the educator and learner’s duty will be to decide whether learning should take place, when it should take place, why it should take place and how it should be achieved.

An adequate learning environment possesses the potential to encourage the learner to allow his or her intellectual competence to guide and direct the learning processes. However, environments cannot on their own succeed in making learners learn. Learners will need appropriate learning mediation strategies, resources and support. Van Wagner (1994); Pauw (1984a and 1991c); Ball and Keller (1994) argue in support of these issues.

(e) Observation (chapter four)

Owing to lack of visual ability, blind learners find it difficult to conduct experiments or observe them. Please see chapter six; the subsections titled educators' interviews and Focus Group interviews particularly (The conduction of simple tests and surveys)

Betts (1993) and Gettys and Jacobson (2000) pointed out that most experiments/observations are visual, e.g. reading a scale or "noting a colour change". If vision plays an essential role in experiments, and while the lack of it deprives blind and visually impaired learners of those visual experiments, then the hypothesis that blind and visually impaired learners will not cope in life sciences is true.

(f) Educational Technology (chapter four)

The literature revealed that technology is indeed a force more than ever before, in the current technological era, that possesses the ability to penetrate the core of life and mind. (Please see chapter four, subsection 4.1.3 and section 4.9.) Blind learners can benefit from it in life sciences and other subjects. Owing to technology, access to information is possible and practical. Authors such as Singh and Manser (2000); Pierce (2002) and Mani (2001b) have expressed this sentiment. Abner and Lahm (2002:98) quoted Earl and Leventhal (1997a:14), who stated that "(a)ny blind person not learning Windows is severely limiting his/her job marketability."

Literature review revealed that technology enhances learning mediation for and the lives of learners with special needs and those of their educators. Technology offers fundamental support for the whole range of learners with special needs.

Additional benefits of information communications technology, according to Allen (1997:6-7), include:

- Information contained could constitute resources for educators;
- Technology enhances professional development;
- Some websites could offer ideas on teaching mechanisms;
- Some websites contain information on specific subject areas;
- Connection to the internet offers educators and learners the facility to contact their peers, regardless of location;
- The internet offers an opportunity to take information directly into schools;
- The internet allows educators and learners to share information and offer mutual support.

(g) Educator training (chapter four)

The researcher noted arguments Pauw (1984a and 1991c); Spungin (1977a); Mani (2000a); Mason (2000) and the Government Gazette, (Vol. 415 2000) that educator training is necessary for educators to understand the educational needs of learners. Furthermore, educators will be made aware of specific assistive devices used by blind learners, and so forth.

Abner and Lahm (2002:98) stated that "(t)o provide high-quality services and instruction, it is vital that certified teachers of students with visual impairments be well versed in the selection and application of

current access technology.” According to them, the following are compelling reasons for educators to develop skills in the use of microcomputers and access to technology. First, educators will be able to provide effective instruction about basic computer skills, to select and use the best access devices, and provide opportunities for the functional application of these skills. Second, educators will be able to maximise the efficient use of their time by using technology to thoroughly prepare instructional materials, maintain records, and complete other necessary paperwork. Third, such educators will be in a position to advocate the purchase of appropriate equipment for students’ use. Abner and Lahm (2002) argued further that to benefit from assistive technology, “...(s)tudents who are visually impaired must have contact with dynamic teachers who have sufficient knowledge and skills in the use of technology.” Adequately trained educators are more likely to facilitate and develop skills in their learners, as they will focus more on the outcomes of learning and the application of knowledge by their learners. Other advantages of educator training were discussed in chapter four (subsection 4.10).

(h) Modification/adaptation of learning mediation activities (chapter four)

The literature reviewed, advocated the adaptation of the various learning mediation activities, including experiments, daily lessons, and the like. According to the literature, adaptations lead to greater autonomy for learners and as a result should be robustly pursued. (Please see chapter four section 4.7.) Techniques necessary for integrating learners as well as for providing them with more meaningful experiences have to be developed. Betts (1993); Flair and Seizer (1990); Van Wagner (1994) and others, are advocates of modifications and adaptations. Flair and Seizer (1990:795-799) argued that experimental modifications leading to greater autonomy for these individuals must be pursued. This implies that techniques that can help in integrating handicapped students into science subjects must be developed.

According to proponents of modifications to learning mediation, modifying and adapting techniques is not the only answer to the problem of mediation of learning to blind and visually impaired learners. Mediating learning to such learner’s further calls for a firm grounding in a multi-sensory approach if blind and visually impaired learners are to receive positive benefits, such as being able to take part in activities related to tactile and auditory interactions. To achieve this, opportunities to manipulate and explore equipment and materials have to be provided. Furthermore, science-learning mediation involves taking risks. Blind and visually impaired learners must not be discouraged from doing so.

(i) Learning mediation aids (chapter four)

Authors such as Betts (1993) and Lipkin (1995) support the idea that mediation aids must be used because they help blind learners to comprehend the different structures of different things. Abner and Lahm (2002:99) argued that with learning mediation aids, learners achieve greater independence in school: for example, scanners, CCTV’s, voice synthesisers, and Braille translation software enable blind and visually impaired learners or students to navigate word-processing software, complete maths assignments, and explore the Internet. This implies that the ability of blind and visually impaired learners to gain access to text and the ease of editing papers on computers significantly improve their reading and writing skills. In this new educational order, most certainly, learning will be closely associated with and facilitated by learning mediation aids. Authors stated above as they put it, “(f)or those who are visually impaired, technology will certainly be one of the tools used to promote literacy.”

Technological learning mediation aids provide blind and visually impaired learners with good access to print materials and, as a result, enhance their competitive equality. Literature reviewed demonstrated that other learning mediation aids are also effective in involving and stimulating blind and visually impaired learners' other senses. Objects, relief maps, embossed diagrams and scale models are some of the learning mediation aids that possess the capability for enabling blind and visually impaired learners to come into contact with new realities. Other advantages of learning mediation aids are discussed in (4.1.5).

(j) Educational approaches (chapter two)

The Education White Paper 6 (2001) argued that there are different education approaches for disabled learners. According to that policy document, the objective of the service sector in any country must be to provide effective services for persons with disabilities. However, before any education system is implemented, stakeholders must carefully weigh the advantages and disadvantages of adopting any particular approach. Different approaches were also discussed in chapter two (subsection 2.5.3).

(k) Attitude towards inclusion (chapter three)

Wall (2002) argued that including blind learners is made difficult because of factors such as educators' lack of confidence and ability to teach these children. The literature further revealed that educators at special schools expect too little from blind learners. According to the literature reviewed, such educators with pessimistic attitudes and experiences will beget more negative attitudes in such learners. Higgins and Ballard (2000:164), regarding negative attitudes, argued that what individuals like to think of as their attitudes, their values, their actions are in fact public rule systems or codes which define all possible modes of thought and action.

According to the literature, attitudes, stereotyped beliefs or stigmas attached to individuals who are blind and visually impaired can be attributed to many factors, e.g. their being perceived as helpless, docile, dependent, melancholic, aesthetic (more sensitive to music and literature) and serious minded. The above-referred authors contended that those stereotypes lead to stigmas because people with severe vision impairments are seen as "different": physically, psychologically, morally and emotionally inferior to sighted persons. The inferiority complex that educators associate with blind and visually impaired learners contributes towards the former not being convinced that these individuals can master biology. This sentiment featured prominently during interviews with educators and focus groups.

(l) Prejudices (chapter three)

The literature revealed that unnecessary demands, unfamiliar surroundings, an inflexible curriculum, inflexible assessment standards, inadequate learning and teaching facilities, badly timed instructions, unwelcoming teaching and learning environments are prejudicial factors resulting in ineffective learning of persons with visual impairments. Authors such as Bond (1998), Van Huijgevoort (2002), Charles and Yewpick Lee (2003) and Mani (2000a) support this notion. According to Van Huijgevoort (2002:60), "(p)eople are limited not only by physical barriers, but by the attitudes of others." He further argued that "(s)tigmatization is an important factor in a person becoming ... isolated." Prejudices may put blind learners at risk of isolation, possessing few friends and inadequate social skills.

According to Charles and Yewpick Lee (2003:53), educators' attitudes and assumptions influence their interactions with and expectations of learners. They stated, "(l)ike most children, children who are blind and vision impaired usually respond positively to being given class responsibilities, to warm friendly guidance and support, opportunities to help others and not always be on the receiving end of help, high but realistic expectations, opportunities to take risks and learn from their mistakes, and opportunities to succeed, both individually and with their peers. The most vulnerable aspect of many learners is a lack of self-esteem. A teacher's positive attitude and belief in a child is crucial and can have lasting effect."

(m) A need for change (chapter two)

According to Curriculum 2005 Lifelong Learning for the 21st Century (1997), Bertram *et al.*, (2000), Education White Paper 6 (2001) and other sources, change in education was necessary for empowering all citizens. Such a change has been instrumental in altering the old values and beliefs. Change had to take place in order to encourage and promote critical thinking. It was instrumental in introducing a lifelong education system which is people centred. Because of this, for the first time in this country, high quality education will be available to everyone regardless of age, gender, race, ability, and so on. Central to that change is the introduction of the new curriculum for Outcomes-based Education and Training.

7.2.2 FINDINGS EXTRACTED FROM THE INTERVIEW TRANSCRIPTS AND FOCUS GROUP INTERVIEWS

The following discussion reflects on the findings that have been uncovered by the feedback in and the reports from the focus group interviews, as explained and reflected in chapter six of this thesis.

FINDINGS APPLICABLE TO THE GRADE 12 BLIND AND VISUALLY IMPAIRED BIOLOGY LEARNERS

Overall, just a small number of blind learners take science related subjects up to Grade 12.

One could attribute this problem to the following factors:

- ❑ Lack of educator training in special education: Most educators working at schools for the blind and visually impaired received a general education training qualification. They lack ideas to adapt the curriculum and accommodate blind and visually impaired learners in the life sciences' environment. This implies that they will not encourage learners to do a difficult subject while they cannot mediate or facilitate it properly.

- ❑ Educators' negative perceptions (see paragraphs 6.4 and 6.5): Some educators express the view that blind and visually impaired learners cannot cope with the demands and challenges of life sciences, including observation, exploration and experimentation. Special schools' educators are not prepared to take risks by allowing their learners to do science. The researcher deduces that in the opinion of such educators, simple subjects (comprising theory and not practice such as languages, commercial subjects, religious subjects, social sciences subjects, et cetera), will assist blind learners to obtain

good Grade 12 grades and as such, be testimony to the entire country that they are good educators, while science subjects may tarnish their teaching reputation because there is a likelihood that the same results may not be achieved.

- ❑ Life sciences competences (see paragraph 6.5): Educators lack the competences to mediate life sciences to blind and visually impaired learners; hence they do not want to expose their weaknesses.
- ❑ Resourcing (see paragraph 6.5): Some schools are poorly resourced. Science subjects require good resources to be successfully mediated. In the absence of human and material resources, few blind learners will follow the science stream.
- ❑ Curriculum: In the past, special schools used to offer their own curriculum (comprising pre-vocational training, commercial subjects, religious subjects, languages and social sciences subjects). Educators, therefore, find it difficult to offer a curriculum nationally prescribed by the Department of Education. This is why they do not abide by the department's directive that mathematics and science are compulsory for all children. Should these problems not receive immediate and urgent attention, few blind and visually impaired learners will gain access to science subjects in general.
- ❑ Physiology: Blind learners seem to cope better in physiology than other life science subjects. This is so because although there are drawings and also good models that the blind can feel tactually. In addition, physiology seems to present fewer problems in terms of adaptations because it comprises more theory than practice. Furthermore, it is offered because it opens a door to one of the popular careers for the blind, which is physiotherapy. It is for this reason that educators prefer it as a subject because it does not expose their weaknesses.
- ❑ Sources of information: Braille books, recorded tapes, friends, educators, magazines, internet, experts, the environment, radio and television are methods recorded as being used when blind learners and their educators at South African schools obtain information in unfamiliar and complex settings.

Regrettably, most schools use outdated and worn out books without diagrams, relief maps, and other methods of tactilely presenting information. When orders are placed with printing presses, books arrive some months or a year later, when they are no longer required. In other instances, printing presses do not produce them because it is not cost-effective to do so due to the small orders placed by schools. Computers could be a solution, but those who are in charge of them are not computer literate and they use them for their private matters. When learners loan books from book lending institutions, because of huge demand learners can keep them for a few months only. When they return them, it means they have no sources to refer to or obtain information from. In the past, special schools used to have Braille specialists whose tasks among others included producing Braille books. Such posts have at the present moment been terminated, with the implication that in-house Braille production is no longer done - at the expense of learners. Print sources are readily available but blind and visually impaired learners cannot access them independently. Public libraries do not make a special effort to acquire accessible print and electronic information. This

implies that without the assistance of sighted people, blind learners cannot benefit from these facilities. Such factors debar blind and visually impaired learners from obtaining information in unfamiliar and complex settings.

- ❑ Potential and interest to learn biology (see paragraph 6.4): Blind learners have the potential and interest to learn biology and it has been proven that biology opens many career opportunities for them. Factors alluded to in previous paragraphs, however, cause them not to study biology, though they may have shown interest and have the potential.
- ❑ Special apparatus (see paragraph 6.4): Special apparatus is very expensive. This not only inhibits learners from using and accessing it, but limits their participation and contribution.

One may attribute this deficiency or total unavailability of special apparatus to:

- ❑ The rand/dollar exchange rate: Importing this kind of apparatus from international manufacturers is expensive, taking into account the current rand /dollar exchange rate.
- ❑ Schools do not show interest in obtaining it: Schools do not invest in this apparatus because learners do not do science up to Grade 12. They feel that this expensive, state-of-the-art, accessible apparatus will just gather dust in the schools' storerooms because of not being effectively utilised, and will constitute a so-called white elephant.
- ❑ Unpreparedness of engineers to invest in small markets: South African engineers do not invent disabled user-friendly technology because it is not a lucrative market to invest in.
- ❑ Lack of innovative and creative skills: Educators are also not creative and innovative even though there are simple things they could do.
- ❑ The non-recognition of technical 'know how': Schools do not have a technical section that could be responsible for adapting some kinds of apparatus or manufacturing others.

The variables highlighted above restrict effective teaching and learning in the life sciences/biology classroom.

THE IMPORTANCE OF ACQUIRING TABULATION SKILLS

Most blind learners lack skills to make tabulations independently. Blind learners should be equipped with such skills, though. The only technique that is applied to make tabulation possible for blind learners was discussed in the previous chapter. This is also indicative of the fact that educators are not innovative. Poor resources also have a profound effect on learners' attainment of tabulation skills.

The value of accessible material (see paragraphs 6.4 and 6.5): Accessible material in Braille and electronic formats helps to lessen blind learners' dependency on partially sighted classmates and educators.

Tests and surveys: Simple tests and surveys are conducted, but only to a limited extent and this should be increased.

Data recording: Learners are encouraged to record data correctly by putting it into Braille for later use. They are encouraged to write notes in Braille. Joaquin Correa in his article entitled, "What Braille has

meant to me” (WBU 2000:6), argued that Braille and typing, which he had been taught at a school for the blind, were to be his only working tools. Braille has enabled him to “...(d)velop a considerable ability to take notes, summarize and transcribe texts, and learn mathematical symbols, in short, to make the very most of Braille and make up for ... educational disadvantages with creativity.”

He continued that “(a)fter a very rewarding academic experience, I graduated from middle school and decided to go on with my career training. Now I believe that without the background I had acquired thanks to my ability to make direct and personal contact with texts of all kinds, without my knowledge of spelling and punctuation and, above all, without the skill to elaborate on texts that I’d drafted in Braille, I couldn’t have succeeded in that stage of my education and Braille has been essential in my professional life.” Not only has my ability to read and write allowed me to mix skilfully and confidently in different work and intellectual environments, but it has helped me express myself in written form and perform any number of tasks, ranging from drafting the minutes, reports, and all other documents associated with serving as secretary of the board, to public speaking and teaching, in which I use Braille to outline my lectures, read out full texts, and engage in other intellectual activities”.

Field trips: Field trips are infrequently undertaken. This could be attributed to:

- Learners and educators expecting Government to subsidise trips.
- Educators not realising their importance.

Observations: There are instances where blind learners observe biology phenomena. However, lack of full visual ability deprives them of the advantage of observing and experimenting.

Blind learners should do experiments even though they experience problems and frustrations. The researcher points out that observations are experiences leading to the systemic recording of events that will be analysed and synthesised by a researcher. Observations are one of any researcher’s best and most effective tools to gather data. Observations depict researchers’ subjective and objective experiences through the meanings they provide. Through observations, researchers investigate and reveal complex and difficult everyday life situations and events. Through observations, sighted people obtain visual experiences, knowledge and understanding. In the sighted researcher’s quest to analyse and synthesise collected data, s/he can be objective. The blind researcher, who depends on second hand information, may be subjective. The reason why blind researchers may not be comfortable with observations is the bias that such practices may present as a result of depending on someone. The dependency may negatively impact on the trustworthiness of the results.

Describing and explaining: Blind learners are able to describe, explain, interpret, analyse, hypothesise, and evaluate programmes. They, however, find it difficult to design certain structures and patterns on their own. Designing normally involves vision. Because blind learners do not see, they therefore, believe that they cannot design structures and patterns.

Blind learners' biology predicaments (see paragraphs 6.4 and 6.5): These seem to be stemming from the following:

- ❑ The content of the learning mediation programmes;
- ❑ Poor management or organisation of learning mediation classes;
- ❑ Stereotypes that some educators still possess towards the blind: that they cannot cope with biology since they lack the visual ability;
- ❑ Educators' inappropriate mediation style and pace;
- ❑ Rigid timeframes for the completion of the biology syllabus;
- ❑ Inadequate methods and techniques of assessment, et cetera.
- ❑ The researcher further noticed that certain predicaments could be attributed to the physical and the psycho-social environments within which mediation of learning occurs.

Most of the variables listed above have been discussed in great detail in this thesis and will therefore not be reiterated again.

7.2.3 FINDINGS EXTRACTED FROM THE INTERVIEW TRANSCRIPTS WITH EDUCATORS

Science process skills:

In 6.3.1.2 (Learning outcome 1: scientific investigation question 1) the data revealed that educators are acquainted with science process skills but due to unavailability of equipment, lack of creativity and innovativeness, learners just concentrate on theory and not practice.

The promotion of a flexible and accessible learning mediation environment:

Data gathered and analysed under 6.3.1.2 (Learning outcome 1: scientific investigation) revealed that few educators worked very hard to promote the accessibility of the biology learning mediation programme and to provide adequate support to blind learners. It became clear that most educators have shown little enthusiasm, dedication, creativity and innovativeness. Educators rarely embarked upon processes that recognised learners' knowledge, techniques and strategies for observing and conducting experiments.

Similarities and differences:

Empirical data, as discussed in 6.3.1.2 (question 2), revealed that educators created opportunities for their learners to distinguish between similarities and differences. The importance of providing blind learners with concrete objects rather than abstract objects was emphasised. Other strategies used for this include comparison and contrast, talking about familiar things before unfamiliar things, and the like.

Recording of data:

Question five in 6.3.1.2 revealed that educators used different strategies to encourage learners to record data correctly. Strategies, e.g. dictating notes to blind learners, giving blind learners prepared notes, and indicating salient points during the learning mediation were used.

Tabulation skills:

Data (in Learning Outcome 1: Scientific Investigation question 6) indicated that it is a challenging exercise, for many educators, to equip learners with tabulation skills. Though a solution to this problem is found in technology, unfortunately blind learners cannot draw nor operate tools such as the Zytec machine.

Learning mediation strategies:

Data in (question 7) showed that educators used common strategies to mediate learning to blind learners. Any recognisable difference was found in modifications here and there to meet learners' needs, their styles of learning and their pace of learning.

Information acquisition:

Data discussed in 6.3.1.2 (Learning Outcome 2: Constructing Science Knowledge, question 8) revealed that different methods, including textbooks, magazines, periodicals, co-workers, newspapers, radio, television, scientific video tapes, the internet, the environment itself, scientific excursions, experts, and so on were used by educators to acquire valuable information.

Describing and explaining phenomena:

Data gathered and analysed (question 9) revealed that educators created opportunities for their learners to describe and explain concepts, principles, laws, models and theories. However, educators emphasised that ability is influenced by the situations in which blind learners find themselves. Educators warned that blind learners should not be expected to describe and explain things that need to be visually observed.

Prediction of outcomes:

Data gathered and analysed (Learning Outcome 3: Science, Society and Environment, question 11) suggested that in order for blind learners to predict the outcomes of an intervention, educators have to give them background knowledge prior to the conducting of an experiment. When learners are given background information, and possess understanding and intellectual ability, predicting the outcomes of an intervention will be possible. The same applies to analysing data, expressing opinions about or reflecting on the mediation of life sciences. For learners to express such reflections, strategies such as discussions, interaction and sharing information, prompting correct responses from them and the like must be used.

7.2.4 THE CENTRAL FINDINGS OF THE STUDY

Having studied the findings extracted from the literature review, feedback and the report on educators and focus group interviews, one realises that there are findings that are crucial and deserve to be discussed further. The central findings of this investigation comprise the following main categories:

Specialised education and support systems:

The study revealed that the needs of blind and visually impaired learners are enormous and largely unmet. This could be attributed to educators not receiving specialised education to effectively and meaningfully mediate learning to these learners and support systems that are not in place. Institutions of higher learning

in South Africa offered and continue to offer special needs education programmes. Great emphasis is laid on learning behaviour and personality development. Aspects that are prominent in those programmes include: contemporary juvenile problems, sexuality, drug abuse, teenage suicide, the milieu deprived child, abuse, juvenile delinquency, child in crisis, et cetera.

The researcher wishes to bring to light the fact that while all of us may argue that blind and visually impaired learners are currently served or would be served by educators who have undergone training in "special needs education" experience with similar efforts and endeavours to homogenize disability specific issues into other large scale human development initiatives, always yield the same results. This implies that the needs of one or more disability groups simply get overlooked or totally lost. In the same breath, the needs of blind and visually impaired learners are overlooked or get lost in the current "special needs education" programmes because such programmes do not equip educators with knowledge of expanded core curriculum for blind and visually impaired learners comprising areas such as: language and communication, literacy through Braille and/or print, listening skills, concept development, visual efficiency, physical abilities, developmental orientation and mobility, social skills, life skills and adaptive technology.

Obtaining knowledge about aspects listed above under the current "special needs education" programme is imperative to any educator. However, cognisance should be taken of the fact that educators facilitating learning to blind and visually impaired learners need both extra knowledge and specific skills to deal with classroom challenges that lack of vision may pose. The body of knowledge and skills unique to the needs of blind learners that educators should acquire, provides a tool for access to the regular curriculum as well as development of independence skills by blind learners. Disabled learners and in particular blind and visually impaired learners, require and deserve specific strategies that address their unique learning mediation needs.

It is a truism that ordinary "special needs education" programmes do not equip educators with skills to reach and meet SPS outcomes listed in the biology Revised National Curriculum Statement. Without the "special needs education" programme/s devoted and dedicated to the teaching and learning mediation of blind and visually impaired learners, educators would battle to efficiently mediate learning to blind and visually impaired learners.

In instances where specialised education and support systems are not in place, effective advocacy, professional advice and technical assistance will not prevail. Further, the goal of equal participation by blind and visually impaired learners and the right to be mediated by educators who fully know and understand them better, cannot be achieved. The implication therefore would be that blind and visually impaired learners in South African schools would continue to be marginalized and deprived the privilege of effective and meaningful learning on the grounds of their educators having not received specialised training. Specialised education and support systems have the capability to drive the promotion and the provision of early detection of blindness programmes, early intervention programmes and other school services which encourage parent/s participation, other family members and the community in general. Further, when adequate support systems are in place, these will ensure that blind and visually impaired learners receive a

firm educational foundation. Blind and visually impaired learners will then be "... equipped with relevant skills and knowledge to function effectively" (Support to Schools Programme 2002:24). Furthermore, support systems are important because they fulfil the role of preparing the learner for lifelong learning.

It is incumbent upon the Government to commit itself to support education for blind learners since it is one of the models of service delivery on the condition that all necessary steps are taken in order to put in place the required numbers of educators trained in the special needs of blind learners. Support systems such as: necessary equipment, accessible learning mediation support material, learning mediation aids, funding, transport to public libraries, career counsellors that understand the unique needs of the blind and visually impaired learners, Braille experts, strengthening of special schools and capacitation of educators, sensory development, et cetera, should be provided on a continuous basis. On the funding front, the researcher is of the view that the previously disadvantaged schools should be strengthened and capacitated. When all those are provided, they promote a high quality education in special schools as an alternative to inclusion or mainstream education.

Resources:

By resources, the researcher is referring to educators, support staff, assistive devices, learning support material and related matters. This study revealed that most blind and visually impaired learners do not have access to a fair share of the available special education resources and that partnerships between learners' families and education providers is essential in overcoming barriers to learning. This study further revealed that regardless of setting (special or inclusive schools) and disability, if the blind and visually impaired learner is provided with timely and adequate human and material resources, he or she can develop appropriate skills that will enable him or her to achieve success and independence. It should be borne in mind that if blind learners do not receive both human and material resources necessary to enhance the development of their competences that meet the sensory deficits of blindness, critical learning mediation opportunities will be lost, thus, diminishing the potential for future accomplishments.

Resources are necessary to guarantee proper mediation and accommodation of their needs. Resources and related matters are capable of enhancing blind and visually impaired learners' functionality during learning mediation. The provision of resources promotes the establishment of a sound education system. Therefore, the government will recognise the basic requirements discussed at length in this work regarding education for the blind and visually impaired learners.

Curriculum adaptation:

The researcher regards curriculum adaptation as the translation of policy into "accommodative action" thus encouraging a transformation in the entire educational system which then become sensitised to the educational needs of blind and visually impaired learners.

This study brought to light the fact that an adapted curriculum has a potential of "reaching the unreachable" and thus eliminate exclusion practices from any type and form of education. It also serves as an instrument to meet and/or accommodate the unique and diverse needs of blind learners. The study further revealed that

educators have a tremendous role to play in enabling the policy makers of education better understand the educational needs of blind and visually impaired learners and other disabilities.

Below is a list of alternative approaches to curriculum adaptation/delivery and assessment:

- Setting a substitute task of similar scope and demand
- Replacing one task with a task of a different kind
- Allowing the learner to undertake the task at a later date
- Using another planned task to assess more outcomes or aspects of outcomes than originally intended
- Allowing the learner extra time to complete task
- Using technology, aides or other special arrangements to undertake assessment tasks
- Using an estimate based on other assessments or work completed by the learner (in circumstances where the above provisions are not feasible or reasonable)
- Considering the format in which the task is presented, e.g. the complexity of graphs, diagrams, tables, illustrations, cartoons, etc. A range of strategies can be followed to make these accessible to blind and visually impaired learners such as:
 - Picture or diagram simplified or shown differently without compromising complexity of question
 - Picture or diagram replaced by written description
 - Picture or diagram supplemented by written explanation
 - Picture or diagram replaced with a real item or model
 - Unnecessary picture or diagram removed
- Amount of information reduced
- Measurements altered
- Inherently visual material replaced with equivalent non-visual material [s.a.] [s.p.]

However, the researcher is of the view that in order to achieve this, the curriculum should be flexible without lowering the set standards. Adapted curriculum guarantees to the blind and visually impaired learners unlimited access to life-long learning as from pre-school, General Education and Training, Further Education and Training, Higher Education and Training and Adult Basic Education and Training. This will minimise dropouts, push-outs and failures in the learning mediation of biology. People who understand blindness and not be administered by those who run psychological services should head the education of the blind. Technical sections to construct apparatus and models should be introduced at special schools. When books are written, or before they are published, an expert or experts in blindness should be consulted and be given the task and opportunity to make them user-friendly. Educators have to know how to adapt diagrams, experiments, and the like.

The provision of assistive devices:

There are no policies regarding the provision of assistive devices to blind learners in order to enable them to participate actively and competently in the education processes. This lack hampers the development and extension of their potential in science subjects. By educational technology, the researcher refers to Braille slate and stylus, Braille writing machines, thermoform machines, computers, et cetera. Advantages and

examples of educational technology for the blind and visually impaired learners were discussed at great length under 4.1.5 and 4.1.11.

Lack of guiding principles and strategies:

Presently, there are no broad guiding principles and strategies adopted by education authorities to accept their responsibility and accountability to make education as accessible and flexible as possible, as well as acknowledging its social and economic value. In the absence of such principles and strategies, there will be no education justice for all.

Educator training:

Education authorities and institutions of higher learning are doing very little to bridge the training gap between regular and special educators. Most institutions of higher learning have not introduced courses in the facilitation of learning to blind learners. This implies that those educators are inadequately skilled and demotivated, because courses, workshops and seminars re-energise them. Student-teachers should be placed at inclusive or special schools for the blind to acquire experience on how to mediate or facilitate learning to blind and visually impaired learners. Not only will they acquire experience but will as well, experience pressures, particular needs and challenges in facilitating learning to these learners.

Baxter (2004:131) has acknowledged that: “(a)s parents, we all want our children to have the best possible chances of maximising their educational attainment. We know that children’s best chances of success come when they have access to teachers who understand the particular needs of children with a visual impairment and who have particular skills in meeting these needs. Appropriate training for teachers is obviously a crucial element in the success of our children.”

Negative perceptions:

Educators exhibit negative perceptions towards the ability of blind learners. All stakeholders will only be able to change such perceptions when there are necessary accommodations and unwavering support from educators, parents and government.

Science process skills:

Data collected from respondents and analysed, indicated that tabulations, poses several problems for blind learners. In his investigation, the researcher discovered that blind learners are only given "ready made" drawings and are not taught how to draw independently. Further, it became clear that no other activities or measures are put in place to supplement a loss in drawing ability. The problem is further complicated by the shortage of diagram producing equipment.

Conducting practical work and experiments at school:

The researcher's observation is that many educators engage their blind learners very seldom in practical work, field trips or related activities. This observation was supported by some educators and learners who participated in the focus group interviews, and caused the researcher to conclude that theoretical work was more prominent than practical work.

Very simple and elementary exercises:

When the researcher circumspectly looked at the practical activities in which blind learners were involved, he formed the impression that the activities were limited to very simple and elementary exercises that called for minimal intellectual challenges or advanced problem-solving skills. He is of the opinion that this finding could be ascribed to factors such as lack of visual ability, negative perceptions stemming from educators, lack of innovative and creative skills, and so on.

Lack of access to subject-related information:

From the interviews conducted with learners, the researcher obtained the impression that very few of them had access to subject-related information, with specific reference to technology, (computers), encyclopaedias and recent publications. Educators disputed the allegation. They indicated that such information systems were available to their learners at all times. Blind learners also complained that the information in Braille was outdated and limited. Educators were actually not facilitating the use of additional information technology systems because they assumed that their learners would access such systems independently.

Traditional facilitation strategies:

Many educators indicated that they adapted the traditional facilitation strategies (such as demonstrations) to enhance learning for the blind learners. Contrary to this, learners indicated that many of the activities relied heavily on “tell and talk” activities. The researcher is also convinced that educators actually used the “tell and talk” strategy because during interviews, they could not give good examples of how they actually go about adapting the traditional strategies.

Special workshops:

Seemingly, educators for blind learners in this new educational dispensation are not invited to special workshops where the development of adapted learning facilitation strategies is shared. This is why many of them called for in-service training.

Cooperative learning:

At schools where blind and partially sighted learners attend separate classes, cooperative learning becomes difficult or impossible when all learners are blind. This further means that experiments are not done because the educator is not able to demonstrate, to explain things and to help learners to record information properly.

Sensory stimulation:

One formed the impression that not much is done to stimulate and develop the senses of blind learners during the teaching of life sciences. Educators lacked clear activities for doing so.

The disposition of blind and visually impaired learners:

What became evident in the investigation was the good amount of time and effort educators were spending with their learners in the biology and life science classrooms. It appeared as if the pastoral role of the educator as defined by the “Norms and Standards of Educators” (2000) predominantly exceeded the

teaching of biology and life sciences to these learners. The researcher got the impression that the emphasis does not fall strongly enough on the achievement of the outcomes envisaged with the biology curriculum but more on the establishment of a caring and supportive classroom environment.

Reality is therefore not exposed to its full capacity and the blind and visually impaired learner is therefore excluded from the full capacity the learning environment and learning mediation strategies have to offer.

Such inferior intervention impacts negatively on the development of the learner. Not only is the learner being excluded from the life science world, but is the learner also leaving a school system that has not fully prepared him or her to take up their positions in society.

7.3 WAYS IN WHICH THIS RESEARCH SUPPORTS AND ADDS TO BOTH PREVIOUS AND CURRENT LITERATURE

It became clear during the literature review that little previous research had been performed in South Africa and elsewhere regarding the teaching of life sciences to blind and visually impaired learners in special schools, and lessons learnt towards establishing an inclusive education policy for the Outcomes-based classroom. Erwin *et al.*, (2001:339) declared that “(a)lthough the literature on the pedagogy of science and children with disabilities is growing, ... there is a dearth of knowledge specifically about science and children with visual impairments. Most of the information on the science curriculum and adaptations for students who are visually impaired was written over 20 years ago.”

One has established that most schools for blind learners offer physiology and natural science to blind learners, while biology is offered to partially sighted learners. The present study further supports this, because it seems the same trends are apparent for blind learners at inclusive schools.

Therefore, the research is deemed to be significant because of the following reasons:

It will encourage South Africa to address the learning mediation problems of biology for blind learners. It will provide a basis for further research in this area (the life sciences) by exploring their current status and their accessibility to blind learners. It will shed light on the perceptions of educators regarding the mediation of biology to blind learners. It has addressed the constraints educators face when facilitating learning for blind learners in an Outcomes-based Education learning mediation environment.

Regarding learners, this study is significant in identifying the constraints they experience when they have to learn biology. Although much information on how to facilitate life sciences to sighted learners is available, there appeared to be little documentation on the availability of such information or material concerning the learning mediation of life sciences to blind learners. Blind learners are a particularly disadvantaged group in South Africa. Therefore, the research adds value to the poor base and limited scope of literature in this field in South Africa. Its findings, recommendations and implications could be useful to stakeholders in education because it will inform them as to how much needs to be adapted, what strategies proved to be useful, whether the outcomes stated in the National Curriculum Statement Grade 10-12 (schools) Biology

Life Sciences Draft October 2002 are achievable by blind learners, and so forth. The study uncovered many barriers that prevent blind learners from benefiting from biology.

The research further builds on the reasons why biology is useful for improving blind learners' level of education, interest and knowledge. It shows how life sciences can offer increased career opportunities for the blind or other learner populations that are vulnerable and whose conditions and situations make them isolated.

It appears that very few blind learners in South Africa have the opportunity to do life science subjects in the senior grades (10-12). If this trend is not reversed, blind learners will be less likely to learn biology than sighted learners. This research could further be useful in dispelling the myth that visual ability is a prerequisite for learning biology. The study makes the authorities aware of the fact that blind learners have special needs and other learning mediation challenges, which must be considered when making the mediation of life sciences accessible to them.

7.4 WEAKNESSES AND LIMITATIONS OF THE RESEARCH

On two occasions, two educators were not tape recorded because of the tape recorder's mechanical failure. One interviewee refused to be interviewed on the basis that his or her principal did not inform him or her in time and consequently, he or she was not ready or prepared for any interview. Because the researcher's assistant was not skilled at using the videotape, only half of most lessons were recorded. Therefore, a complete reflection of the lesson was not videoed. Information that the sighted assistant captured cannot be relied upon by itself as it is much more open to misinterpretation by the blind researcher.

It is the researcher's prerogative to include or exclude information during the collection of data. If an assistant does this for the researcher, it is likely that the information might be inaccurately recorded, resulting in further errors of analysis being made. Some respondents lacked a good command of English and the researcher exercised his own discretion in clarifying what they intended saying. The problem is that the way he perceived matters might not necessarily have been what the respondent tried to bring to his attention.

In addition, qualitative research cannot be divorced from research biases (refer to the "methodology" section). Interviewees were not given a chance to check mistakes in transcripts.

The researcher has directly experienced other factors contributing to weak areas in the research. They include but are not limited to:

Lack of access to research material:

The researcher experienced problems regarding effective access to print material. The issue was that one had to do a significant amount of reading, which was not accessible as it was in print and the researcher is blind. As long as institutions of higher learning and other public libraries do not possess the right

technology for the blind, it then becomes a daunting task for the blind student and researcher to work independently. Maguvhe (2003b: 117-118) argued that, like any other researcher, the blind researcher is very passionate about access to print: it is always fulfilling, rewarding and satisfying when the blind researcher is able to get without difficulty what s/he wants from the vast store of published work, whether instructional, cultural, recreational, academic, and so on. However, in South Africa at the present moment, and in particular at both public libraries and libraries at institutions of higher learning, accessible material and technological tools are not available for blind researchers to read what they need and want independently and timeously.

Accessible material and technological tools are not only essential in blind researchers' academic lives and contributions. They also play a meaningful role in blind researchers' professional lives and afford them numerous and exciting opportunities to take full advantage of them.

The researcher further believes that the following factors might have flawed this study:

- The possibility of the researcher not having kept fully abreast of the workload, challenges and high demands of the study, as a blind researcher having to be reliant on sighted readers.
- The possibility of not having extracted enough or sufficiently relevant information from the limited text despite much energy, dedication and research time.
- The possibility of misinterpreting the supervisors' comments, which were in some cases in print.

7.5 RECOMMENDATIONS AND IMPLICATIONS OF THE STUDY AND ITS IMPACT ON THE BROADENING AND STRENGTHENING OF POLICY ON INCLUSIVE EDUCATION

Under this header, the following recommendations and implications are discussed:

- Accommodative measures for blind learners;
- Research;
- Government duties and responsibilities;
- Policies and legislation;
- Special devices;
- Modification of materials;
- Inclusive settings;
- Provision of better services;
- The development and field-testing of a comprehensive science package; and
- The South African National Council for the Blind's responsibilities.

7.5.1 ACCOMMODATIVE MEASURES FOR BLIND LEARNERS

The first batch of recommendations comprises accommodative measures for blind learners. Guidelines discussed in chapter four should form the basis of how blind learners must be accommodated.

In addition, it is further pointed out that:

Blind learners require from educators and stakeholders the delivery of an education that meets and suits their learning mediation needs and that is on par with that of their sighted peers?

The implication therefore is that experienced blind individuals, themselves experts in the field of blindness and blind learners, must play a monitoring and advisory role as to the way the psychosocial, physical and classroom environments are prepared to accommodate these learners.

In activities such as experiments, if possible, educators must accord blind learners individualised mediation or encourage a collective and co-operative working relationship among learners.

The researcher further recommends that:

Blind learners be provided with assistants who will help them during experiments. The implication is that more teacher assistant posts will have to be created for this purpose.

Inclusive schools should utilise special educators in making the overall classroom atmosphere conclusive for blind learners.

To achieve this, it is recommended that:

Such a person must promote and inculcate an understanding of the blind learners' potential. The implication is that the Department of Education will have to allow educators from special schools to play a leading role.

In order for blind learners to learn biology, the researcher recommends that:

They must request from their educators clearly defined objectives regarding the outcomes they have to achieve. This will guide them concerning what to look for and expect during learning mediation. In this regard, this implies that the role of the educator will be that of assessing and evaluating the results and progress of learners in order to see whether the strategies used have been helpful in meeting educators' objectives.

It is further recommended that:

Blind learners' tactual and kinaesthetic skills are stimulated in order for these to be used in biology learning mediation. This implies that sensory development and sensory stimulation programmes will have to be initiated so as to achieve this. Should other senses be stimulated, they could compensate for the loss of visual ability. This further implies that educators should not only use media to stimulate verbal, symbolic and cognitive learning but also accord their learners the opportunity to handle, touch, smell and, where possible, taste examples. Sensory experiences are important for helping blind learners to remember and retain information.

In order to enhance effective discrimination between objects and other biological components, schools for the blind, and in particular their educators, must work very hard to present colour, intensity, depth, three-dimensionality, contrast, change and movement to blind learners.

It is further recommended that:

Schools must acquire suitable equipment that will encourage blind learners to count, measure, list, compute and weigh data and objects. The implication is that schools will have to budget for the acquisition of such equipment and that technical sections should be established to adapt or develop equipment.

It is also recommended that:

Blind learners are taught how to manipulate pens, pencils, rulers, protractors, etc. from a very young age, in order to gain a good grounding regarding the manipulation of such tools.

7.5.2 RESEARCH

The researcher recommends that the education authorities, independent researchers and other research institutions:

1. Conduct research into typical South African life sciences mediation problems hampering blind and visually impaired learners' success in life sciences. Erwin *et al.*, (2001:339) contended that “(i)n schools in which there is a preponderance of children with disabilities, a critical examination of the science curriculum and its accessibility for all students has yet to be conducted, however.”
2. Conduct research into employment opportunities for blind scientists. Houtenville (2003:133) argued that “(e)mployment is one of the major social roles that people perform over their lives. The inclusion of people with disabilities in the world of employment is crucial to their social integration and economic independence.”

On the other hand, Spungin (1997b) argued that “(a)s a field, we need to be much more supportive and actively involved with these research efforts. Given the small size of the population of visually impaired students, there needs to be a national research center, not only to collect data to verify our needs, but to show our successes and market those accomplishments far and wide.”

Regarding what Swartz (2005) [s.a.] [s.p] refer to as “capacity-building and workforce diversity” as a nation, we face major challenges in the developing cadres of disabled researchers, of whom there is a shortage. As he argues, “(t)his relates partly to “downstream issues”. Many competent disabled people in South Africa have been denied access to adequate education, even at school. A good example is that of a colleague who had a keen interest in electronics, but was advised at school that, since he was blind, he could not study mathematics. This colleague has now excelled in an area of the humanities, but South Africa has lost the potential contribution to the “hard” sciences of a person who had both the interest and aptitude to study further in this area. There are many people of talent who have been denied any hope of tertiary education, let alone specialist research careers. Stereotypes still abound, such as the idea that blind people should become telephonists, wheelchair users should become call-centre operators, and that deaf people should become stock controllers. We have a long way to go before it is universally accepted that it is not the disability which should determine a person’s career path, but the person’s talents and abilities.”

The benefits of conducting research into employment opportunities for the blind include:

Assisting blind individuals to enter, re-enter, or retain employment by providing career counselling, training opportunities, accessing job placement services and job maintenance services. Further, research will provide valuable "... information and technical assistance to schools, employers, and community organizations to facilitate recruitment, placement and accommodation" (Houtenville 2003:134). Employers will be obliged to provide reasonable accommodation for individuals with disabilities. O'Day (1999:234) argued that the creation of employment opportunities for the blind will encourage blind and visually impaired individuals to develop concrete career goals and by so doing not "...become pigeonholed into specific occupations that are designated for people who are blind, or drop out of the labor market altogether."

3. Encourage the establishment of consultation services for blind and other people who would want to conduct research in this field.

Swartz (2005) [s.a.][s.p.] argued that even when disabled people themselves do not primarily define a research issue, it is important to have a credible consultation process with representatives from the disabled community. The disability sector in South Africa is well organised and experienced at providing constructive and invaluable feedback.

The implications of conducting research include:

Units for research into the disabled: Research agencies/organisations should establish such units and these units must be an integral component of the research system. The creation of such units will be instrumental in ensuring that disabled researchers are supported technically and materially: "(t)he units would have to be well equipped so that they would be able to provide for the full learning and research needs experienced by blind students or researchers" (Maguvhe 2003b:118).

Bina, Barnartt, and Cole (1997:198) support the previous point by commenting that "(w)hen I think of some of my former ... students, many of whom went on to graduate from college, I know that they were able to succeed even without a special college for blind students. But I wonder, if some of these college graduates had had ongoing ... instruction in college, more disability-sensitive professors, and better accessibility to learning materials, for example, how much more successful could they have become? How much more could they have thrived and fulfilled their full potential if the playing field had been more level?"

4. Research practices and styles: Research agencies/organisations must be encouraged to develop and promote flexibility in research practices and styles. The implication is that a variety of research methods/options where blind researchers can be accommodated have to be put in place. "(t)his implies that a variety of research options need to be put in place so as to accommodate blind researchers and encourage them to become part of the research team" (Maguvhe 2003b:118).

Furthermore, flexibility, technical and material support will encourage disabled researchers to participate in research activities. Swartz (2005) [s.a.][s.p.] noted that "(w)herever possible, disabled

people should have meaningful roles in research concerning disability. Research leadership by disabled people should be a goal.”

De L’Aune (2004:323) maintained that as a research consulting editor and as a member of editorial boards of several journals in the field of blindness and visual impairment, he is constantly complaining about the need for more rigorous research designs and larger studies. Unfortunately as a researcher, he is confronted with a low-incidence population, minimal resources, ethical and logistical issues, and a constellation of other constraints making it difficult to implement these designs and studies.

5. Accessible information programmes: The government must play a leading role by establishing an accessible information programme. “(t)his would not only support, but also encourage training institutions to follow suit” (Maguvhe 2003b:119). Swartz (2005) maintains that “(a)n interesting feature of disability research is that it can combine fascinating technical questions (such as the design of computer software to increase disabled people’s access to print and other media) with questions about how to change social attitudes (such as how to assist companies and departments to develop an integrated, skills-based workforce).” The author continued noting that it is important for researchers, and for all concerned with building a cohesive society, to realise that research which brings us closer to the goal of what is called, a “barrier-free society” in disability literature is not only necessary for our social role, but is also very stimulating intellectually.

Based on the argument of making information as accessible as possible, the implication would therefore be that the government must provide accessible material and basic accessible research equipment to blind researchers. Another implication is that research institutions must, as part of their staff establishment, employ individuals with an in-depth knowledge of blindness who will be in a position to adapt research techniques. Maguvhe (2003b:119) argued that “(w)ithout the involvement of such experts, blind researchers will continue to be deprived of the opportunity to achieve academically and therefore fail dismally to contribute to the development of our country”. Institutions must provide blind researchers with paid readers in instances where equipment in libraries is inaccessible. With paid readers at institutions of learning and public libraries, these researchers will be able to access some of the information they don't have access to right now.

6. Funding: Maguvhe (2003b:117) argued that blind researchers in South Africa in this new political dispensation, just as in the past, are marginalised and prejudiced in terms of access to resources. The problem emanates from funding agencies and academicians who doubt blind researchers’ intellect and capability to conduct research. He further argued that “(a)ttempts to do research work would be virtually doomed unless blind researchers had access to financial assistance, both from Government and private sector funding agencies. Since most potential donors are not aware of successful blind researchers, it seems as if they have their doubts about the latter’s intellect and their capability to conduct useful research. They probably also doubt whether a blind person would be able to meet the high academic requirements and keep up with the demands set by research.”

7. Skilling: Institutions of higher learning must equip blind researchers and other interested individuals with research competences to encourage research in the field of blindness. This will help to dispel the myth that “(m)any people believe that if one sense is gone, then it means that everything else is gone, so they can't realize that just because your eyes are short doesn't mean that the rest of your brain isn't functioning” (O'Day 1999:230).
8. Publications: Editors of and contributors to current publications and others that may be established in the future must invite and encourage researchers to write articles, critiques, and the like in the field of disability education so as to contribute to its development and growth.

7.5.3 CAPACITATING PROCESS

The Government must take the responsibility upon its shoulders to see that educators for the blind are better skilled and motivated. In addition, skilling and motivation of staff must also involve the holding of training workshops and the provision of resource persons with specialised knowledge.

Many other things will be possible when:

- ❑ The Government takes financial responsibility for ensuring that schools provide accessible equipment, apparatus and learning support material to blind learners. These resources are undeniably some of the valuable factors that could make learning mediation much easier for the majority of blind and visually impaired learners.
- ❑ Government must offer specialised training on how to adapt the curriculum, the learning mediation environment, the production of books and sketches, and so on in order to enhance educators' teaching skills.
- ❑ Access to the Internet and Braille books for blind learners through public libraries must be investigated and implemented.

ICEVI and WBU Joint Education Policy Statement (3rd IDP Africa Forum 23-27 May 2004:3) urges governments to:

- Guarantee to blind and visually impaired children, youth and adults the same rights and access to educational services as is guaranteed to all children, youth and adults in accordance with the Universal Declaration on Human rights.
- Place the educational services for blind and visually impaired children and youth should be placed under the same Government bodies as that of children without blindness or visual impairment.
- Guarantee all blind and visually impaired children and youth in integrated, inclusive, or special school programs – as well as their teachers – access to the equipment, educational materials and support services required, such as:
- Books in Braille, large print or other accessible formats, and low vision devices for those who require them, at the same time as non- disabled students, in order to facilitate their equal access to all aspects of the educational services provided to other children.

- Offer education of a high quality and standard in a range of educational options, including special schools.
- Give prominence to the voice of parents and (where appropriate) children and youth in decisions about placement.
- Provide quality literacy and independence skills and lifelong opportunities for adult blind and visually impaired persons who have not been given basic education in their childhood.

7.5.4 POLICIES AND LEGISLATION

Educator and learner responses in chapter six provided insights into barriers to learning and some potential policy solutions. Insights gained from this research could be validated with qualitative research. The following paragraphs present policy recommendations, aimed at those who make and implement them.

O'Day (1999:627) argued that policies must be promulgated in order to “...(a)ddress both the barriers ... and the specific needs of each group of ... people with visual impairments.” Further, inaccessible education “...(i)s the frontier that must be conquered in the 21st century if people with disabilities are to become fully integrated into this society.”

Based on this argument, one therefore recommends that:

Laws be passed or clauses be inserted in the Rights Chapter that deal specifically with the education of the disabled, access to information and access to assistive and conventional technologies, similar to the British Act SENDA (Special Educational Needs and Disability Act 2001) and the American Individuals with Disabilities Education Act (P.L. 101-476), supplemented by Americans with Disabilities Act (P.L. 101-336), Technology-related Assistance for Individuals with Disabilities Act as amended in 1994 (P.L. 103-218) and Rehabilitation Act as amended in 1992 (P.L. 102-569).

The implication of education related legislation is that there will be a guarantee that all disabled learners will receive free public education that is appropriate to their learning mediation needs.

Secondly, the legislation law will ensure that these learners are provided with supplementary services that permit them to benefit from education, including orientation and mobility training, activities of daily living, physical therapy, and assistive technology services.

According to New Beacon (2002:26) educational laws are also important because they ensure that disabled learners are not treated less favourably, “...(w)ithout justification, for a reason which relates to their disability; and to make reasonable adjustments so that disabled pupils are not put at a substantial disadvantage to pupils who are not disabled ...” Laws ensure that there are duties in place for authorities to plan strategically and make significant progress in increasing accessibility to schools, premises and to the curriculum, and “...(i)n improving the ways in which written information provided to pupils who are not disabled is provided to disabled pupils.”

A law regulating access to information will guarantee to blind and visually impaired learners the availability and accessibility of all information in whatever format. Such a law will provide accommodation measures in public facilities. Therefore, that law must be put in place.

Regarding technology related legislation, the researcher recommends that:

The proposed Technology Act must focus on the elimination of barriers that prevent consumers of disability services from gaining access to assistive technology. According to the USA Technology-Related Assistance for Individuals With Disabilities Act of 1988 (Public Law 100-407, August 19, 1988) [s.a] [s.p] assistive technology in this context should be understood as any item, piece of equipment, or product system, whether acquired commercially or off the shelf, modified or customized, that increases, maintains, or improves functional capabilities of individuals with disabilities. Furthermore, it could mean anything from a single tool with no moving parts to a sophisticated mechanical/electronic system. Neibaur, Day and Sebastian (2002:98) argued that the advantage of using computer technologies in education is that they provide flexible delivery of information and opportunities for collaboration in learning. Computer technologies are capable of linking educators and learners and allow for group interaction without meeting face to face as a group.

The Disabled Children Action Group (2004:1), regarding the importance of having unrestricted access to technology, argued that “(c)hildren with disabilities have the right to access appropriate assistive devices that are necessary to ensure their participation in community life.”

The implication of a technology-related law is that:

Assistive devices will be part of the service package offered free of charge to qualifying learners. Although the total costs and degree of Governmental support (particularly the national Department of Education) for these proposals are not known, one is convinced that a major overhaul of the educational programmes and the provision of adequate support are needed if blind and visually impaired learners are to enjoy and benefit from education in significant numbers.

Abner and Lahm (2002:100) stated that “(a)ddressing assistive technology in students’ Individualized Education Programs (IEP’s) is a hot topic, since it has significant financial implications for school districts.” The implication therefore would be that the Government should commit funds for assistive devices and will be informed by data provided by schools, parents, organisations, and other sources. There will be co-ordinated information and monitoring systems on assistive devices that have been distributed by the Department of Education both nationally and provincially. This will further imply that there would be some kind of legislation/policy that will ensure the provision of assistive devices as a “right” for learners with disabilities. It will ensure that assistive devices are appropriate and suit the different conditions and situations that learners find themselves in.

Wittenstein and Pardee (1996:203) argued that technological devices are useful in the enhancement of Braille but do not replace it. Further, they remarked that technology and Braille play important roles and that “...(c)hoices should be made on the basis of the needs and preferences of individual students.”

Technology will reduce dependency amongst students and the effective severity of learners' disabilities.

In addition, the authorities will have to:

- ❑ Keep a record of numbers and types of assistive devices that have been issued;
- ❑ Keep a record of numbers and types of assistive devices that are awaited; and
- ❑ Keep a record of qualitative changes occurring as a result of assistive devices; for example, documenting how an assistive device contributes to enabling a learner who is blind or visually impaired to actively and fruitfully participate in different activities. Blind and visually impaired learners can participate in different activities if they, for instance, have access to some of the following equipment:

(a) Science kit

It will be necessary for all schools to have adapted standard science kits, which the blind will make use of during the learning mediation of life science subjects.

(b) Scientific calculations

For scientific calculations, blind learners must be encouraged to use the abacus and other related instruments. Knowledge about such instruments must be part of the curriculum. Wittenstein and Pardee (1996:203) advised that more emphasis must be placed on the abacus. They added that "(i)t is a more easily accessed and speedy way for "(d)oing calculations."

(c) Computers and scientific calculators

Computers and scientific calculators are essential tools in modern science. As a result, the researcher believes that appropriate teaching regarding how to use these instruments and other equipment must be emphasised.

(d) Tactile models

Because tactile models reinforce the mediation process of blind learners studying life sciences more effectively than drawings, the researcher recommends that they be made readily available at institutions solely for that purpose. In addition, models could be research tools in the hands of blind learners. They are capable of making a difference during the teaching and learning mediation. Lipkin (1995:122-123) argued that just having models surrounding blind learners makes a big difference. He also contended that there is a great need for tactual tools in mediating learning in subjects like chemistry to blind learners or disabled learners, because they simply learn better by holding something in their hands. Spungin (1977a:157) maintained that "(f)or visually handicapped children, the sense of touch is even more important than it is for sighted children, since it must be relied upon to mediate aspects of perception that vision would ordinarily perform. In addition to its general role as an important avenue of information about the world, touch is particularly important for certain specific functional behaviors, such as the acquisition of tactual material via Braille and the perception of pictorial or other representative educational material, such as maps of the spatial environment." Blind learners make more sense of what they tactually perceive.

Lipkin (1995:123) indicated that blind people are severely underrepresented in the scientific community. According to him, “(w)ith the right educational technologies, more students with disabilities could participate in science and choose it as a career.” Models represent some of the technologies referred to in Lipkin’s work. Blind individuals doing biology, physics, toxicology and other subjects benefit from models. He further argued that “(t)here is a tremendous need for better teaching tools at every academic level.”

It should further be borne in mind that blind and visually impaired learners need different types and amounts of assistance in order to benefit from and effectively participate in educational activities. Based on this argument, the researcher therefore recommends the establishment of technology lending institutions, so as to allow learners who are visually impaired to take equipment to their schools, or to borrow such assistive devices until their schools or public libraries are able to purchase what is needed. The Government, through the national Department of Education, must work with schools, parents and learners to develop networks for the purpose of knowing who possesses what equipment, which will be useful for learners. Such services could be instrumental in ensuring that blind and visually impaired learners obtain the assistance they need.

Appropriate laws will help to ensure that they enjoy equal education opportunities and to create and guarantee enabling education environments. Laws, policies, principles, programmes, processes and practices will protect and advance disabled people educationally, as people who were previously and presently disadvantaged. Hunter House Inc. (1996:55) argued that when laws are enforced, they have the potential to greatly improve the civil rights of people with disabilities. Among many benefits, these pieces of legislation provide access to assistive and conventional technologies for individuals with disabilities in certain situations. When laws are enforced, institutions of learning and government departments become “...(m)ore accessible and sensitive to the needs of persons with disabilities” (Bina, Barnartt and Cole 1997:198).

(e) Training in assistive technology

The researcher recommends that:

Educators be prepared regarding how to appropriately facilitate learning to blind learners in the manipulation of notetakers, print enhancing programmes, Braille translators, scanning programmes and more.

It is further recommended that:

Educators be exposed to actual learning mediation methodologies with each programme or device. Such training should be geared to improving the professional development of educators and should also include all communication methods, reading and writing methods which are suitable for the blind learners.

Educators should be equipped with adaptation or modification skills which will help them to cope with Outcomes-based Education demands and expectations, e.g. difficult formulas, equations, illustrations, tactile graphs, maps, tables, etc.

7.5.5 EDUCATOR TRAINING

Training is severely lacking, for educators currently at special schools or who want to join special schools in future. Forlin and Cowan (2004:5-6) argued that whilst the emphasis on adapting the curricula is to be commended, they have concerns that both current and pre-service teachers are being provided with insufficient training to be able to meet the demands to be associated with appropriately differentiating the curriculum for students with diverse needs and abilities.

Educators who will deal with blind learners on a daily basis must receive both pre-service and in-service training in order to acquire competences for effective and meaningful mediation of learning, not only in life sciences but in other learning areas as well. Wittenstein and Pardee (1996:202) stated that “(m)ore comprehensive training is needed. No one should have to claw and scratch ...”

Abner and Lahm (2002:102) have cautioned, though, that at times such training does not have an impact on educators. They stated that “(t)he primary way teachers receive training is through participation in in-service training and workshops. These training formats, which are short term and focused, have been found to have little impact ... but other opportunities are seldom available or used”

According to Van Huijgevoort (2002:63) educator training is important in helping educators to understand the role that visual impairment plays in a person’s life, how such a person constructs meaning out of his or her impairment, and which tasks and challenges have to be faced by that person during learning mediation. Abner and Lahm (2002:102) declared that “(i)f teachers are adequately trained and provided with support to continue learning, their students will be better trained ... and hence will have the skills they need to succeed in college and the job market.”

The Educator (2004:63-64) suggested that educator training is essential for providing student educators with a positive orientation towards disability, “...(t)hereby developing an understanding of what can be achieved in schools with locally available support services. The knowledge and skills required are mainly those of good teaching and include assessing special needs, adapting curriculum content, utilizing assistive technology, individualizing teaching procedures to suit a larger range of abilities, etc. In teacher-training practice schools, specific attention should be given to preparing all teachers to exercise their autonomy and apply their skills in adapting curricula and instruction to meet pupils’ needs as well as to collaborate with specialists and co-operate with parents.”

Training in special needs education leads to additional qualifications, which must be integrated with or preceded by training and experience as a regular education educator in order to ensure complementary and mobility. Specialised training must be offered with a view to enabling educators to work in different settings under different conditions and play an instrumental role in special educational needs programmes. The Educator (2004:64) stated that “(a) non-categorical approach encompassing all types of disabilities should be developed as a common core, prior to further specialization in one or more disability-specific areas.”

This means that South African institutions of higher learning have a major advisory and training role to play in the process of developing special needs education, pertaining to research, preparation of educator trainers, designing and evaluating training programmes and study materials. Weisser (2004:74) is of the view that courses developed at institutions of higher learning have two advantages. Such courses are accredited, thus providing graduate level units in special education. Undergoing such training could lead to extra benefits to educators in the way of promotions and salary increases. He indicated further that courses initiated by government institutions, while sometimes difficult to initiate, are likewise not easily discontinued.

The researcher fully concurs with Forlin and Cowan (2004:6) that:

- ❑ There should be more emphasis on policies which recognise that teacher quality makes the greatest contribution to student achievement;
- ❑ Professional development should achieve long-term self-analysis and growth for teachers; and

One further concurs with Flair and Seizer (1990); Friend and Bursuck (1999) Pauw (1984a, 1990b and 1991c) and Spungin (1977a:119) that educators mediating learning to blind learners must possess the following competences:

- ❑ Knowledge of formal and informal assessment procedures; this implies that an educator possessing this competency will have knowledge crucial for selecting assessment procedures and instruments for specific blind learners; procedures for administering and/or scoring of assessment for blind learners; methods for interpreting, reporting and analysing information acquired from assessments;
- ❑ Ability to transmit assessment of blind learners, using a variety of procedures, to other school personnel, parents and community workers;
- ❑ Knowledge of content of the specialised curriculum for blind learners.

This competency, according to Spungin (1977a:119), would help educators in possessing knowledge:

- ❑ Of the specialised curriculum regarding concept development for blind learners;
- ❑ Of communication skills necessary for blind learners;
- ❑ Of social and independent living skills necessary for blind learners;
- ❑ About the basic orientation and mobility skills necessary for blind learners, including orientation concepts, movement skills, obstacle detection or avoidance skills.

Additional competences include: knowledge of the pre-vocational career education skills for blind learners; knowledge of the visual and perceptual process in learning mediation and utilisation of low vision; knowledge of auditory and linguistic processes in learning; knowledge of the sequence of development in tactual learning; knowledge of the sequence of development of gross and fine motor skills; knowledge of the requirements for an effective field trip for a variety of blind learners; knowledge of play skills for blind learners in order to maximise “...(t)heir intellectual, emotional, social and physical development” (Spungin 1977a:120); and knowledge of the effect of blind individuals on the seeing population.

Educators with these competences will be able to accommodate blind learners' needs because they understand them. According to the ICEVI and WBU Joint Education Policy Statement (3rd IDP Africa Forum 23-27 May 2004:5), educator training assures that teachers who are in different education settings with different programmes, receive adequate training and skills in Braille and other educational means in order to provide quality education. However, ICEVI and WBU encourage remuneration commensurate with qualifications and training in order to ensure that investments in human resources are adequate. Education authorities therefore have to organise local, regional, national and international seminars, training courses and conferences to regularly update the skills and knowledge of educators and others working with blind and visually impaired children, youth and adults.

7.5.6 MODIFICATION OF MATERIALS

According to O'Day (1999:230) lack of accommodation and outright discrimination, natural outgrowths of the fear of blindness, and other negative attitudes are a common experience as far as blind and visually impaired persons are concerned and one that impacts negatively on their education, social and economic lives. Blind and visually impaired learners (because of their disability) need more accommodative measures in order to be equal.

Bina *et al.*, (1997:198) argued that “(c)ertainly, some blind students achieve in spite of this lack of special accommodations, but I suspect there are more who could benefit from assistance that puts them on an equal footing with their sighted counterparts.” On this basis one recommends that:

Posts in the Departments of Education from national level to local level be created for the purpose of modifying materials and Common Tasks Assessments. New Beacon (2002:27) argued that Government must take the lead in establishing national co-ordinating machinery to increase the amount of accessible school material and speed up its delivery.

The Government must look closely at requiring, from the publishers of prescribed learning support material in specific learning areas, access for the public to circumspectly examine that material. Publishing companies must, as a condition, provide the public and authorised bodies with an electronic file or one in any other format in order to examine and facilitate the job of creating accessible formats for blind learners.

This thinking has been brought about by the following general discoveries:

- ❑ Only a handful of educators have an understanding of the complex situation and didactic principles that apply in the modification of visual materials in accessible formats;
- ❑ That in most of the schools for the blind, biology in particular is not taught in upper grades;
- ❑ That the Department of Education and schools for the blind would have to acquire the capacity to modify curricula and examination papers to allow blind learners to work at levels equivalent to those of sighted peers;
- ❑ That the technology used in the mediation of science is expensive; and that
- ❑ In addition to the intellectual challenge of biology, the physical processing of information by blind learners requires considerable manual dexterity.

According to the researcher, accommodating blind and visually impaired learners imparts major benefits, including:

The feeling that even if one is disabled, one is on an equal footing with sighted counterparts. In other words, learners will not have to ask for services and as such, there will be no limitation on their participation in any learning mediation activity. According to Bina *et al.*, (1997:199-200) blind and visually impaired learners will, in short, enjoy and make the same choices as do other students. Accommodations encourage learners to become part of the community and network. Enabling/accommodative environments will allow blind learners to “...(f)ocus on their education without the distractions that disability status conveys”.

Accommodative environments are capable of creating more opportunities for learners to develop their academic skills, “...(a)s well as the confidence that comes from accomplishment, and ... there is plenty of time for coping skills to be developed after college”. Bina *et al.* also argued that accommodative measures offer blind and visually impaired learners adequate support in the use of additional methods for taking and putting out information. Bina *et al.*, (1997:201) added that “(a)ll students would know when to use their brailewriter or portable notetaker and when their slate and stylus is most handy.”

7.5.7 INCLUSIVE SETTINGS

(a) Sensitisation

Inclusive education should create a learner population that accommodates, appreciates and acknowledges the diversity of needs and the many learning mediation techniques that enable the entire learner population to access education without hindrance. To be able to achieve this, the learner population or student body, personnel from local to national level, educators, therapists, examiners, markers, and all professionals involved in education have to be trained in and sensitised to the learners’ needs, equipment, learning mediation techniques and adaptations of learning resource materials.

(b) Avoid conflicting interests

The researcher recommends that educators must balance their interests, because if they focus more on sighted learners, who are in the majority, blind learners will suffer. Similarly, if they focus more on blind learners, who are in the minority, sighted learners will suffer. He therefore suggests that educators must pursue education initiatives, which will address the needs, interests, and aspirations of their learners on an equal basis.

(c) Inclusive education programmes

He further recommends that:

Programmes such as networking and capacity building, adaptation of the environment (physical, environmental, educational, and, communicative) be developed to make all stakeholders aware of the implications of including blind learners.

7.5.8 THE CURRICULUM

Blind learners cannot learn biology if there are still myths and misconceptions that this learning area is only suited to the sighted, because of the particular challenges it poses.

The researcher recommends that:

The adaptation of the curriculum must include correcting misperceptions of the disability because when people mention disability or access, they often only mean built environments. Adaptation of the curriculum must also focus on access to information, technology, etc. Educators must know basic Braille, orientation and mobility, touch typing or basic computer skills, behavioural management, leisure activities for the blind, independence training, social skills, etc.

7.5.9 SUPPORT SERVICES

Learners and educator support services must be put in place and properly co-ordinated so that the learning mediation processes can be effective and productive and the goals of learning can be reached. Goals can also more easily be reached if the status of blind learners is improved. Such an improvement should entail the modification of the learning mediation environment in the course of time, identification of needs, styles of learning, pace, interests, etc. Should this be carried out, more appropriate services will be rendered to blind learners. In other words, there must be interventions with regard to blind learners' different needs, aimed at increasing "...(f)unctional independence and optimum participation in life situations" (Van Huijgevoort 2002:61). Parents of blind learners must be offered courses on how to help their children at home in different learning areas.

7.5.10 TERTIARY INSTITUTIONS

South African tertiary institutions should be encouraged to admit blind students to pursue undergraduate and graduate degrees related to life sciences so that they gain in-depth knowledge in this regard and become valuable assets for other blind people.

7.5.11 EXPERT KNOWLEDGE

It is recommended that:

Seminars on expert knowledge and sound methodologies in the facilitation of biology and consultative meetings be held, which are outcomes focused, for the inclusion of blind learners in the learning mediation of biology and learning mediation practices in general. The approach to be adopted should be that of bridging the gap between blind and sighted learners and an accessible education and assessment model, which offers academically viable solutions that benefit both the education system and the individual.

For blind learners to benefit from biology and their education in general, the Department of Education must:

- ❑ Develop and implement accessible learning mediation programmes;
- ❑ Develop and promote, through workshops, seminars, symposia, distance learning and so on, the acquisition and improvement of learning mediation skills;
- ❑ Conduct, from time to time, audits of disabled learners (especially of blind learners) who have taken biology as one of their subjects, to determine what outcomes they have achieved, what needs to be improved, how, when, why, where, etc. The audit must also take into account such factors as the learning mediation environment, human and material resources, and equipment available.

7.5.12 THE DEVELOPMENT AND FIELD-TESTING OF A COMPREHENSIVE SCIENCE PACKAGE

The national Department of Education in collaboration with the Department of Science and Technology must develop and field-test a comprehensive science package for the benefit of visually impaired learners.

The package should cover the following areas:

(a) Methodology of teaching science

This area should deal with the general techniques and strategies used for teaching science in general and for teaching the learning area to blind and visually impaired learners. It should further specify methods and techniques for preparing science text material, the learning needs of blind and visually impaired learners, and assessment procedures in science.

(b) Use of science equipment

The area should provide a list of available adapted science equipment, sources where it can be obtained, detailed self-instructional procedures to learn to use it effectively, and so on.

(c) Use of science Braille code, signs and symbols

The area should focus on providing illustrations on how to use the science Braille code, signs and symbols. These should be described and accompanied by pertinent illustrations.

(d) Science mediation strategies

The area should provide guidelines on how to adapt procedures and practices for teaching science concepts at school level. In addition, procedures are useful in helping educators to be aware of and to understand those concepts before they teach them to blind and visually impaired learners.

(e) Creative science

This area must, specifically, deal with a whole range of creative activities, e.g. using available material and the natural environment for mediating and understanding science concepts.

(f) Low-cost mediation aids

The area must provide guidelines for the acquisition and preparation of low-cost learning mediation aids to teach science properly. This knowledge will help poor schools to save money.

7.5.13 THE RESPONSIBILITIES OF THE SOUTH AFRICAN NATIONAL COUNCIL FOR THE BLIND

The following are the activities, which the South African National Council for the Blind should carry out:

SANCB needs to closely work with educators and other service providers, including advisory services, in ensuring that the needs of the learners are adequately provided for.

It should further:

- Train its staff members and those of member organisations regarding all education legislation and policies, and consider the implications of these documents for the service rendered by it;
- Offer training to stakeholders in education concerning legislation and policies for meeting the needs of both blind children and young blind people;
- Work with a diverse group of professionals to promote and facilitate the development of what is known as “multi-agency” work that will ensure that the needs of blind children are met;
- Empower the youth (through its youth co-ordinator and education services co-ordinator) so that they can take an active role and participate in present and future educational decisions which will affect them;
- Continue to campaign for the right to read, learn in conducive environments and have access to information;
- Campaign for better transport services so that blind learners can go to public libraries and related facilities to expand their knowledge;
- In collaboration with other service providers, needs to ensure that when children and young people who are blind are discriminated against, it can act as an advocate on their behalf and hold discussions to solve their problems;
- See to it that learners receive equal education in all education settings.

7.5.14 FURTHER RESEARCH POSSIBILITIES

- How can biology be adapted so that it is flexible and accessible to all learners regardless of their learning needs?
- To what extent are blind learners who are not doing biology or any other life science subject at a disadvantage, as compared to those who do study these subjects?
- Are blind learners in South Africa more excluded from doing life science subjects than their counterparts in the rest of the world?
- How can blind learners benefit or not benefit from carrying out observations?

- How does South Africa compare with other countries with regard to supporting blind learners in the education system?
- How can other South African researchers contribute in this field so that we can gain more insights and achieve more worthwhile results?