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Reimagining New Approaches in Teacher Professional Development

Edited by Vimbi Petrus Mahlangu

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http://dx.doi.org/10.5772/intechopen.77155
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Contributors

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Notice

First published in London, United Kingdom, 2018 by IntechOpen
eBook (PDF) Published by IntechOpen, 2019
IntechOpen is the global imprint of INTECHOPEN LIMITED, registered in England and Wales, registration number: 11086078, The Shard, 25th floor, 32 London Bridge Street
London, SE19SG – United Kingdom
Printed in Croatia

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library

Additional hard and PDF copies can be obtained from orders@intechopen.com

Reimagining New Approaches in Teacher Professional Development
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p. cm.

Print ISBN 978-1-78984-189-3

Online ISBN 978-1-78984-190-9

eBook (PDF) ISBN 978-1-83881-838-8

Meet the editor

Prof Vimbi Petrus Mahlangu holds a B.A.Ed. (Vista University), B.Ed., MEd, and Ph.D. degrees from the University of Pretoria. He is an Associate Professor at the University of South Africa, Department of Educational Leadership & Management. He is responsible for teaching and research. He has presented papers at national and international conferences. He is a recipient of the Dean's Award for Excellence in Teaching in the Faculty of Education (2011) at the University of Pretoria. He has published extensively in accredited journals and authored a book and book chapters.

Contents

Preface

This book contains selected chapters submitted to IntechOpen publisher by scholars from all over the world. After review, a number of chapters was selected to be included in the book. Reimagining New Approaches in Teacher Professional Development is the main concept used in the title of the book. Most chapters directly or indirectly present and discuss new approaches in professional development in general. The purpose of the book is to inform readers that there are new ways of developing teachers professionally, and to equip readers with the skills needed to teach in a professional way. The book aims to providing new knowledge about professional development to academics, education authorities, teachers, parents, governing body members and university lecturers.

Prof. Vimbi Petrus Mahlangu
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Chapter 1

Introductory Chapter: Reimagining New Approaches in Teacher Professional Development

Vimbi Petrus Mahlangu

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.81120

1. Introduction and background

The book aims at providing new approaches in teacher professional development, geared towards improving quality teaching and learning to increase trust in our teachers' pedagogy at educational institutions. Professional development opportunities take time to accomplish, and the increase in workload could result in more feelings of stress and burnout in some teachers. Similarly, teachers could easily experience job stress from personal and environmental influences. Generally, other stress may emanate from behavioral problems of students and low teacher motivation. Again, another source of stress may come from work issues such as high teacher workload, unusually high numbers of students in their classes, or too many professional responsibilities given to them [1]. Teachers need development in communication skills for them to collaborate within different contexts and school cultures and to have administrative support to influence their professional development [2]. They need to have greater teaching efficacy. Teaching efficacy is a teacher's judgment of his or her capacity to cope with the teaching situation in ways that bring about desired outcomes and ought to revolve around teachers' confidence in being able to implement instructional strategies that could boost students' learning, engagement, and desired behaviour [3].

On the other hand, teacher professional development ought to focus on mediating outcomes (teacher knowledge, beliefs, and practices) for understanding the process by which professional development programmes might affect student learning. In addition, the focus should also be on content, on classroom applications, and on opportunities for teachers to interact with and learn from each other in different contexts [4]. The quality of teacher-student interactions plays an important role in fostering desirable affective-motivational learning outcomes in students. Prolonged development interventions and continuous reflection are necessary for teachers to change their practice and make changes sustainable, even if on the way towards

those goals, teachers might show their individual learning path [5]. Key components needed for successful implementation of professional development should include shared beliefs, values, and mission; shared and supported leadership; supportive conditions; caring and respect among members; and collective learning with intentional sustained focus on student needs. Core elements that teachers should know in their development should include the promoting of the culture within and outside school, gaining active engagement from families and community, and building sustainable leadership. This type of professional development ought to be aligned to transformational learning theory in that teachers need to be empowered to take ownership to identify and solve problems that affect their teaching and outcomes for their students [6].

There is a tendency for professional development activities to focus on technology and not on pedagogy. *Pedagogy* refers to the 'essential dialog' between the activities of teaching and learning and how we think and talk about, plan, and structure those activities. Pedagogy involves a way of knowing as well as a way of doing. In various professional education situations, teachers are not only expected to act professionally but to behave professionally. Therefore, teacher professional development focuses on assisting them in acquiring on-the-job knowledge, skills, and abilities relevant to their discipline. In addition, advanced teacher professional training need also to adopt the professional values and behaviors that society associates with being a professional. Rather than being explicitly taught, however, much of what is learned ought to be acquired tacitly through observation of role models and enculturation in professional practice settings, often termed the 'hidden curriculum' [7]. Decision-makers and schools are expected to weigh the advantage of professional development against the disadvantage of adding a time-consuming activity to the lives of already burdened and busy teachers.

2. Structure of the book

In this section the editor provides an overview of what each author covers in their chapter. The book comprises of eight chapters covering the idea of reimagining new approaches in teacher professional development. In Chapter 1, Vimbi Petrus Mahlangu of the University of South Africa (UNISA), Department of Educational Leadership and Management, argues that the book provides new approaches in teacher professional development, geared towards improving quality teaching and learning to increase trust in our teachers' pedagogy at educational institutions. Teacher professional development ought to focus on mediating outcomes (teacher knowledge, beliefs, and practices) for understanding the process by which professional development programmes might affect student learning. Key components needed for successful implementation of professional development should include shared beliefs, values, and mission; shared and supported leadership; supportive conditions; caring and respect among members; and collective learning with intentional sustained focus on student needs.

In Chapter 2, Ulas Kayapinar of the American University of the Middle East, Kuwait, discusses the reflective practitioner development model (RPDM) for professional development of teachers based on principles of reflection and measurement of the development of teachers'

reflective abilities and self-efficacy. Teachers are required to manage their students' study skills, enthusiasm, motivation, and other skills of themselves as self-control, conflict management, and decision-making. Therefore, self-efficacy belief has a role as a tool for management and control power for teachers to provide effective teaching for themselves and effective learning for their students. The reflective practitioner development model (RPDM) to work should have the following elements, namely, (i) measurements of teacher reflection using Teacher Reflection Scale (TRS), (ii) measurements of teachers' self-efficacy beliefs using Teachers' Sense of Efficacy Scale (TSES), (iii) professional development (PD) workshops, (iv) reflective (classroom) observations, (v) feedback, (vi) focus group discussions, (vii) co-planning, and (viii) peer observations.

Chapter 3 is a critical review of the kind of training or professional development typically offered to teachers. Tebogo Mogashoa of the University of South Africa, Department of Curriculum and Instructional Studies, College of Education, is of the view that high-quality teacher training or professional development is essential for producing quality education in all schools in the Republic of South Africa. Continuing training or professional development programmes can only have the potential to be transformative and life-changing if they have personal meaning for the participating teachers. Teachers should work together and create learning area or subject clusters in order to resolve common curricular issues. The initial and continuous professional training of teachers should always aim at developing them with knowledge and skills that will enable them to fulfill their tasks as facilitators of learning processes. Professional development of teachers ought to be guided by research and practice knowledge about how effective transformation happens in education environments.

In Chapter 4, Evon MO Abu-Taieh, of the University of Jordan, Aqaba, Jordan, discusses cyber security body of knowledge and curricula development. The author attempts to put basic step and a framework for cyber security body of knowledge and to allow practitioners and academicians to face the problem of lack of standardization. The physical security of data software and hardware from authorized and non-authorized access includes, but not limited to, protecting the server room, its location, the switches, the cable, data, and data storage devices from fire and excessive heat intruders. As such, server rooms are typically equipped with fire distinguisher, air conditioned, and insulated from fire, and its floor is raised to docket the cables. For authorized personnel, another layer of protection to access the IT systems should be to set up password-protected access or magnetic card to retina scan to lock and key.

In Chapter 5, Yitzhak Ezuz of the Beit Berl College, Kfar-Saba, Israel, discusses about moving from training/taming to independent creative learning: based on research of the brain. For survival and energy-saving purposes, the brain developed in such a way that the learning process is as short as possible, while most energy is devoted to converting the results of learning into automatic activity. The move to automation of learning outcomes is based on mechanisms, which can be used to tame animals, including man. Humans yield most of the time to the processes of self-taming/training of the brain, even empowering them through the Western concept of learning which idolizes focused narrow specialization. Through automatic learning, the brain suppresses the vast majority of the information that floods it through its representative use of the brain's ability to create basic patterns, which are then complemented

through information already stored in the brain unconsciously. In this way the brain does not need to make an effort every time to convert all the information to brain information; flexibility enables the brain to avoid having to remember entire knowledge schemas but rather builds them again every nanosecond. Therefore, without developing man's creative potential, humanity will fade away.

In Chapter 6, Welcome Mswazi Kubeka of the University of Johannesburg, Johannesburg, South Africa, discusses corporal punishment as a disciplinary measure as it was abolished in South African schools since 1994. The chapter is about the views of teachers about the different disciplinary measures they use as alternative to corporal punishment at selected primary schools in Tembisa, Gauteng Province, South Africa. The findings revealed that the majority of teachers had not received any training pertaining to the management of discipline after the abolishment of corporal punishment in Tembisa schools. Teachers view poor academic performance of learners as affected by the lack of proper discipline. Disruptive and anti-social behaviour can have a harmful influence on teaching and learning. Schools should involve parents to assist them with the discipline of their children.

In Chapter 7, Idar Lyngstad of the Nord University, Levanger, Norway, discusses hiding techniques in physical education—categories, causes, and pedagogy. The author proposes that the teaching of physical education in schools across cultures and countries should be a safe area for all pupils. The teacher at a deeper level than just to observe their physical-motor skills and sports achievements should follow up pupils who use hiding techniques in physical education in the class. The need for a pupil to use hiding techniques should be analyzed and prevented. Different pedagogical tools must be considered and used. Being seen in physical education relates to how the teacher establishes a good relationship with the pupils, caring, helping, and supporting them if physical education classes are experienced as difficult. In addition, hiding techniques in physical education are indicators of pupils' poor self-confidence in their subjects, which will adversely affect the learning process and learning outcomes.

In Chapter 8, Isaac Buabeng[1], Lindsey Conner[2], and David Winter[3] of the [1]University of Cape Coast, Cape Coast, Ghana; [2]Flinders University, Adelaide, Australia; and [3]University of Canterbury, Christchurch, New Zealand, discuss about professional development and physics teachers' ongoing learning needs. Physics teachers are not happy with the lack of formal physics-focussed professional development opportunities available to them to support their professional growth. On the other hand, teachers tended to rely on personal critical inquiry and infrequent practitioner meetings to inform their practice. Physics teachers tend to view centralized government-funded professional development as being ineffective. Physics teachers can be supported through induction, mentoring, and opportunities for collaboration because they have the capability to deliver the best physics instruction. Professional development organized for teachers should enable them to take ownership of the learning process through reflecting on their practices, identifying their own needs, and connecting their practices with relevant theories, and connecting together in professional learning groups. Physics teachers need professional learning development in the areas related to understanding student thinking in the subject to deepen their own content knowledge.

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Chapter 2

Reflection in Teacher Development

Ulas Kayapinar

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.78257

Abstract

Correlative and empirical studies on reflection seem to have a lack of concern regarding teacher development. This chapter presents the reflective practitioner development model (RPDM) for professional development of teachers based on principles of reflection and measurement of the development of teachers' reflective abilities and self-efficacy. The model focuses on reflective development of practitioners with self-efficacy, the procedure of the program, and the measurement of reflection and self-efficacy of teachers. It was tested through collecting quantitative and qualitative data. The findings suggest that the model had strong evidence for the educators to use, including the support to creating and promoting reflection and self-efficacy.

Keywords: reflection, self-efficacy, professional development, measurement

1. Introduction

The continuous development of societies requires a growing need for individuals who are well prepared for their profession. In order to find out whether individuals are well prepared, measurement and evaluation procedures can take place. Continuous development, as each profession requires, is also a requirement for teaching. Earlier, Schön [1] made an influence on teacher education and development stating when practitioners reflect, this can work as a corrective for reflection helps questioning the everyday practice and experiences. Individuals find themselves in an uncertain or unique situation which is experienced by surprise, puzzlement, or confusion. Recently, professional development is based on constructivist approach, and teachers are seen as active learners who teach, assess, observe, and reflect [2–6]. To achieve these tasks, teachers should become reflective practitioners who can question themselves, reflect on their practices, build new pedagogical techniques when needed, and develop their expertise using continuously-acquired knowledge of the profession. In this way, they can

reflect-for-action, reflect-in-action, and reflect-on-action. With this emerging need, this chapter focuses on presenting a new model for teachers and educational institutions to create a reflective teaching and learning environments in which reflective practitioners are involved.

Although there are many models and/or studies which have been implemented on teacher development, the literature indicates a lack of special emphasis on any research for the overall measurement of reflective development teachers in preservice or in-service programs while there is an extensive nature of the research on teacher education, reflection, and teacher beliefs independently [7–11]. Research on the effect of a reflective development process on teachers' reflective behavior and self-efficacy is also underrated. Taking evaluation as the generative source of other elements of curriculum [12], this chapter focuses on presenting some ways for teachers' reflective development with a new model called reflective practitioner development model by Kayapinar [13], shortly RPDM, ensuring and maximizing the use of reflection and self-efficacy.

The model emerging from "experiential learning" [14] tries to support professional development of teachers by using reflection and continuous development. As teachers are not always able to develop their knowledge and skills needed and/or required by the institution at which they work, reflection can play an effective role in self-improvement. Such an improvement can be provided by the practitioner's own comprehension of self and practice [15]. Reflection makes them able to observe, act, and evaluate their experiences and develop a habit of learning from those experiences. They become able to frame practical issues they face everyday, question them, reframe them within different perspectives, and take action [16], so they can become reflective practitioners. In this way, they may adopt a reflective stance to practice as a means of on-going professional development [17].

Continuous development, as reflection does, takes learning as a continuous process grounded in experience which requires the resolution of conflicts relating to or resulting from experience [18].

Self-efficacy refers to people's beliefs about what they are capable for taking action successfully in order to achieve desired outcomes [19]. One's judgment of capabilities and competences within a specific framework is the concern of self-efficacy. In brief, it concentrates on one's own assessment of abilities building on personal experiences in the past.

In-service professional development of teachers using a new model to develop teachers' reflective abilities and self-efficacy beliefs can develop teachers' reflective abilities and self-efficacy beliefs, and their awareness of the potential of engaging in problem identification can be raised through noticing and questioning events of everyday practice [20]. In this regard, the primary purpose of this chapter is to present some ways that teachers develop their reflective abilities and self-efficacy beliefs for teaching practices in a reflective in-service development program and demonstrate the potential of the new model for reflective practitioners to initiate the procedures and the context of the model that could be involved.

2. The RPDM context

Reflection, requiring personal and intellectual growth of oneself and of others, is a meaning-making process and a systematic, rigorous way of thinking which moves a learner from one

experience into the next with deeper understanding in interaction with others [21]. In order to develop teachers' reflective abilities and their awareness of the consequent demands of time and expertise which may be imposed on teachers [22–25], integrated foundation courses in McGill University-RCJY English teaching project were used to test the new reflective practitioner development model for 16 weeks. The project provided English instruction for local college students' mastery of English at the technical workplace. The teachers' reflective development process within the new model was initiated by the head/academic coordinator in 2012–2013 academic year. A total of 45 teachers went through the in-service development processes, teaching practices and the gaps perceived between what had been provided and what had been needed at the end of the previous year.

The model contains the following elements: (i) measurements of teacher reflection, for example, using Teacher Reflection Scale, in short, TRS [26]; (ii) measurements of teachers' self-efficacy beliefs, for example, using the Teachers' Sense of Efficacy Scale, in short, TSES [27]; (iii) professional development (PD) workshops; (iv) reflective (classroom) observations; (v) feedback; (vi) focus group discussions; (vii) co-planning; and (viii) peer observations.

2.1. Measuring reflection

Measuring reflection of each teacher provides important data and evidence of each teacher's reflective abilities in the beginning of the teaching and learning process. This can be done in different ways. The best way of doing it is the use of a valid and reliable scale to compare the reflective performances of the teachers in the beginning of the teaching and learning process and at the end of it. Some sessions for formative evaluation can also be held to see the continual reflective development of the teachers. These sessions can be arranged by superiors based on the course calendar and examination systems. Comprehensive experiences of preparation will make teachers feel well-prepared, so they will consequently be more persistent in the profession, and, teach in a more effective way than their less well-prepared colleagues [28]. The professional's own perception of his or her practice driven by well-preparedness and readiness to teach can foster improvement of the practical [15]. Accordingly, each teacher can respond the items in TRS to develop reflective abilities in a valid and reliable manner. The purpose of using a reflection scale is to see whether, or in what sense, each teacher is aware of and interprets teaching experience, and is able to generate possible explanations and solutions for the confusions or problematic situations by being able to describe those [16]. In this way, teachers' reflective abilities of noticing and questioning events of everyday practice and of especially themselves can be framed and their reflective abilities can then develop, and their awareness of the potential of engaging in problem identification can be raised through noticing and questioning events of everyday practice [20]. This measurement can be supported with an easy and purely personal way of reflection, which is teacher diary. In and/or after each lesson, teachers make notes and/or write their feelings and reactions considering the entire lesson objectives and each activity or technique they used during the lesson. They can use two simple questions to do that as in the following:

1. What have I done?
2. What can I do for the better?

The responses to these questions will probably be helpful for describing their reactions and feelings for each lesson holistically and for each learning point and unexpected occurrence in the lesson analytically. Still, it is good to do this alone, but better to do it with a colleague or a mentor who can record, give feedback, and look into each reaction with a background knowledge and experience of reflective teaching.

RPDM study showed a significant change in teachers' reflective behavior at the end of an in-service practitioner development process ($Z = -2.711$, $p = 0.007$). The mean scores increased sharply from 69.53 to 80.13%.

2.2. Measuring self-efficacy

TSES is used in order to reveal and check the teachers' reflective abilities and self-efficacy perceptions because the beliefs of teachers as learners concerning their abilities to do an activity and the value of this activity may influence their individual selections, insistences and performances to carry out the activity [29]. In addition to this, teachers are required to successfully manage their students' study skills, enthusiasm, motivation and such other skills of themselves as self-control, conflict management, and decision making. Thus, self-efficacy belief has a role as a tool for management and control power for teachers to provide effective teaching for themselves and effective learning for their students. It can influence either students' motivation to participate more readily in the lessons, work harder, and persist longer and emotional reactions through their learning or teachers' motivation as choice of activities, level of effort, persistence, and performance in their teaching practices [30]. TRS and TSES measurements are a good way for the teachers to raise awareness about reflection and self-efficacy, to mirror teachers' own concrete experience in the teaching-learning environment, and later, to lead the way for them to reflect, conceptualize, and evaluate what they have experienced in that environment.

TSES measurements also revealed that there is a sharp increase in self-efficacy scores of the teachers after the application of RPDM. The mean score increased from 77.45 to 86.15. Statistical analysis also showed a significant change in favor of RPDM ($Z = -4.360$, $p = 0.000$).

Apparently, the mean is higher at the end of the RPDM process, which might mean that the teachers are more reflective and their reactions toward problematic situations, confusions, or irregularities in professional teaching environment. One of the factors which lead to these results is professional development workshops. These workshops which provide opportunities for teachers to share ideas, improve their knowledge, and gain insight to reflect and find ways to develop are explained in the following.

2.3. PD workshops

Educational organizations need to approach collaborative time with a focus on teacher learning and development that are on organizational practice and how they relate to teacher efficacy sources that is in need of consideration [31]. Workshops, in this sense, could benefit both teachers and the leadership team. For teachers, workshop contents might emerge from both the academic coordinator by using a reflective stance, and it can lead formal observations,

peer observations, focus group sessions, and critical reflections. In these workshops, teachers can deliver short presentations on problematic aspects of their daily teaching practice that they strive to better. In order to encourage teachers to present and bring out some discussion for the potential growth, they can work in pairs or groups first. Later, they can be more motivated to engage in a more elaborate brainstorming session. These brainstorming sessions can be helpful for exchange of strategies and techniques to overcome possible challenges. These pairs or groups then make larger groups sharing and discussing experiences in a more comprehensive way. Teachers can then contribute to their reflective abilities and sense of efficacy by cooperation, question-answer, feedback, and reinforcement. In this way, possible confusions, moments of hesitation in the classroom, engagement of students with learning to achieve the objectives, and management of the teaching and learning process, applying practical techniques to real-life environments, and meeting specific needs of both students and teachers can lead to development and improvement of reflective abilities.

2.4. Reflective observations

Observation sessions and immediate feedback exchange are used for reflection-on-action to reflect on the experience by discussion on classroom practice and challenges in the classroom environment. Reflective observations can also be employed for assessing and mirroring the development of the professional. Within the RPDM cycle applications, these observations should occur at least twice; one in the beginning right after the first application of TRS and TSES measurements; one at the end right before the second application of TRS and TSES measurements. These reflective observations can also be employed as teachers' formative and summative performance evaluations which could be held in periodical sessions regarding the needs for each teacher. Teachers, in this way, will be able to see their progress of the reflective practitioner. The findings of these reflective observations can also be used as motivational tools for reflective feedback and idea exchange in reflective sessions of practitioner development held immediately after the observation session. These reflective feedback and idea exchange sessions provide opportunity for critical reflection and discussion on the observed sessions. The outcomes of these sessions can be marked as part of the path for the reflective development process. Reflective observations are a good way of seeing challenges and gaps which give opportunities for teachers to fulfill their role effectively. Follow-up observations should also be scheduled until the teachers see they are on the right track. The observation tool should cover all the criteria needed to see the real performance of the teachers depending on the performance expected from the teachers considering the expected outcomes of the curriculum. In RPDM study, the observation scores of the teachers increased significantly ($Z = -5.737$, $p = 0.000$). Relatively, the mean score increased sharply from 55.65 to 73.51.

2.5. Reflection and feedback

Kayapinar states reflections are concise, bullet-pointed inquiry regarding staff members' thoughts, critical flashbacks, and self-questioning on their performance [13]. Reflections can be used by both teachers and the leadership team, and each reflection session, as long as it is done in a habitual way, it could drastically improve teachers' teaching and learning

environments and their professional skills. Teachers can also include a few lines on their lesson plans, attendance sheets or in a separate notebook or binder for recording their insights and comments about the lesson plan, its flow, and the way students were engaged and responded. Continuous reflection would serve teachers as a great benefit. These reflections could then be archived to build on previous observation sessions and gain a sense of development of a reflective practitioner. Specifically, the teachers are recommended to ask themselves the following three questions emerging from two basic questions of reflection that are "What have I done?" and "What can I do for the better?" [26] suggested by Kayapinar [13]:

i. Which elements of my learning environment helped my students' success?

ii. Which elements of my learning environment impeded my students' success?

iii. How can I improve my learning environment?

The quality and quantity of teachers' reflections could be evaluated in reflective feedback sessions between the teacher and the superiors. These sessions could be scheduled on week days and can be held in office hours. They can also be gauged implicitly or explicitly through formal observations. Reflections could then be discussed during the post-observation feedback sessions or focus group sessions or before each formal observation and factored into the assessment.

2.6. Focus group discussions

Focus group discussions comprise interaction within a group based on prespecified topics [32], and they can contribute to reflection and sense of efficacy by its nature and features like organized discussion [33], collective activity [34], and interaction [35]. Organized discussion, collectivity, and interaction enable participants to ask questions, to get feedback, to re-evaluate and reconsider their own understandings and experience. In the RPD cycle, the academic coordinator to discuss and comment on, from personal experience, the topic that is the reflection of classroom practice, assembles the teachers. Information on experiences is elicited in a way which allows the academic coordinator and the teachers to find out why an issue looks prominent. The gap between what people think they do and what they do can be better found out by asking the following two questions: "What have I done so far?" and "What can I do for the better?" [26].

Many participants can find opportunities on reflection, working on confusions, and finding solutions in a collaborative way empowering. This can lead to a sense of efficacy and autonomy by using reflective insights on teacher and student behavior within a structured group work process and collecting information for precise issues which are complicated, unknown, or disturbing.

2.7. Co-planning

While co-planning has been noted in some fashion at all institutions, its potential has yet to be fully realized. The core benefit of co-planning is reflection-for-action [13]. Reflection-for-action is also called flash-forward of the classroom practice. It improves both the collective

sense of efficacy by exchange of continuous feedback and the quality of lesson plans by opening up teacher's office hours, critical reflections, post-observations meetings, and preparation for workshops. The updated system is run as follows; teachers –within their respective level/section- will devote one day of office hours to planning a lesson using the template given. They have a discussion on these lesson plans and give feedback to each other until they have consensus that the particular lesson plan reflects the objectives and the outcomes of the particular class. Then the final draft is presented to others teaching the same course in order to be used by everybody. Using this way, teachers can plan for the entire week or a two-week period depending on the number of teachers who teach the same course. This helps everybody be on the right track as they make discussions, exchange ideas, share feedback, fill in the gaps, improve themselves, and grab an opportunity of continuous development. Archiving these lesson plans provides another advantage in daily practice. Archived lesson plans can be used on demand when one of the teachers calls in sick, a new hire should step into the classroom immediately, or the semester begins. Co-planning can also be measured using formal and peer observations in an implicit way, or it can be measured explicitly via some prespecified criteria, checklist, or rubric of best practice.

2.8. Peer observations

Teachers with skills, which need to be developed in one area, could be paired with teachers boasting strong skills in that same area. They could either pair themselves up-having reviewed their reflections- or be paired by the leadership team. Teachers can go over the lesson plan and review each item in it as well as the criteria and objectives of peer who will do the observation. These criteria can be determined either previously by the teachers and the leadership team based on the objectives or by the peers who will do the observation and who will be observed based on the objectives. The peers should have the opportunity for a quick reflection session and peer dialog after the observation, and they should share their notes for future reflection. Following peer observations can be based on these reflective outcomes and the objectives of the session which will be observed. Peer observations can also be measured implicitly or explicitly by formal observations or making use of reflective outcomes of each peer observation and post-observation discussions. Peer observations, besides being a useful form of professional development, are a tool to build a team of trust among colleagues, provide mutual support, and enrich student learning especially when the observee and the observer work together and reflect on the teaching practice held in the observed session. The observed sessions can become more effective when the observees model new ideas and/or techniques they acquired at professional development workshops. Based on the components explained so far, the Reflective Practitioner Development Model can be visualized in the way below, and it can give an idea about the reflective model briefly [13].

The figure below simply gives a cycle of RPDM. The cycle starts with TRS and TSES measurements, so each teacher's reflection and self-efficacy levels are measured in the beginning of the process to be compared at the end of the Reflective Practitioner Development Model program. These measurements are followed by the first round of necessary workshops of professional development and reflection. These workshops can also be driven by teachers' reflections and/or focus group sessions. Teachers could come prepared to deliver a short presentation on a

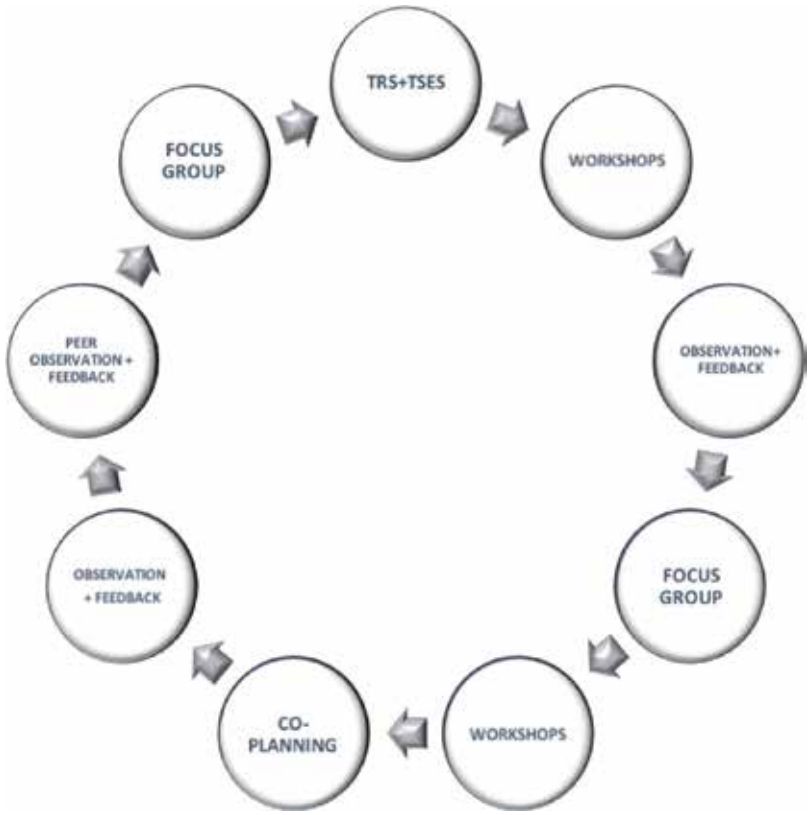

Figure 1. Components of RPDM.

problematic aspect of their teaching practices in the teaching and learning environment. Next is the observation and feedback step. The teachers are observed and motivated to reflect on the experience as soon as possible and discuss on immediate feedback on specific successful engagement with the students or confusions and problematic situations in the classroom environment. Next, focus groups session or sessions are arranged to discuss the reflections of classroom practice, and the experiences are elicited in a way which allows the teachers to find out why an issue is worthy of note. The second round of workshops is then held to fill in the gaps and see the improvements of the teachers. Later, co-planning is held in order to reflect-for-action giving an opportunity to flash-forward the classroom environment. It also improves both the collective sense of efficacy by exchange of continuous feedback and the quality of lesson plans. Then observation and feedback sessions are organized again to give an opportunity for teachers to reflect on their practices in order to receive appropriate feedback on their teaching performance. These observations precede peer observations and feedback sessions which are held by peers who are more experienced or chosen by the observee. The second round of focus group discussions are held again to create an environment for teachers to share their experiences by reflecting and exploring attitudes and feelings and drawing out precise issues that may be unknown, confusing, or causing pressure in the environment. Finally, TRS and TSES measurements are used for the second time to see possible differences

which RPDM has created throughout the practitioner development program. The RPDM timeline is presented in the following to make this process more apparent to see [13]:

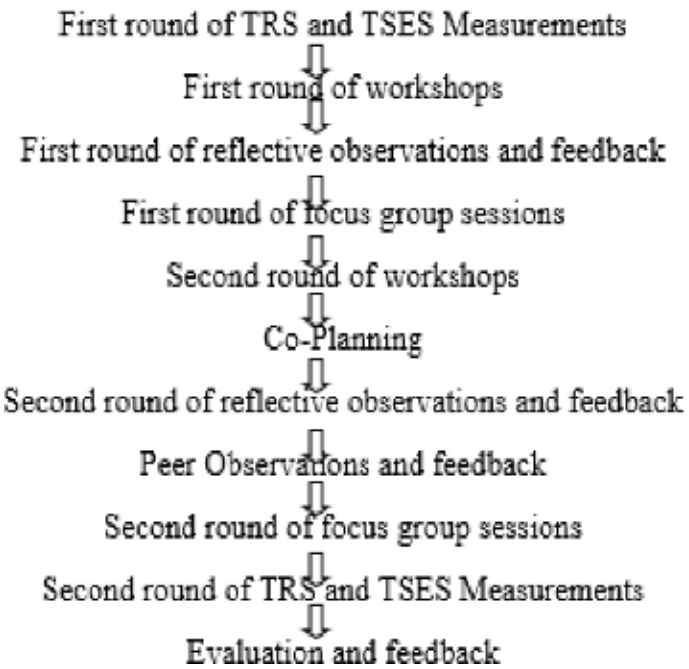

Figure 2. RPDM timeline.

Using the components in **Figure 1** and the timeline presented in **Figure 2**, the reflective practitioner development model cycle was adapted to Kolb's reflective cycle. This cycle is presented below [13] (**Figure 3**).

The cycle gives us the stages of reflective learning. First a new experience or situation is encountered. This experience starts with TRS and TSES measurements and necessary workshops in RPDM cycle, and the teachers start teaching. For most of them, reflection and self-efficacy are new experiences when they respond to TRS and TSES scales and are given related workshops. While they are experiencing this new encounter or situation, they are motivated to reflect on their practices, and reflective observation starts to see any inconsistencies or irregularities between the experience and the understanding of the teacher. This stage is supported by observations by an outer party who can reflect and guide on the reflections of the teacher. The stage of abstract conceptualization starts with the focus group discussions, workshops, and co-planning. At this stage of the cycle, the teacher begins to reshape his or her ideas and the existing concepts in his or her mind are welcomed to be modified. This stage is also supported by focus group discussions and workshops, so the teacher can find answers to the questions which cannot be answered by the existing knowledge or experience of the teacher herself/himself. Co-planning completes this process by working on amendments and modifications with a peer, usually a more experienced one. Last, the active experimentation

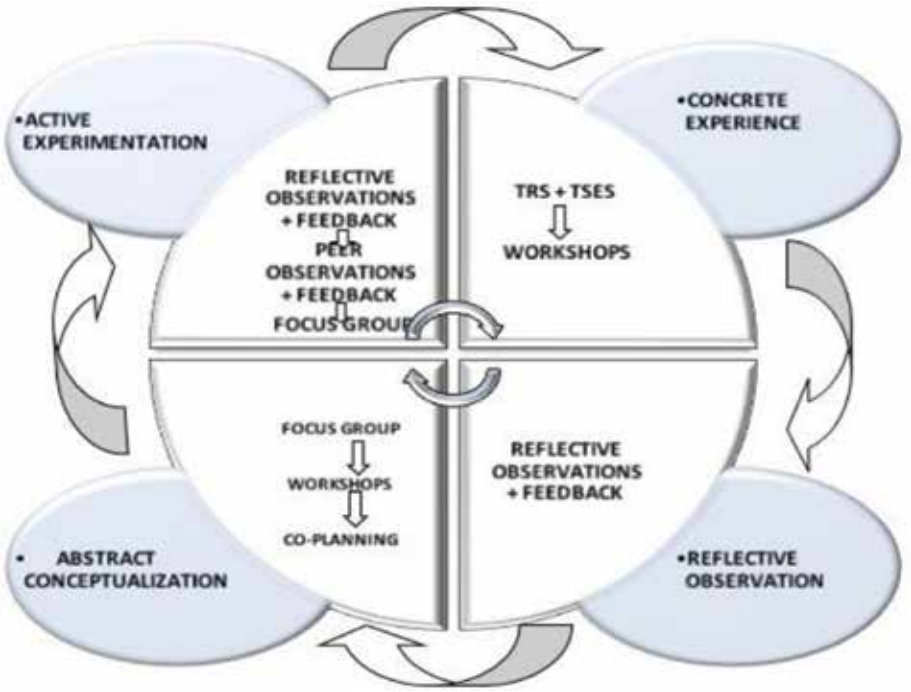

Figure 3. RPDM cycle.

stage takes place for the teacher to see the application all the new concepts, knowledge, ideas, techniques, etc., depending on the necessities during the teaching and learning process. This stage is also realized with the second round of reflective observations, peer observations, and focus group discussions while the teaching is being continued. This stage fills in the gaps and completes the process of reflective practitioner development. Finally, the teachers take TRS and TSES to see their development throughout the model process.

3. Conclusion

The reflective practitioner development model raises awareness and advances teachers' reflective development and sense of efficacy. The reflection scores of the teachers in the study gives evidence to this development (the TRS mean score is 80.13 in the second round whereas it is 69.53 in the first round.) This was supported with the result of the correlation analysis ($p = 0.007$). Similarly, the TSES mean score of the teachers show a higher level of self-efficacy in the second round application (86.15) when compared to the mean score of the first round (77.45). This was also supported with the result of the correlation analysis ($p = 0.000$).Moreover, focus group discussion sessions fitted the objectives and the development of the model clearly. The teachers apparently became aware of the reflective processes and more reflective with a high level of sense of efficacy. Teachers' evaluation of the process is positive (80.14%) and their feedback on the evaluation of the ongoing

professional development via their open ended comments also indicate that the professional environment was collaborative and reflective, and this made them develop personally and professionally. Especially the corrective action plans and the workshops which were organized periodically that are tied in with professional development resources and mentoring based on observation data and reflection were highly appreciated. The lack of communication between the teachers and the leadership time to time could be seen as a weakness in this research, which should be taken into consideration as an important step for future improvement of RPDM. Another step for future improvement of the model could be student questionnaires and evaluations of the program and teachers' reflective practice. In addition, a larger number of teachers could be included in the program to meet the requirements of normal distribution and to have more reliable results of the statistical analyses. Focusing only on reflective abilities and sense of efficacy that are emphasized in the teaching and learning process could also do observations. Some questions might arise for the effect of reflective thinking and teaching, and the change in teacher attitudes, beliefs, and performances. This might lead far-reaching implications for decision makers and teacher educators to question the possibilities of reflective thinking and teaching for all preservice teachers since each of them gains insight and increases higher levels of reflective thinking by becoming reflective agents while challenging problems and having opportunities for learning and practicing reflective skills. In sum, this study gives an insight to a built-in procedure of a new design and model of reflective teaching and reflective practitioner development as a professional development program for the teachers, assesses the strengths and weaknesses, and makes suggestions for improvement.

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Chapter 3

A Critical Review of the Kind of Training or Professional Development Typically Offered to the Teachers

Tebogo Mogashoa

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.78741

Abstract

The main aim of this research was to review the type of professional development or training that was offered to the teachers so that they can implement policies on teaching and learning. The researcher used critical theory as the basis of his research. Qualitative research assisted the researcher to review the type of professional development or training that was offered to the teachers so that they can be able to implement policies on teaching and learning. Data analysis included sorting, conceptualising, refining and organising data into a coherent new structure. Furthermore, the researcher discovered after data interpretation that some of the teachers were professionally developed or trained on the different policies for teaching and learning. The Department of Basic Education should provide teachers with pre-service and in-service training programmes or professional development programmes. Such professional development programmes or pre-service and in-service training programmes should be provided in order to empower teachers with knowledge and skills that will enable them to fulfil their roles as mediators of teaching and learning.

Keywords: development, curriculum, implementation, programmes, strategies, transformation

1. Introduction

The new democratic dispensation was faced with many reforms and among those reforms proposed by the South African government was transformational outcomes-based education.

That educational reform ushered Curriculum 2005 (C2005) with emphasis on outcomes-based learning and teaching. It was believed by the education authorities that C2005 would empower all South African learners with knowledge, skills, attitudes and values which would provide productive and valuable agents of social change in creating a better future for all [1, 2]. That transformative approach to outcomes-based education introduced by the Department of Education also emphasised critical outcomes. In 1997, C2005 was introduced and then piloted in some selected schools in the Republic of South Africa. Education authorities conducted a pilot study in Grade one classrooms in those few selected schools around the entire country from August to November 1997. Furthermore, in 1998, the Department of Education then introduced C2005 in all schools in the Republic of South Africa.

According to Mda and Mothata [3], the introduction of C2005 brought about a shift from teacher and content curriculum to outcomes-based and learner-centred curriculum. This brought in a paradigm shift on the side of both teachers and learners. Learners had to change the way they used to learn and be engaged in the learning processes while on the other hand, teachers also had to change the way they used to plan their lessons and teach their leaners. Due to many challenges experienced by teachers concerning the new teaching and learning policy, C2005 was reviewed in the year 2000. Thus, a Ministerial Committee was established, chaired by Linda Chisholm, which emerged with the Revised National Curriculum Statement (RNCS) [4]). However, in July 2009, another Task Team was established by the Minister of Basic Education to investigate the nature of the challenges and problems experienced by teachers in implementing the RNCS and to develop a set of recommendations designed to improve its implementation. The review committee of the RNCS then introduced the National Curriculum Statement (NCS). That was not the end of the new teaching and learning policy because another Task Team was established in order to review the NCS and then introduced a new document the replacement of the NCS and it is called the Curriculum and Assessment Policy Statement (CAPS). The researcher deemed it necessary, logical and appropriate to review the type of professional development or training offered to the teachers in order to implement these policies on teaching and learning.

2. Research design and methods

In this chapter, a qualitative mode of inquiry was used. [5] Reflects that in the research design one does not have to explain the details of how to implement the techniques, but only discusses the technique/s that will be used. [6] Indicate that research methodologies on qualitative studies evoke participants' accounts of meaning, their experiences or perceptions by producing descriptive information in their own spoken words. Qualitative research is usually used to answer questions about the complex nature of phenomenon, often with a purpose of describing and understanding the phenomenon from the participants' point of view [7]. The participants in this research were teachers who are teaching in the intermediate phase (grades 4–9) and who have been trained in Curriculum 2005, Revised National

Curriculum Statement, National Curriculum Statement and Curriculum and Assessment Policy Statement. Teachers in the intermediate phase were selected or sampled because of their noticeable experiences of the C2005, RNCS, NCS and CAPS. The participants in this research were also interviewed separately on individual basis. In order to create an environment of multiple/diverse ideas, the researcher conducted the research in five different schools.

2.1. Theoretical frameworks

In this research, the researcher used critical theory as a lens to base his arguments. The key focus areas in the philosophy of critical theory are the 'change and emancipation' of societies from being indoctrinated towards being critical and questioning [8]. As for [9] as cited in [10], the essence of education about society is that social reality is made by people and can be changed by people. This theory would assist teachers in realising that political and social reality is not fixed, but that these concepts can be changed and transformed by those living in that society or environment. This may be caused by the fact that most of the curricula facing most implementers or teachers in most developing countries are handed down for implementation without any room for them to actively participate in curricula development. Through critical theory, learners can learn the skills in collecting, analysing, organising and critically evaluating information. The most important aspects of the philosophy of critical theory are emphasised in reconstructing and in critically questioning the attitudes in the new curricula. Critical theory always raises some problems of the conscious especially when one deals with knowledge. Critical engagement about issues of education that affects the communities should be emphasised. It is imperative to give learners some learning activities that will cause them to be in engagement with themselves and the nature.

2.2. Data collection

According to Voce [11], the primary methods of data collection in qualitative research are observations, interviews and focus group discussions. Interviews were used as the main data collection method. However, other supplementary methods of data collection such as audiotapes, diary notes and videotapes were also used in this research. Furthermore, the researcher used interviews in order to provide room for face-to-face interaction with the participants to clarify some concepts that might be confusing to them. Qualitative data can be the best if collected from fewer participants. The interviews were also tape-recorded, and as a researcher, there was a need to play a leading role in data collection.

2.3. Data analysis and interpretation

According to Michelle [12], qualitative data analysis consists of identifying, coding and categorising patterns found in the data. [13] As cited in [1], once the data had been interpreted and that a specific understanding of the scope and contexts of the most experiences under scrutiny, coding of themes will provide the researcher with a critical system

in organising data. This will assist to uncover and document additional connections within and between some concepts and experiences as discussed in the data provided. Collected data should be managed appropriately in order to maintain high quality and accessibility. The researcher made sure that data collected were stored and retrieved for analysis. In order to address the issues that were raised in the research questions of this chapter, the researcher involved a systematic analysis of sources and opinions. Data were sorted accordingly, conceptualised, refined and organised into a coherent new structure [1]. Furthermore, the audio-recorded interviews with the participants were transcribed and then analysed. The researcher made sure that contradicting points of view, opinions and new insights were revised and refined. On the other hand, the researcher made sure that collected data were compared against each other and then consolidated into meaningful discussions.

3. Research findings and discussions

The thematic issues that emerged from the narratives of participants' lived experiences of the kind of training or professional development typically offered to the teachers are noted below:

3.1. The kind of training teachers received in respect of the new teaching and learning policies

Most teachers who participated in this research conceded that they received training and workshops for Curriculum 2005, Revised National Curriculum Statement, National Curriculum Statement as well as Curriculum and Assessment Policy Statement. A few of the verbatim responses are indicated below:

Participant S said, "We attended workshops for C2005, RNCS, NCS as well as CAPS".

Participant T, "We did attend some training workshops for policies on teaching and learning such as Curriculum 2005, Revised National Curriculum Statement, National Curriculum Statement as well as Curriculum and Assessment Policy Statement. The facilitators of the workshops came from the Department of Basic Education. They were curriculum implementers or subject advisors called learning area specialists".

Participant G, "The Department of Basic Education organised workshops for Curriculum 2005, Revised National Curriculum Statement, National Curriculum Statement as well as Curriculum and Assessment Policy Statement which we attended. However, the number of days we spent in the workshops was not adequate. We attended for three days only and then expected to implement those policies on teaching and learning. Some of the concepts for those policies were not clearly deliberated and as such, we were expected to implement what we did not understand well".

In order to identify the various aspects, the teachers received, teachers were asked to elaborate more on the workshops they attended.

3.2. The workshops teachers attended

In responding to the questions asked, most teachers mentioned that the workshops were not easy to understand. Few participants in this study had different points of views as indicated below:

Participant A, "In most of the training workshops we attended, the conductors provided us activities and tried to guide us on how to interact with those activities and we were also provided with chances to show how we will implement these teaching and learning policies in our classrooms. However, the content of the workshops were so huge to assimilate within three days only".

Participant N, "The workshops we attended, that is C2005, RNCS and the NCS, the facilitators told us different issues which were could not easily understand. The facilitators could not interpret the different documents the same way. We were also provided with many forms to complete. The presentations made by the participants in those workshops were actually not the same to what we were actually practicing in our everyday activities. However, the workshops for Curriculum and Assessment Policy Statement were easily understood. The facilitators of the workshops were clear and the content was also clearly organised. Actually, I can say the content we must teach is clearly stipulated".

Participant K, "The learning area or subject advisors organised some workshops for us. We attended for three days after school. The facilitators for Curriculum and Assessment Policy Statement were well prepared than those who took us through Curriculum 2005, Revised National Curriculum Statement and the National Curriculum Statement".

Participant B, "The curriculum advisors were not well prepared or maybe they also did not understand those new policies on teaching and learning. The workshop for Curriculum 2005 was very confusing. The facilitators were not clear about what teachers should do. At least, the workshop for Curriculum and Assessment Policy Statement was better".

In order to identify the kind of support, the teachers received from the Department of Basic Education, some questions were asked and the participants in this research responded appropriately.

3.3. The support teachers received from the Gauteng Department of Basic Education

Workshops were organised for the various policies on teaching and learning. All teachers who participated in this research indicated that the only support they received were workshops though follow-ups were inadequate.

3.4. The relevancy of training activities to what teachers were doing in their classrooms

Teachers responded appropriately to the questions asked. All teachers who were interviewed in this research indicated that the workshops were relevant, but it was not easy to implement the new knowledge and skills in real classroom environment. This was emphasised

by teacher O, when he said, "We attended various workshops and trainings activities were relevant, but it is totally different from what we do in our classrooms. In the classrooms, there are those who are very slow, and some are very intelligent and can easily understand what is taught. The training activities are relevant but more challenging to implement in the real classroom environment. When you present in the workshops there are only the educators but when you present in the classroom is a different story. You are faced with a real teaching and learning situation. Learners do not respond like teachers. Teachers pretended to be learners but they are not learners. In the workshops it is not a real learning and teaching situation".

Participant C said, "Facilitators took us through theories while in the classroom is a real teaching and learning environment. The workshop activities were relevant but we struggle on how to implement them in real classroom situation". This was further emphasised by teacher P who said, "Theory and practice are two different things. In the workshop is theory but in the classroom you must do things practically. The activities are relevant but the problem is implementation".

The above-mentioned responses were followed by other questions to determine teachers' opinions about the competency of S or coordinators of these policies on teaching and learning.

3.5. The competency level of the workshop facilitators or coordinators of the workshops

All teachers who participated in this research indicated that the competency of the facilitators who trained them for Curriculum 2005, Revised National Curriculum Statement, and National Curriculum Statement was inadequate but for the situation for Curriculum and Assessment Policy Statement was better.

4. Conclusions

An analysis from the research findings and discussions of this article indicates that teachers received training on the various teaching and learning policies. However, further analysis of these findings and discussions reveals that some policies were not deemed appropriate to what teachers were actually doing in their classrooms. The number of days that teachers spent in the workshops was not adequate. This research further found that the only intervention strategy the Department of Basic Education used to assist teachers in implementing policies on teaching and learning was in the form of workshops. This chapter also indicates that the coordinators or facilitators of the workshops were not sufficiently competent in Curriculum 2005, Revised National Curriculum Statement and National Curriculum Statement but were better in Curriculum and Assessment Policy Statement.

5. Recommendations

High-quality teacher training or professional development is crucial for producing quality education in all schools in the Republic of South Africa. According to Guskey [14] as cited in [1], authorities responsible for drawing policies recognise more that schools or classrooms

can be no better than administrators and teachers together. It is, therefore, imperative to find appropriate professional development strategies to make sure that all the teachers, even the most experienced ones, are capacitated with the appropriate knowledge and skills for improving performance by their learners [15]. Just like the practitioners in many other recognised professions, teachers also need to increase their knowledge and capacitate their skills over the course of their professions (Report on Teacher Professional Development 2006). Research tends to show that most training and professional development programmes for teachers are not satisfactory and also do not meet what they are intended for [16]. All stakeholders in education and more especially the policymakers have to scrutinise professional development or teacher training to understand clearly what would be the best for changing teachers' classroom practice [17]. As cited in [1], the researcher assets that current views of training or professional development usually emphasise the significance of involving teachers in defining their needs and developing opportunities for their training or professional development. In order to make appropriate policies and programme decisions for training or professional development, district officials, school administrators and leaders need to understand if training or professional development programmes are recently satisfying the teachers who need them most [18]. It is imperative always to involve teachers in the decisions to be made by the education authorities. Teachers are the principal actors in continuing professional development and any other programmes on which to be decided. Teachers should therefore be allowed to give their viewpoints and ideas on teacher training or professional development programmes.

This research has revealed significant sets of findings, and these findings provide recommendations for what the teachers realised as the best characteristics of effective training or professional development programmes. For training or professional development programmes to be useful, such programmes have to be meaningful to the teachers who are participating in them. The most challenging issues to people who make policies and management are to understand what the participants in those policies need and what the participants find useful. They can then develop continuing training or professional development programmes that respond to the participants' needs. Continuing training or professional development programmes can only have the potential to be transformative and life changing if they have personal meaning for the participating teachers.

The researcher, therefore, recommends that in order to effectively implement teaching and learning policies, the National Department of Basic Education must supply adequate curriculum staff that have knowledge to do excellent training for both the teachers and School Management Team members. Capacitation and professional development of teachers in new strategies, skills, insights and qualities should also be given first priorities. Teachers' training or professional development should be more extended, although shorter than initial professional development or training. Teachers should work together and create learning area or subject clusters in order to resolve common curricular issues.

Initial and continuing professional training should always aim at developing teachers with knowledge and skills that will enable them to fulfil their tasks as facilitators of learning processes. This can involve the revision of curricula in teacher training institutions to meet the demands of the current world. As part of teacher professional empowerment, the National Department of Basic Education should assist teachers to take courses that will upgrade them.

As teachers are lifelong learners, ongoing education is a requirement for teachers in all schools. Workshops, seminars and training courses can be conducted. Teachers can take part in upgrading activities such as courses/workshops (on subject matter or methods and other education-related topics), education conferences or seminars (at which teachers and researchers present their research findings, results and discuss education challenges), qualification developmental programmes (e.g. diploma or degree courses), observations at other schools, participating in networks with teachers mainly for the capacitation of teachers, individual or collaborative researches or a topic of professional interest as well as assisting and peer observations and coaching as part of formal school arrangement [1]). This will assist teachers to stay abreast of new trends and learn new strategies, techniques and methods for classroom activities.

Training or professional development should always align with and support system-based changes that encourage learning. Quality training or professional development must focus on empowering the improvement of teaching by enhancing knowledge and skills. Training or professional development programmes must also assist to change teachers' thinking regarding current developments. Professional developers must be guided by the research and practice knowledge about how effective transformation happens in education environments. The National Department of Basic Education must develop differentiated training or professional development programmes to respond to teachers' different of challenges.

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Chapter 4

Cyber Security Body of Knowledge and Curricula Development

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Shaha T. Alotaibi and Ghadah Aldehim

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.77975

Abstract

The cyber world is an ever-changing world and cyber security is most important and touches the lives of everyone on the cyber world including researchers, students, businesses, academia, and novice user. The chapter suggests a body of knowledge that incorporates the view of academia as well as practitioners. This research attempts to put basic step and a framework for cyber security body of knowledge and to allow practitioners and academicians to face the problem of lack of standardization. Furthermore, the chapter attempts to bridge the gap between the different audiences. The gap is so broad that the term of cyber security is not agreed upon even in spelling. The suggested body of knowledge may not be perfect, yet it is a step forward.

Keywords: body of knowledge, cyber security, ciphering, compression, database, operating systems, computer network

1. Introduction

Cyber security is a newly developed concept, proving to be of significance in the cyber world. The concept of cyber security admitted by many is not clear hence not standardized. This chapter aims to suggest a body of knowledge (BOK) based on two aspects: practitioners and academia. The chapter studied previous work of ACM, NICE, NICCS, and major academia institutes that offer master programs in cyber security. Furthermore, the chapter attempts to bridge the gap between the different audiences. The gap is so broad that the term cyber security is not agreed upon even in spelling. Then, the chapter presents the suggested body of knowledge.

The research first discusses the notation of body of knowledge: discussing the definition, incentive, and mechanism. The accreditation process is the application of the body of knowledge; hence accreditation and accreditation incentive are discussed and the ACM & IEEE development of body of knowledge to different disciplines in the Information Technology Arena.

The research then addresses duality of spelling of the term cyber security versus cybersecurity, both are used interchangeably. This discrepancy in spelling the term serves as the base gap among the cybersecurity community. While such a gap must be bridged commencing with reaching an agreement on one spelling, however, in the scope section, a framework of elements is suggested to at least limit the intrusions of some unrelated terms.

Then, the research gives a presentation about cyber security in the academic arena. The showcase of academic perspective of cyber security included 61 master programs and 17 different countries namely Australia, Cyprus, Czech Republic, Estonia, Finland, France, Germany, India, Italy, Lithuania, Malaysia, Malta, Netherlands, New Zealand, Spain, UK, USA. The showcase presented the many irregularities and anomalies of cyber security master programs. Next, the chapter sheds the light on cyber security from Practitioner Perspective, citing the work NICE to standardize the body of knowledge of cyber security. The research concludes with a suggested body of knowledge for cyber security. Based on a comprehensive definition of cyber security, the chapter also suggested two matrices that represent the interaction among the different elements of computer system with physical and non-physical threats, and a matrix that shows the interaction of physical/ non-physical threats with conductor of the threat internal and external. Furthermore, the final section presents and explains the core elements of the cyber security. This research is an expansion from a paper titled Cyber Security discussed in SC2 IEEE conference [1].

2. Body of knowledge

This section covers four topics to be discussed: first, the definition of body of knowledge and what incites the development of body of knowledge, further, giving examples about the body of knowledge in the different disciplines. The next two sections discuss the accreditation bodies and the incentive of accreditations. The last section discusses ACM & IEEE efforts in developing body of knowledge to different disciplines in the Information Technology arena.

2.1. Body of knowledge: definitions, incentives, and examples

Body of knowledge (BOK) is best stated by [2] "(1) structured knowledge that is used by members of a discipline to guide their practice or work." (2) "The prescribed aggregation of knowledge in a particular area an individual is expected to have mastered to be considered or certified as a practitioner." Another definition of BOK is by [3] "A BOK is a term used to represent the complete set of concepts, terms, and activities that make up a professional Domain. It encompasses the core teachings, skills, and research in a field or industry."

There are many incentives to build a BOK in different disciplines cited by many researchers: [4] said that "BOK describes relevant knowledge for a discipline and will need show the consensus in the Knowledge Areas (KA), and related disciplines"; in addition, the same source states that BOK is useful for curricula design for innovation while industry context present. [5] said that BOK is a practice to support education, research, professional development, and practice. Furthermore, [6] listed that BOK will allow to meet the challenge of rapidly changing landscape and the challenge of accommodating the diversity of emerging technologies. Again, the same source recites that BOK is used in curricula development, and BOK is the basis of evaluating the knowledge and skills of the discipline graduates, hence providing a roadmap to follow.

In different disciplines, there are many BOK, for example: Systems engineering (G2SEBoK), Information systems engineering (ISEBOK), Software engineering (SWEBOK) [5–7], Information Technology (ITBOK), Project management (PMBOK-1, PMBOK-2), Body of Quality Knowledge (BOQK), New Product Development Body of Knowledge (NPDBOK), Software Requirements Traceability Body of Knowledge [8], Canadian IT Body of Knowledge, Civil Engineering Body of Knowledge, Geographic Information Science and Technology Body of Knowledge, Project Management Body of Knowledge, Business Analysis Body of Knowledge, The requirements engineering body of knowledge (rebok) [3].

2.2. Accreditation bodies

The ultimate goal of accreditation bodies of higher education is to first standardize education and maintain the quality of education in the different educational institutes. The second is to enhance the credit transferability among different educational institutes and furthermore different countries. Next, we present some international and national quality assurance and accreditation organizations from Germany, Spain, Hong Kong, Pakistan, Canada, Swiss, Austria, and USA. In addition, there are two important information technology-based organizations: ABET which is IEEE-based organization and ACM.

Internationally, there are two organizations: The International Network for Quality Assurance Agencies in Higher Education (INQAAHE) which has 280 members [9]. The second is US-based organization; Council for Higher Education Accreditation has 467 quality assurance bodies, accreditation bodies, and ministries of Education from 175 countries, and has 3000 member institutions [10]. CHEA is a member in INQAAHE. CHEA replaced Council on Postsecondary Accreditation (COPA) and Federation of Regional Accrediting Commissions of Higher Education (FRACHE). In Europe, there is European Association for Quality Assurance in Higher Education (ENQA) which has 51 organizations and 28 countries. ENQA [11] established The European Quality Assurance Register for Higher Education (EQAR), the European Students' Union (ESI), the European University Association (EUA), and the European Association of Institutions in Higher Education (EURASHE), and ENIC-NARIC (National Academic Recognition Information Centre) comprises all countries of Europe as well as Australia, Canada, Israel, the United States of America, and New Zealand.

In Germany, Kultusministerkonferenz (KMK) [12] was founded in 1948, and then in 1957, German *Council of Science and Humanities* (Wissenschaftsrat) was founded. KMK established *Accreditation Council* (Akkreditierungsrat). Associated with the Accreditation Council, 10 agencies are as follows: Swiss Agency for Accreditation and Quality Assurance(AAQ), Accreditation, Certification and Quality Assurance Institute (ACQUIN), Accreditation Agency for Study Programmes in Health and Social Sciences (AHPGS), Agency for Quality Assurance and Accreditation of Canonical Study Programmes (AKAST), Agency for Quality Assurance and Accreditation Austria(AQ Austria), Agency for Quality Assurance by Accreditation of Study Programmes (AQAS), Accreditation Agency for Degree Programmes in Engineering, Informatics/Computer Science, the Natural Sciences and Mathematics (ASIIN), evaluation agency Baden-Württemberg(evalag), Foundation for International Business Administration Accreditation (FIBAA), and Central Evaluation and Accreditation Agency Hannover (ZEvA).

In Spain, the *Agencia Nacional de la Evaluación de la Calidad y Acreditación* (National Agency for Quality Assessment and Accreditation), which is dubbed (ANECA), was founded in 2002 [13]. ANECA is a full member of European Association for Quality Assurance in Higher Education (ENQA), International Network for Quality Assurance Agencies in Higher Education (INQAAHE), and European Quality Assurance Register for Higher Education (EQAR).

In the United Kingdom, there is Quality Assurance Agency (QAA) which is a member of INQAAHE and ENQA [14]. In Hong Kong, the Hong Kong Council for Accreditation of Academic and Vocational Qualifications (HKCAAVQ) replaced the Hong Kong Council for Academic Accreditation [15].

In India, there are 12 professional councils: All India Council for Technical Education (AICTE), Distance Education Council (DEC), Indian Council for Agriculture Research (ICAR), Bar Council of India (BCI), National Council for Teacher Education (NCTE), Rehabilitation Council of India (RCI), Medical Council of India (MCI), Pharmacy Council of India (PCI), Indian Nursing Council (INC), Dentist Council of India (DCI), Central Council of Homeopathy (CCH), and Central Council of Indian Medicine (CCIM) [16].

In Pakistan, under Quality Assurance Agency of Higher Education Commission of Pakistan, there are National Accreditation Council for Teachers Education (NACTE), National Agricultural Education Accreditation Council (NAEAC), National Business Education Accreditation Council (NBEAC), and National Computing Education Accreditation Council (NCEAC) [17–20].

In Canada, the Canada's Association of I.T. Professional (CIPS) is a Full Member of the Association of Accrediting Agencies of Canada (AAAC). CIPS has established the Computer Science Accreditation Council (CSAC), the Information Systems and Technology Accreditation Council (ISTAC) and the Business Technology Management Accreditation Council (BTMAC) as autonomous bodies. CIPS was established with this name in 1968. CIPS accredits the University, college/applied degree programs. The programs include Computer Science Degree Programs, Software Engineering Degree Programs, Interdisciplinary Programs, Management Information Systems Degree Programs, Business Management Technology Programs, Computer Systems Technology type Diploma Programs, and Applied Information Technology Degree Programs.

In the USA, the *Higher education accreditation in the United States* is categorized: regional, national, programmatic, and faith-based accreditors. There are six regional accreditors namely Middle States Commission on Higher Education, New England Association of Schools and Colleges, Northwest Commission on Colleges and Universities (NWCCU), Higher Learning Commission (HLC) (formerly, North Central Association of Colleges and Schools (NCA)), Southern Association of Colleges and Schools (SACS) Commission on Colleges, and Western Association of Schools and Colleges (WASC-ACCJC). There are six national accreditors (nationwide not international): Accrediting Bureau of Health Education Schools (ABHES) (recognized by USDE), Accrediting Commission of Career Schools and Colleges (ACCSC) (recognized by USDE), Accrediting Council for Continuing Education and Training (ACCET) (recognized by USDE), Council on Occupational Education (COE) (recognized by USDE), Distance Education Accrediting Commission (DEAC) (recognized by USDE and CHEA), and Accrediting Council for Independent Colleges and Schools (ACICS) [21]. The specialized or programmatic accreditors are generally under CHEA or Department of Education US (USDE), and there are 76 agencies.

ABET is programmatic Accreditation established in 1932 and has 3369 programs [10]. ABET accredited 3852 programs at 776 colleges and universities in 31 countries according to [22]. ABET covers disciplines of applied and natural science, computing, engineering, and engineering technology at the associate, bachelor, and master degree levels. ABET has four accreditation commissions: Applied and Natural Science Accreditation Commission (ANSAC), Computing Accreditation Commission (CAC), Engineering Accreditation Commission (EAC), and Engineering Technology Accreditation Commission (ETAC). ABET is a federation of 35 societies and organizations [22]; furthermore, ABET stemmed from seven engineering societies. The first computer engineering program accredited by ABET was in 1971 at Case Western Reserve University [25]. Another report was published for the body of knowledge for Information Technology; the report is 161 pages long.

The Association for Computing Machinery (ACM) established in 1947 has 100,000 members. ACM is an organization for academic and scholarly interest in computer science. ACM has 171 local chapters, 37 special interest groups, and more than 50 scholarly peer-reviewed journals [23].

2.3. Why accredit

A body of knowledge "can be very useful to provide a comprehensive and integrative view of the discipline, for assessment of professionals and organizations, for self-assessment as well as for curriculum development for academic or professional development courses and degree programs" [2]. Accreditation in accordance to body of knowledge affects students, institutions, public, and professionals. In fact, accreditation is the process and implementation phase of the body of knowledge. The ultimate goal of both the idea (body of knowledge) and the process (accreditation) is to create a better-educated computer professional. Such computer professional shall practice with an ethical manner to the well-being of the ordinary user, organization, establishment, and the public. Such professional is required in industry and government, and hence, all parties need to cooperate to create the proper environment for such professional to spring to life. Industry standards must be met by the Institutes in the supply–demand manners. Furthermore, properly accredited institute can provide computer

students with proper education that will prepare them to further advance their higher education. Also, institutes can self-evaluate, analyze, and bridge the gap between industry and education.

The accreditation process must be fair, unswerving, confidential with clear process, transparent, and objective. The accreditation agency must be independent and autonomous from educational institute. The accreditation process must be carried out by qualified reviewers. Resources must be available to carry process effectively. Accreditation process, goals, steps, and time must be clear and set, and such guidelines are set by [24].

2.4. ACM and IEEE efforts in body of knowledge

ACM and IEEE developed a body of knowledge, explained in a report published in 15/Dec/2016 as shown in [25]. The report was developed by two delegations, both represented ACM and IEEE computer society delegates came from USA, China, and Scotland from 10 universities and IBM. The delegates came from 10 universities namely Hofstra University (USA), Milwaukee School of Engineering (USA), Clarkson University (USA), University of Florida (USA), Georgia Institute of Technology (USA), Mississippi State University (USA), Tsinghua University (China), Peking University (China), University of Strathclyde (Scotland), and Auburn University (USA). The delegates were four from IEEE and seven from ACM.

The report describes in five specialties pertaining to computers and leaves the sixth for future model. The report lists 14 underlying principles that guide the committee through the description of the body of knowledge as seen in pages 14 and 15 of the report [25]. In Chapter 3 of the document, the body of knowledge of *Computing engineering* was described in detail. In 2013, a report was published for the computer science curricula [26], and the body of knowledge of *computer science* was discussed in Chapter 4 of the 518-page document.

In 2016, C.C. Walrad said "the IEEE Computer Society's (CS's) Educational Activities Board merged with the Professional Activities Board to form the Professional and Educational Activities Board (PEAB) in 2015. This merger facilitated the development of the Guide to the *Software Engineering Body of Knowledge* (SWEBOK) and training in the SWEBOK knowledge areas, as well as coordination of IT curriculum development activities and the creation of a Guide to the Enterprise IT Body of Knowledge (EITBOK), which will be available in wiki form later this year. Moreover, the merger serves to strengthen the CS's joint work with ACM" [27].

In 2017, a report was published for Information Technology curricula [28]. The body of knowledge was discussed in Chapter 6. Chapter 6 discussed four topics: structure of IT curricula framework, distilling the IT curricular framework, IT domain clusters, and contemporary illustration of IT.

3. Cyber security scope

The term cyber security has a duality: some write the term as one word, while others write the term as two words; accordingly, this is the key gap within all players in the cyber security community, which could be overcome by reaching a unanimous decision on one spelling. In

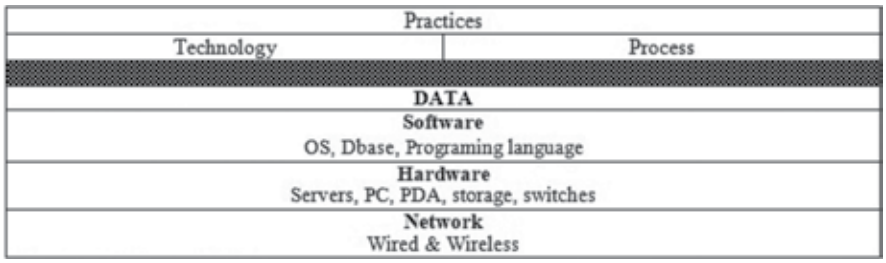

Figure 1. Cyber security elements.

the scope section, a framework of elements is suggested to at least limit the intrusions of some unrelated terms; as such, in this section, the chapter presents the different discussions about the definition of the term "cyber security." Moreover, the section illustrates the elements of the cyber security framework, as shown in **Figure 1**.

Most importantly is to define cyber security, which entails cyber security as "The ability to protect or defend the use of cyberspace from cyber-attacks" [29], using the term as one word. However, in 2014, [30] conducted a whole research to clarify the ambiguity of the term. In this context, the authors of the chapter found nine different definitions and came up with the 10th definition, denoted as "Craigen's definition" as follows: "Cyber security is the organization and collection of resources, processes, and structures used to protect cyberspace and cyberspace-enabled systems from occurrences that misalign de jure from de facto property rights." Cyber security entails protecting *what from who* and *means* of protection; [31, 32].

The three parts of the definition drive each other; the *what* part of the definition includes hardware, software, network, and data, the *means* of protection are practices, technology, and process, while the *from who* part of the definitions includes internal and external/hostile or naïve threats and attacks. In this token, the different attacks rely on the technology and its development, and so the *means* of protection relies on the technology and how attacks are dealt with, thereby creating a vicious cycle.

4. Cyber security in academia

This section discusses the flounder of the academic arena regarding cyber security. The study reviewed a total of 61 master programs in 61 institute, 19 of them were studied with details of courses offered. Geographically, the study covered 17 different countries that are considered well developed, with respect to Information Technology namely Australia, Cyprus, Czech Republic, Estonia, Finland, France, Germany, India, Italy, Lithuania, Malaysia, Malta, Netherlands, New Zealand, Spain, UK, and USA.

Table 1 illustrates the number of master programs distributed geographically, which highlights that UK and USA have the most master programs pertaining to cyber security, where USA has 25 master programs, followed by UK with 16 master programs, whereas Spain, Estonia, Finland, France, and Netherlands follow with two programs, and the remaining 10 countries with only one program each.

Country	Number of programs
Australia	1
Cyprus	1
Czech Republic	1
Estonia	2
Finland	2
France	2
Germany	1
India	1
Italy	1
Lithuania	1
Malaysia	1
Malta	1
Netherlands	2
New Zealand	1
Spain	2
UK	16
USA	25
Total	61

Table 1. Master programs in different countries.

In light of the abovementioned, it is worth noting that a report, by professor Andrew McGettrick, the Chair of Education Board in ACM, titled "Toward Curricular Guidelines for Cyber security" within "Report of a Workshop on Cyber security Education and Training "clearly stated that "Cyber security is currently an immature and ill-defined subject and not a true discipline since it lacks some of the criteria normally applied to disciplines" [33].

4.1. Cyber security trending in academia

Academia is supposed to lead the world in standardization and setting the rules. Yet, in this case, academia is at loss for the following reasons: first, there is a discrepancy in the wording of the term cyber security; some use "Cyber Security," others use "Cybersecurity," and others use the term "security." Second, the offering of cyber security master program is under the umbrella of Master of Science, Master of Arts, engineering, criminal justice. Third, the faculty conducting the program is computer science, engineering, business, management, Arts and Social Sciences. Fourth, the master program is offered online, traditional, and distance learning. Fifth, in research, the only paper tackled the subject was [34], which discussed the need from *JOB POSTING* perspective. In the next section, each of reasons will be presented along

http://dx.doi.org/10.5772/intechopen.77975

with 61 different master programs offered worldwide with each program the university, faculty, and country, shown in Appendix A.

In respect to the term cyber security, being used as two separate words "Cyber Security," 17 universities used it, namely KL University, North Umbria University London Campus, The University of Waikato, University of Westminster, University of Greenwich, Tallinn University of Technology, The University of Warwick, Harbour Space, Saint Peter's University, Estonian Information Technology College, University of Southern California, The University of San Diego, Wright State University, University of York, University of south Australia, Temple University, George Mason University. On the other hand, 16 institutes used the term "Cybersecurity," as one word, namely The George Washington University, St. Mary's University, University of Central Missouri, Webster University Leiden, University of Maryland, University of Dallas College of Business, Sacred Heart University, Johns Hopkins, University of Maryland, NYU Tandon School of Engineering, University Of South Florida, Fordham University, University of Dallas, Villanova University, Embry-Riddle Aeronautical University, John Jay College of Criminal Justice. However, other terms referring to the term "Cybersecurity" like "Information Security" and "Digital Security" were used in the naming of the master program namely University of Turku, University of Kent, Eurecom, Asia Pacific University of Technology & Innovation (Apu), Cardiff University, Ferris State University, Vilnius Gediminas Technical University.

Moreover, the term "security" was used in nine program names to show that the program is related to the issue, namely: The University of Findlay, Eit Digital Master School, Cranfield University, Edinburgh Napier University, University of Amsterdam, Brunel University, Leeds Beckett University, Aalto University, and Esiea Graduate Engineering School.

The programs were offered as Master of Science (MSC) in the faculty of computer science like University of Maryland, University of York or engineering like Villanova University, University of Southern California; still, others offered their program as a Master of Arts (MA) or under the faculty of Business like Brunel University and Temple University or faculty of management like University of San Francisco or faculty of criminal justice like John Jay College of Criminal Justice.

On a different note, while Brunel University program is a distance learning type, some institutions offer "Cyber security" programs online such as University of Liverpool, University of The Cumberlands, Norwich University, NYU Tandon, whereas others require a traditional way of teaching.

According to numerous academic programs, "Cyber security" is referred to as digital security. In fact, there are 19 different names that pertain to cyber security according to different academic programs, inter alia: Digital Forensics, Network Security, Applied Security and Analytics, Security and Privacy, Information Security and Cryptography, Forensics, Electronic Warfare, Counter Terrorism and Organized Crime, Information Security and Biometrics, Security and Management, Information Technologies Security, Intelligence and Security Studies, Information Security & Privacy, Information Assurance, in Network Security and Pen Testing, Cyber Security Engineering, Network & Information Security, Operations and Leadership, IT Auditing and Cyber Security.

The chapter reviewed the 61 master programs listed in Appendix A, of which 19 disclosed their detailed classes offered within their respective programs. In turn, the researcher studied 110 different classes offered within the 19 programs and found the following: (1) six programs listed a course pertaining to programming and algorithms; (2) five programs listed a course pertaining to assurance using titles like Computer Systems Assurance Units, Development of high assurance systems, Information Assurance, Information Assurance and Security; (3) one master program offered a course about auditing entitled "*Software Security Assessment*"; (4) seven programs offered a course about cryptography under different titles like *Applied Cryptography*, *Mathematics for Cryptography*; (5) one program covered database courses; (6) seven programs offered Forensics under different titles like *Cyber-crime and Computer Forensics*, *Digital Forensics*, *e-Crime*, *e-Discovery and Forensic Readiness*, *Forensic Computing*, *Network* and *Internet Forensics*; (7) four programs offered Identity with titles like *Identity and Access Management*, and *Identity Management for Federal IT*; (8) four programs offered courses pertaining to Law and Ethics, such as *Information Security and Ethics, Cyber Security Operational Policy*, *Human Aspects of Cyber security*: *Law*, *Ethics and Privacy* as well as *Introduction to Ethical Hacking*; (9) 13 programs offered curses on Networks, ranking the topic as the highest to be offered under different titles: *Advanced Network and Data Communication*, *Computer networking*, *Cryptography & Network Security*, *Cyber Network Security*, *Network and Internet Forensics*, *Network Essentials Intensive*, *Network Security*, *Network Visualization and Vulnerability Detection*, *Networks and Protocols*, and *Security applications in networking and distributed systems*; (10) five programs covered the topic Operating systems (OS) under related titles: *Operating Systems Security*, *Practical Unix*, and *Secure Operating Systems*; (11) eight programs offered Windows Administration; (12) eight programs offered Software engineering under different titles: *Information System Infrastructure Lifecycle Management*, *Complex Systems Engineering Management*, *Secure Software Design and Development*, *Software Engineering & Design*, *Software engineering*, *Software Security Lifecycle*, *Trusted System Design*, *Analysis* and *Development Units*; (13) four programs covered Digital logic and microprocessors design under different descriptions: *Computer Architecture*, *Secure Systems Architecture*, *Securing Digital Infrastructure*, and *Computer systems*; (14) more significantly is that 14 master programs used the term security vaguely in a number of courses, utilizing it as follows: *Information Security*, *Application Security*, *Best* Practices Managing Security and Privacy for Cloud Computing, Computer Security and Privacy, Computer Security Fundamentals, *Computer Security*, *Critical Infrastructure and Control System Security*, *Cyber Network Security*, *Cyber security Essentials*, *Foundations of Cyber Security*, *Hardware Security*, *Host Computer Security*, *Information*, *Security and Privacy*, as well as *Management and Cyber Security*.

In all the 19 master programs, there are 18 courses that are of special interest to cyber security:

1. Intrusion Detection
2. Advanced Penetration Testing
3. Cyber Fraud and Theft
4. Cyber Incident Handling and Response

5. Cyber Incident Response and Computer Network Forensics
6. Cyber Intelligence
7. Cyber Intelligence & Counterintelligence
8. Cyber Security: Emerging Threats and Countermeasures
9. Cyber Terrorism
10. Cyber Security: Threats and Defense
11. Electronic Evidence Analysis and Presentation
12. Imaging for Security Applications Watermarking & Biometrics
13. Incident Detections & Responses
14. Intrusion Analysis and Response
15. Malware and Intrusion Detection
16. Security Attacks and Defenses
17. Security Tools for Information Security
18. System Exploitation and Penetration Testing

5. Cyber security from practitioner perspective

In this section, the chapter discusses the body of knowledge represented from a practitioner approach. Accordingly, the chapter researched the perspective of National Initiative for Cyber Security Education (NICE) and National Initiative for Cyber Security Careers and Studies (NICCS).

Managed by the Cyber Security Education and Awareness Branch (CE&A) within the Department of Homeland Security's (DHS) Office of Cyber security and Communications (CS&C), NICCS is an online resource for cyber security training that connects government employees, students, educators, and industry with cyber security training providers throughout the nation to ensure that the government workforce has the appropriate training and education in the cyber security field. Likewise, NICE is an initiative led by National Institute of Standards and Technology in the USA department of Commerce with partnership between government and academia focusing on cyber security training and education and workforce development; the NICE Program Office operates under the Applied Cyber security Division, positioning the program to support the ability of USA to address current and future cyber security challenges through standards and best practices [35], with the strategic intent to entice a nationwide dialogue, thereby leading an action on how to address the critical shortage of a skilled cyber security workforce.

Moreover, the NICE Cyber security Workforce Framework (NIST Special Publication 800–181) serves as a fundamental reference resource to improve the communication needed to identify, recruit, and develop cyber security talent. To reverse engineer and attempt to define the core body of knowledge, NICE limited The Cyber Security Work Categories to the following seven categories of common cyber security functions:

1. Operate and maintain
2. Securely provision
3. Protect and defend
4. Oversee and govern
5. Analyze
6. Investigate
7. Collect and operate.

In addition, NICE had in mind the following audience for the framework: employer, employee, training, education, and technology providers. Within this context, NICCS developed 17 focus areas of education used as guidelines to education institutions [36]:

1. *Cyber Investigations*: focuses on analyses of computer incidents and intrusions to determine attacker/source, infiltration path, mechanism, system modifications and effects, damages, exfiltration path, data exfiltrated, and residual effects.
2. *Data Management Systems Security*: concentrates on secure configuration, operation, and maintenance of databases and database management systems housing sensitive data.
3. *Data Security Analysis*: the analysis of data (e.g., system logs, network traffic) aims to identify suspected malicious activities.
4. *Digital Forensics*: the analysis of computer systems (hosts, servers, network components) aims to determine the effects that malware has had on the system.
5. *Health-Care Security*: focuses on design, development, operation, and maintenance of computer systems used in health-care applications.
6. *Industrial Control Systems—SCADA Security*: concentrates on design, development, operation, and maintenance of industrial control systems used in real-time infrastructures.
7. *Network Security Administration*: focuses on secure configuration, operation, and operation of an enterprise computer network.
8. *Network Security Engineering:* concentrates on the design of secure network infrastructures and security analysis of network traffic.
9. *Secure Cloud Computing*: targets design, development, operation, and maintenance of secure cloud architectures.

10. *Secure Embedded Systems*: concentrates on design, development, utilization, and management of secured embedded systems technologies.
11. *Secure Mobile Technology*: focuses on design, development, utilization, and management of secure mobile technologies, devices, and services.
12. *Secure Software Development*: revolves around the development of secure software.
13. *Secure Telecommunications*: involves design, development, and secure use of secure telecommunications systems whether the system is digital and analog.
14. *Security Incident Analysis and Response*: examines system vulnerability analysis and developing the right future response.
15. *Security Policy Development and Compliance*: revolves around the IT policy of an organization and the monitoring and evaluation tools related to such policy.
16. *Systems Security Administration*: focuses on secure configuration, operation, and maintenance of a computer system (host or workstation).
17. *Systems Security Engineering*: involves using system development life cycle while embedding and taking into account security issue.

6. Suggested cyber security body of knowledge

Cyber security encompasses physical and non-physical security of data, software, and hardware, from harm by both authorized and non-authorized access, whether access is internal or external. Cyber security is conducted via technology through predetermined processes. Since technology is advancing expeditiously, it is not only challenging but it is also imperative to predetermine the process of security; as such, several best practices and lessons learned are traded among practitioners.

The physical security of data software and hardware from authorized and non-authorized access includes but not limited to, protecting the server room, its location, the switches, the cable, data and data storage devices from fire, and excessive heat intruders. As such, server rooms are typically equipped with fire distinguisher, air conditioned, insulated from fire, and its floor is raised to docket the cables. In addition, the switches are usually installed in hidden high places to limit the reachability, and cables are docketed in walls or under a raised floor. The location of the server room is another issue that is part of physical security. The major issues that pertain to this subject are summarized in the subsequent matrix.

For authorized personnel, another layer of protection to access the IT systems should be in place, varying from setting up password-protected access or magnetic card to retina scan to lock and key, as illustrated in **Figure 2**. However, oftentimes, physical security and non-physical security are not confined to external threats and attackers and could be considered internally, in which case, if the assessed damage is considered either intentional or non-intentional. For intentional damage, a rigorous policy should be established to ensure employee compliance and discipline like cameras and employee follow-up; yet, non-intentional damage is alleviated by proper training and teaching.

	Physical	Non-physical
Data	Keep copies in different locations	Ciphering, password
Software		
• Operating system	Copies	Password/biometrics
• Application	Copies	Password/biometrics
Hardware		
• Network	Not visible	Password/biometrics
• Server	Location/fire distinguisher/air condition	Password/biometrics
• Switch	Location	Password/biometrics
• Cable	Embed in walls	Away from power

Figure 2. Matrix of interaction computer system with physical and non-physical threats.

	Physical	Non-physical
Internal	Damage to hardware & software (intentional or non-intentional) set policy and provide proper training	Viruses: limit access to external systems +policy
External	Physical attacks	Hacking +viruses: Fire walls + antivirus

Figure 3. Matrix that shows the interaction of physical/non-physical threats with conductor of the threat internal and external.

The non-physical damage is not only more sensitive but it is immensely difficult to follow, in view that the more significant threat comes from unlawful use and access to the system. Viruses are a major threat in this case, hence, limiting the access to the system by using strict policy and good antivirus may halt the effect.

The external threat of damage like hacking and viruses poses as the most challenging, albeit, software tools like firewall and antivirus may protect the system, as illustrated in **Figure 3**; however, external physical threat, such as attacking and looting ATM machines or physical attacks on server room, switches, cables, and data, can be overcome by setting up tangible measures. These methods can include, but not limited to, setting up servers in protected rooms, ensuring that switches and cables are not visible to external entities, and storing data in secure locations with copy and the use of enormous storage.

6.1. Core element in cyber security

The core elements in cyber security are the following 12 elements; these are the pillars or the base to any cyber security program:

1. Cyber Security Assurance
2. Cyber Security Assessment

3. Ciphering
4. Algorithms
5. Networks
6. Digital Logic and Microprocessors Design
7. Operating Systems
8. Database
9. Cyber Law & Ethics
10. Viruses & Hacking
11. Software Tools & Techniques
12. Software Auditing & Software Engineering.

The following will further explain the 12 pillars (see **Figure 4**) and core elements in the cyber security body of knowledge.

6.1.1. Cyber security assurance

Cyber security assurance is best defined by Lipner [37] and he also explained how to achieve security assurance. To define assurance, Lipner stated that "assurance: making systems that can resist attack." And he added "Assurance is achieved by integrating security into the process of designing, building, and testing systems" [37]. In a research conducted by [38] to develop Software Assurance Curriculum for master level and again in [39] to develop for Software Assurance Curriculum for master's level, the authors proposed a comprehensive curriculum specialized for software assurance. Cyber security special must learn method like *Mission Risk Diagnostic (MRD) described by* [40] used to assess risk in systems across the life cycle and supply chain. In addition, specialist must learn SQUARE. Security Quality Requirements Engineering (SQUARE) is a nine-step process that helps organizations build security, including privacy, into the early stages of the production lifecycle [41–43].

6.1.2. Cyber security assessment

Cyber security assessment is a process to assess an organization's level of risk and preparedness. The process is repeatable and measurable. The process has two parts: Inherent Risk Profile & Cyber security Maturity [44]. The assessments are conducted in domains according to five levels of maturity according to FFIEC [44] suggested model. According to [45], an assessment framework was developed and was adopted by 30% of US organizations. The framework provides a risk-based approach for cyber security through five core functions: identify, protect, detect, and respond and recovery. Furthermore, the cyber security

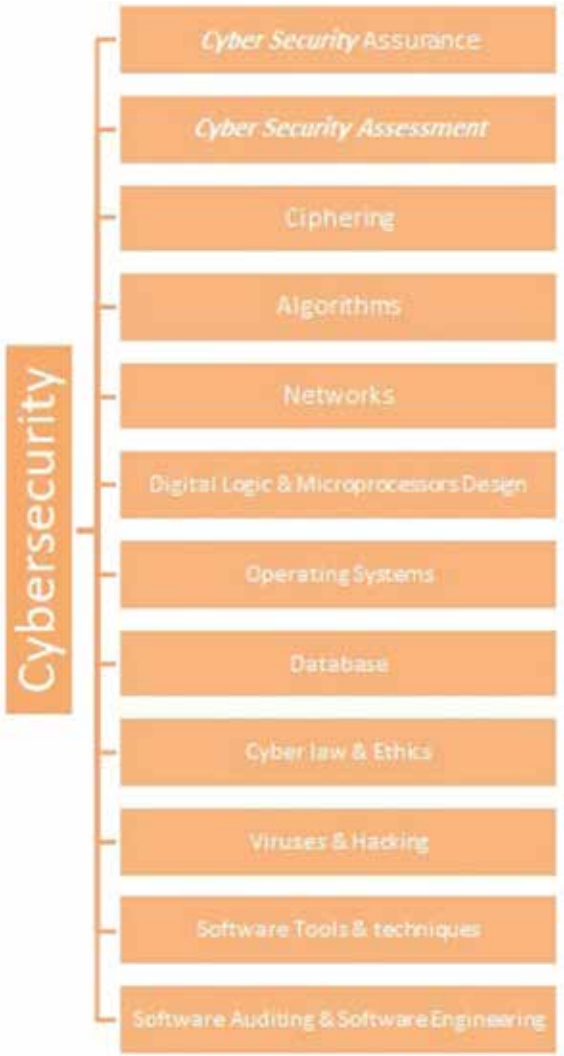

Figure 4. Pillars of cyber security.

professional should be able to create and conduct a cyber security assessment by understanding the various methodologies across all industries on how to conduct and manage a cyber security assessment, risk analysis, and how to mitigate various cyber security threats by conducting the following: first, understand and write reports on cyber threat attack analysis. Second, understand and write cyber security policy based on assessments. Third, detect and analyze incidents of action of attacks and threats. Fourth, establish cyber security controls based on established models and frameworks. Fifth, manage attack countermeasures. Sixth, mitigate risks of threats and attacks. Seventh, cycling of reports and evidence procedures for prosecution after such assessments have been produced.

6.1.3. Ciphering

Ciphering is an essential part of security that allows the data to be transferred from point to point safely and without allowing anyone to look at the data being transferred. Ciphering is an old technique yet still needed for security. There are many types of ciphering that entails hardware and software, tools and techniques in addition to ciphering algorithms. Ciphering algorithms can be classified according to key as symmetrical and a symmetrical, according to type of operations conducted: substitution, transposition, bit manipulation, and to the cipher process block or stream cipher. Hence, public key ciphering RSA, and block cipher algorithms like IDEA, RC2, RC5, CAST, ElGamel, DSA, and Skipjack are important for the cyber security specialist. Topics like cryptanalysis, hash functions, digital signatures, and web security should be covered in detail.

6.1.4. Algorithms

Algorithms are the backbone of software. To develop any software, one must understand the logic behind the building blocks of the software. Algorithms deal with data taking into account speed, space storage, and time complexity. Search, sort, compression, and data structure are all based on algorithms. Algorithm is the language that a programmer, analyst, designer speaks with the computer to materialize their idea into working software. Hence, developing the logical sense to security specialist is a must trait. Typical course must include the following in the syllabus: sort & search algorithms, graph algorithms (Graph traversal (DFS, BFS) and applications, Connectivity, strong connectivity, bi-connectivity, Minimum spanning tree, Shortest path, Matchings, Network flow), and hard problems (Traveling salesman problem, Longest path, Hamilton cycle, Boolean circuit satisfiability, Clique, Vertex cover). Algorithm design: Divide-and-conquer, Graph traversal, Greedy, Dynamic Programming, Reductions, Use of advanced data structures. Algorithm correctness: Proofs and proof techniques (assumptions, basic logic inference and induction), Tree and graph properties. Algorithm analysis: Time and space complexity, Asymptotic analysis: Big Oh, Little oh, Theta, Worst case and average case analysis, Lower bounds. Tractable and intractable problems: Polynomial time algorithms, NP algorithms, NP hardness and NP completeness, NP Reductions.

6.1.5. Networks

Networks are a backbone of the data transfer; it is the roads to cars. The types and standards of networks are essential to anyone working in the cyber security. Networks are not only hardware they are standards, and routing algorithm, in addition to hubs, switches, cables, and jacks. Furthermore, the security models of computer networks along with ISO standard of these models, that is, Open Systems Interconnection (OSI), and transmission control protocol and Internet protocol (TCP/IP). Typically, a network course covers the following topics: Fundamentals, Link Layer, Media Access, Internetworking, Routing, Transport Layer, and Application Layer. The Fundamentals & Link Layer which includes Building a network, Layering and protocols—Internet Architecture, Network software, Performance; Link layer Services: Framing, Error Detection, Flow control. The Media Access & Internetworking which

includes Media access control—Ethernet (802.3), Wireless LANs 802.11, Bluetooth, Switching and Bridging, Basic Internetworking (IP, CIDR, ARP, DHCP, and ICMP). The routing topic which includes Routing (RIP, OSPF, metrics), Switch basics—Global Internet (Areas, BGP, IPv6), Multicast addresses, multicast routing (DVMRP, PIM). The Transport Layer topic which includes Overview of Transport layer, UDP, Reliable byte stream (TCP), Connection management, Flow control, Retransmission, TCP Congestion control, Congestion avoidance (DECbit, RED), QoS, Application requirements. The Application Layer which includes Traditional applications: Electronic Mail (SMTP, POP3, IMAP, MIME), HTTP, Web Services, DNS, and SNMP.

6.1.6. Digital logic and microprocessors design

Digital logic and microprocessors design are basic and fundamental for cyber security. Under this topic, things like the principles of programmable logic devices, combinational and sequential circuits, and the principles of hardware design, the structure and electronic design of modern processors. In addition, logical gates, flip-flop, and binary world are included.

6.1.7. Operating systems

Operating system (OS) is the layer of software that lay between hardware and applications. Through OS, a person can speak to the computer hardware using a programming language. The essentials under this topic are processes and threads, mutual exclusion, CPU scheduling, deadlock, memory management, and file systems, distributed systems.

6.1.8. Database

Database is where data are stored in a computer system, topics under database are (but not limited to) data models like Entity Relations (ER), relational; query languages including relational algebra, Structure Query Language (SQL); implementation techniques of database management systems including index structures, concurrency control, recovery, and query processing; management of semi-structured and complex data; distributed and NoSQL databases.

6.1.9. Cyber law and ethics

Knowing the difference between cyber laws and regulations to cyber security is like knowing the laws and regulations to policeman. It is essential to know cyber laws and regulation since borders do not exist in the cyber world. There also many ethical issues that pertain to the topic not to mention the power that comes with such territory.

6.1.10. Viruses, warms, and hacking

Cyber security specialist must be aware of the methods and tools and techniques used to counter affect viruses, warms, hacking the malware software in general. For a policeman to be good at his job, he must be aware of the criminal acts and how they are conducted.

Cyber security must know the different types of viruses, warms, and hacking methods in order to deal with such problems. Malware ranges from annoying malicious software to cyber-weapon that attacks and destroys. Furthermore, detection, analysis, control, and eradication of such software are essential part of cyber security education. Tools like Dependency Walker, Fakenet, FileAlyzer 2.0, HxD, IDA Free, ImpREC, LordPE, Malcode Analyst Pack, OllyDbg, PEiD, PEview, Regshot, Resource Hacker, Sysinternals Suite, UPX, Visual Studio, Windbg, Wireshark, System Monitor, Process Explorer, CaptureBAT, Regshot, VMware, BinText, LordPE, QuickUnpack, Firebug, PELister, PEiD, IDA Pro, OllyDbg and plug-ins such as OllyDump, HideOD, Rhino, Malzilla, SpiderMonkey, Jsunpack-n. Internet Explorer Developer Toolbar, cscript Honeyd, NetCat, Wireshark, curl, wget, xorsearch OfficeMalScanner, OffVis, Radare, FileInsight, malfind2, apihooks, SWFTools, Flare, and shellcode2exe are essential for cyber security expert.

6.1.11. Software tools and techniques

There are tremendous amount of software tools and techniques that is especially developed for cyber security. The simplest is antivirus software, database management software, operating systems management software, network management software, and so on. Hence, cyber security specialist must be familiar with these tools and techniques.

6.1.12. Software auditing and software engineering

Software auditing and software engineering is the 12th pillar that is of core importance to Cyber security. Most attacks on cyber systems are viruses or hacks coming from internal or external source, thereby misusing a vulnerability of software. For example, a programmer forgot to take into account certain case or a port. Software engineering should take the right measure so that such case does not occur. Regular auditing to software and data and building self-tests within the software will catch such problem beforehand. Hence, cyber security specialist must be aware of the tools, techniques, and methods of software engineering and auditing. Furthermore, security specialist must have the knowledge of Software Assurance Framework (SAF) explained in [46]. Software Assurance Framework (SAF) is a collection of cyber security practices that programs can apply across the acquisition lifecycle and supply chain. Hence, cyber security specialist must be aware of software security framework such as IMAF. IMAF is a framework suggested by [47] that aligns drivers with software security codes of practices. There are many codes of practices listed by [47]: Building Security in Maturity Model (BSIMM), Open Web Application Security Project (OWASP), Software Assurance Maturity Model (SAMM), Department of Homeland Security Measurement work and Assurance for CMMI Process Reference Model, and CERT Resilience Management Model.

None-core competencies and elements are important but since technology keeps changing, further courses can be developed through course training or self-training or both. Such elements include but not limited to Intrusion Detection (Analysis and Response), penetration testing, Intelligence & counterintelligence, and Electronic Evidence Analysis.

7. Conclusion

This research first discussed the body of knowledge notion and scope of cyber security definition and then gave a presentation about cyber security in the academic arena. The showcase of academic perspective of cyber security included the 61 master programs from 17 different countries namely Australia, Cyprus, Czech Republic, Estonia, Finland, France, Germany, India, Italy, Lithuania, Malaysia, Malta, Netherlands, New Zealand, Spain, UK, and USA. The showcase presented the many irregularities and anomalies of cyber security master programs. Next, the chapter presented cyber security from practitioner perspective citing the work NICE to standardize the body of knowledge of cyber security from practitioner perspective. The last part of the chapter presents a suggested body of knowledge for cyber security. Based on a comprehensive definition of cyber security, the chapter also suggested two matrices that represent the interaction among the different elements of computer system with physical and non-physical threats, and a matrix that shows the interaction of physical/non-physical threats with conductor of the threat internal and external. Furthermore, the section presents and explains the core elements of the cyber security.

A. Master programs, their affiliation, country, and faculty

Name	Institute	Country	Faculty
MSc in Computer Science	University of Nicosia	Cyp	
MSc in cyber security in CS	The George Washington University	USA	Engineering & Applied Science
Master in Digital Security	Eurecom	Fr	
Master of Engineering in Cybersecurity	University of Maryland	USA	School of Engineering
MSc in Computer, Communication and Information Sciences - Security and Mobile Computing	Aalto University	Fin	
Mastère Spécialisé SIS: Sécurité de l'Information et des Systèmes	Esiea Graduate Engineering School	F	
Master of Information Systems	University Of San Francisco	USA	School of Management
Masters of Science in Engineering in Artificial Intelligence and Robotics	Sapienza University of Rome	It	
Digital Forensics and Cybersecurity programs	John Jay College of Criminal Justice	USA	
Master of Technology in Cyber Security and Digital Forensics	K L University	Ind	
Network Security and Pen Testing MSc	Middlesex University London	UK	
MSc Cyber Security	Northumbria University London Campus	UK	

Name	Institute	Country	Faculty
Master of Cyber Security	The University of Waikato	New Z.	
MSc in Applied Security and Analytics	The University of Findlay	USA	
Master in Security and Privacy (S&P)	Eit Digital Master School	Ger	
Master's Degree Programme in Information Security and Cryptography	University of Turku	Fin	
Computer Engineering	International University Alliance	USA	
MSc Cyber Security and Forensics	University of Westminster	UK	Science and Technology
Electronic Warfare, Information and Cyber Degrees	Cranfield University	UK	
International Security Degrees	Cranfield University	UK	
Resilience, Counter Terrorism and Organized Crime Degrees	Cranfield University	UK	
MSc Computer Forensics & Cyber Security	University of Greenwich	UK	
MSc Advanced Security and Digital Forensics	Edinburgh Napier University	UK	
MSc in Cyber Security	Tallinn University of Technology	Estonia	
MSc Information Security and Biometrics	University of Kent	UK	
Master in Cyber Security and Management (CSM)	The University of Warwick	UK	Warwick Manufacturing Group Wmg
Master in Information Security	Harbour.Space	Spain	
Master of Information and Information Technologies Security	Vilnius Gediminas Technical University	LT	
1. MSc System and Network Engineering: Security	University of Amsterdam	NL	
MSc in Digital Security and Forensics	Asia Pacific University of Technology & Innovation (APU)	Mal	
MA Intelligence and Security Studies (Distance Learning)	Brunel University	UK	College of Business, Arts and Social Sciences
Master in Cybersecurity	St. Mary's University	USA	
Master in Cybersecurity	University of Central Missouri	USA	
MS Cybersecurity	Webster University Leiden	NL	
MSc Cyber Security Engineering (CSE)	The University of Warwick	UK	Warwick Manufacturing Group Wmg
MSc in Information Security & Privacy	Cardiff University	UK	
Master in Embedded Systems	Masaryk University	Czech R.	
MSc Digital Forensics and Security	Leeds Beckett University	U K	

Name	Institute	Country	Faculty
Master of Science in Cyber Security	Saint Peter's University	USA	
MSc in Cybersecurity (Information Assurance)	University of Dallas	USA	College of Business
MSc in Network Security and Pen Testing	Middlesex University Malta	Malta	
MSc in Information Security and Intelligence	Ferris State University	USA	
Masters in Cyber Security Engineering		Estonia	Information Technology College
MSc Network & Information Security	Kingston University London	UK	
Máster en Ciberseguridad UCAV-DELOITTE *	Universidad Católica De Ávila	Spain	
Master of Science: Cybersecurity	Sacred Heart University	USA	
MSc in Cybersecurity	Johns Hopkins	USA	Johns Hopkins Engineering
Master of Engineering in Cybersecurity	University of Maryland	USA	Computer Science
Master of Science Cyber Security Engineering	University of Southern California	USA	Viterbi School of Engineering
Cybersecurity Online	NYU Tandon School of Engineering	USA	
Cybersecurity Master's Degree	University of South Florida	USA	
MSc in Cybersecurity	Fordham University	USA	
Master of Science in Cyber Security Operations and Leadership	The University of San Diego	USA	
MSc in Cybersecurity	University of Dallas	USA	College of Business
MSc in Cyber Security	Wright State University	USA	The College of Engr & C S
MSc in Cybersecurity	Villanova University	USA	College of Engineering
MSc in Cyber Security	University of York	UK	Department of Comp. Sci.
MSc (Cyber Security and Forensic Computing)	University of South Australia	Aus	
IT Auditing and Cyber Security	Temple University	USA	Fox School of Business
Applied Information Technology, Cyber Security Concentration (MS)	George Mason University	USA	School of Engineering
MSc in Cybersecurity Engineering	Embry-Riddle Aeronautical University	USA	College of Engineering

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Chapter 5

Moving from Training/Taming to Independent Creative Learning: Based on Research of the Brain

Yitzhak Ezuz

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.79373

Abstract

Learning is the ability to cope with changes and to understand their interaction with the dynamic body. Animal brains, and specifically the human brain, are developed in such a way to make learning possible. Based on findings from brain research, we can show that this is the primary function of the brain. For survival and energy-saving purposes, the brain is developed in such a way that the learning process is as short as possible, while most energy is devoted to converting the results of learning into automatic activity. The move to automation of learning outcomes is based on mechanisms, which can be used to tame animals, including man. Humans yield most of the time to the processes of self-taming/training of the brain, even empowering them through the Western concept of learning, which idolizes focused narrow-specialization. I will present here findings from brain research and describe the characteristics of Western culture on which these claims are founded, as an expression of the threat to the continuing development of modern human culture due to characteristics which demonstrate a process similar to the cultural degeneration of past civilizations, which at their peak, could not have imagined such a fall to be possible.

Keywords: training/taming, independent learning, creative learning, brain, association, emotions, intuition, uncertainty

1. Introduction

The aim of this chapter is to describe the human brain's capacity for learning, which deviates somewhat from the evolutionary path of animal brains in related species. Although the physiological changes that took place in the evolution of the human brain compared to apes are small, these changes crucially enabled a different kind of learning capacity compared to other animals.

The secondary aim of this chapter is to show how Western culture has taken advantage of the unique learning capacity of humans to suppress these abilities beyond natural suppression due to survival needs. This led on the one hand to great technological achievements, but on the other hand has harmed the possibilities of developing human learning abilities which would allow people to broaden their learning potential. This potential, if left undeveloped, will lead to the decline and degeneration of modern culture [1] and will remove the chance of fostering a developed democratic consciousness that requires the exploitation of the brain's learning ability to combat numerous natural tendencies that are contrary to democratic ideas.

The animal brain developed to allow natural learning, without which the fate of animals would be the same as that of plants – entirely dependent on their surroundings. As their natural habitat **changes**, so their chances of survival fall. Plants have some measure of flexibility which enable them to survive when their living conditions **change**, but their ability to adapt is very limited compared to animals who, while they may be adapted to a particular habitat, have a brain which is sufficiently flexible to deal with unexpected **changes** which may occur in their natural habitat. What this means is that plants are not able to **change** their natural surroundings to improve their chances of survival. In contrast, animal brains enable them to **change** their location, and thereby to improve their survival chances even when their natural living conditions **change**. One of the best examples of this is migration in different species, which allows animals to **change** their location (and consequently weather conditions and food availability) to improve their chances of survival. Compared to other animals, man is the only creature with the ability to live in extremely diverse geographic areas, even before the human brain developed sufficiently to allow the development of technology.

The unique evolutionary **change** in the human brain enabled technological learning in humans, the first examples of which were the creation of clothing from animal skins and controlling fire – these two skills allowed humans to exist all over the planet without the need for a long evolutionary adaptation period that would be required by an animal needing to adapt to different extremes. Until then, mankind was limited to small living areas even more so than animals in a prolonged evolutionary process which created the required adaptation to different extreme climate conditions. So, for example, animals living in equatorial regions can adapt to life in snowy regions or in desert regions, but this ability to change location was only possible following a prolonged evolutionary adaptation to new living conditions. Meanwhile this developmental process reached its peak in man's exploration of life outside the planet – after conquering almost the entire planet, man set his sights on exploring beyond planet earth. This process characterized man as an animal like any other before the development of this ability for technological learning. I have emphasized here the word "change" to clarify that the animal brain, and particularly the human brain, developed in such a way to be able to cope with changes as a condition of survival. As such, the animal brain developed in such a way that it could learn to cope with changes in its environment and in the way, it relates to the environment. The ability to learn about the changing world is dependent on the brain's ability to deal with changes – this ability is so fundamental that even the most basic senses – sight, hearing, smell and touch – are merely brain potentials which turn into useful information about the outside world only through a process of active learning. The most basic senses go from mere brain potentials to fulfilling their role as agents in the perception of the world to the brain only

if the body is subject to changes while the senses are being stimulated. Learning occurs as a result of simultaneous changes in the world and the body's place in the world. The animal brain develops a natural learning ability which enables the animal to cope with changes, as a necessary condition of survival, but only when changes occur simultaneously out in the environment and inside the body. A repetitive action, be it external or internal, calms down the brain's processing activity, including learning (as there is no new information to consolidate).

2. The learning brain

The brain works as an information processor comprising a total brain wiring system that connects wires within distinct information processing regions that specialize in generating commands designed to activate certain physical systems [2][1]. This allows the brain to process information and then generate specific action commands while controlling all the bodily systems and their expressions as brain activity. In other words, in order for the body to be able to function in an adaptable way, the brain must enable adaptable information processing for specific functions, and at the same time each such activity will act in coordination with the needs of the entire body according to changing priorities in accordance with changing circumstances. Neurons in the cerebellum unite brain activity and are responsible for making the brain a single processing entity; while neurons in the cortex are arranged such that specific areas of focused information processing are created. The process of processing information into learned knowledge then involves raw information from different and sometimes contradictory sources meeting in the dendritic trees, while the type of processing is influenced by a continual flow of huge amounts of information from contradictory sources, with each new piece of information differing from its predecessor in size and frequency (flow speed) which together comprise power. Changes in the quantity and speed of information flow influence how the information is processed at any given moment – and whether an electrical command, a spike, will be passed from one neuron to other neurons, where the results of information processing are an expression of automatic learning occurring in the brain. The more powerful the information, the poorer the processing of said information (or learning), and the transition of information will maintain the automatic processes reinforcing the taming trend – no learning will occur.

So learning begins as a result of changes in the amount of information of a particular type and the speed of flow of the same information. The combination of the quantity and speed of the flow of information constitutes its power, which can change in fractions of a second, and affect the outcome of information processing in the dendritic trees. Processing the quantity and intensity of information, while relating to the changes occurring at each fraction of a second, comprise the natural or automatic learning process which occurs in each of the dendritic trees involved in information processing activity. In fact, each of the hundred billion dendrites, which form an integral part of the hundreds of millions of neurons in the brain, constitutes a specific learning unit within the overall automatic learning system. So each of

[1]The subject of the brain in this chapter is based on my book and the many sources used in it related to brain research. I will minimize references, instead refer to [2].

the dozens of billions of dendritic trees found in the cortex form an automatic learning hub specialized in a particular field, while the dozens of millions of dendrites in the cerebellum form learning hubs, which together create automatic learning systems.

Each dendritic tree is designed to be able to process information which is changing every millisecond, this is a basic condition for the automatic learning ability of the animal brain. I will go on to briefly explain the structure and type of flexible information processing that takes place in the dendrites, which allows the animal to learn to deal with a changing environment. It is important to point out here that the fluency of the learning process in the dendrites enabling continuous and automatic learning. In order for the brain to be capable of flexible learning, systems communicate via the neurons, which pass the results of the information processing to other relevant neurons, which must also be flexible. Thus each dendrite processes huge quantities of changing information every millisecond, and the output of this processing includes the processing of the changes in information flow and strength, which are also products of learning. The output, if sufficiently strong, once it is past the cell body, passes to the next neuron as information (a spike) which reinforces the historical information flow created thus far. The automatic learning forms the basis of raw data for the information processing in the dendrites of the next 30,000 neurons in the cortex which each neuron is connected to, which also receive information from 30,000 sources at different levels of variability, including contradictory information, and from 300,000 sources of data in the dendritic trees found in the cerebellum, some directly and others indirectly. First, I will describe the activity of the emotional system which forms the basic communication system of the brain, operated via the associative communications system which makes up 70% of the brain cells, and which enables the creation of imagination as a basis for creative thinking. This communications system has been less researched due to the limitations of research tools [3]. Next, I will present the structure of the dendritic trees and the manner of data processing in which information passes from neuron to neuron and the influence of the results of this processing on the transfer of information to the next dendritic trees, and consequently on all of the subsequent dendritic trees. The activity of the dendrites is presented separately from the activity of the communications system due to the complexity of the interaction between them. This interaction is created due to the speed and quantity of information (which together forms the power of information) which arrives at the axon from an infinite stream of data which is then automatically processed into learned knowledge in the dendritic trees. This influences the power of the data processing in the axons in a circular process. There are in fact continuous interactions between the activity in the dendritic trees and in the axons and synapses and the level of branching between them, which turn the brain into a single united data processing system.

2.1. Associative and intuitive communication as a necessary condition for flexible survival learning

The thalamus, located in the midbrain, receives information from all of the senses and internal organs, and by painting them as emotions facilitates a prioritization system based on the huge quantity of contradictory information received, which changes every millisecond. In this way, it is the first transit station of the senses, creating an emotional level of abstraction before they undergo primary cortical processing and more abstract processing in the frontal cortex.

http://dx.doi.org/10.5772/intechopen.79373

Several nuclei convert the various signals into primary (general) sensations: touch, heat, taste, smell, sound, light and darkness. This first distinction is crude, but essential for many of the body's automatic responses. These are unconscious primary motivational forces, which are commonly referred to as impulses. Damasio calls them "emotions," in order to distinguish "feelings" – which are later expressions of emotions, with the level of awareness distinguishing between them [4]. So, for example, the lateral geniculate nucleus (LGN) transfers emotional information to the primary cortical area which deals with visual processing. Auditory information, which arrives from the inner ear, receives its first emotional characterization in the medial geniculate nucleus (MGN) before being transferred to the primary cortex. Similarly, motor activity related to coordination receives sensory input (the person feels coordination) via the ventrolateral nucleus, which receives integrated messages from the cerebellum and the basic cartilaginous nuclei before passing the information to the primary cortical area. Preliminary processing and prioritization between the different senses also occurs in the thalamus in the lateral geniculate nucleus (LGN), based on contradictory emotional processes. Setting priorities influence the preference for activity in various brain and body systems. This preference is characterized by defining activity on a scale from pleasure to pain, the most fundamental feelings. This description clarifies the basic potential of the brain's flexible activity, which involves such huge quantities of information that no logical supervision could possibly cope with. A further expression of the prioritization of activity is the degree of alertness versus the tendency to fall asleep. The more urgent and important the task at hand is, and thus the more resources are allocated to the relevant systems, the more the thalamus will invest in maintaining alertness, and will lower the priority and calm down the systems which drive the urge to fall asleep (release of different chemicals in the relevant areas). The results of these adaptations are primary sensory characterization, the generation of attention preference and degree of arousal, which are then transferred to the more complex and abstract processing in the cortex. This is a case of two conflicting states, and the need to find balanced interactions between them, which change according to brain activity destined either for processing during sleep or for processing accumulated information continuously during waking hours. This explains the tendency to fall asleep during activity such as a lecture delivering a large amount of information, which the brain is unable to process [5]. The brain needs sleep to continue processing and assimilating the information received, and to remove unnecessary information accumulated during the day. Sleeping a sufficient number of hours also contributes to significantly improved memory [6].

Some systems are referred to as automatic since most of the time the coordination between them is automatic. The level of awareness required for conscious control varies depending on previous attempts, which influence the involuntary interpretation that the brain applies prompted by physiological and social cues – parents, family, close and distant social networks and so on. This is a process which emphasizes the complexity of naturalistic activity and the dependency that exists between the different elements involved in these automated actions. We generally cannot control these actions, since they take place unconsciously, creating our unconscious urges, which drive us to action. For animals, although most of their actions are automatic, processes of unconscious learning still occur based on past events [7].

Two central nuclei in the basal ganglions are responsible for emotional and muscular activity, and receive commands from the cortex. One is the caudate nucleus, which supervises

emotional activity. It receives information from different regions in the cortex, such as the frontal lobe responsible for eye movement, and the associative areas of the parietal lobe, which are responsible for visual information. This information is passed to the Globus Pallidus and the thalamus with a circular connection to the frontal lobe. Thus, a revolving balance is created, allowing for the processing of information which is changing in real time. In combination with a communication circuit for the limbic region, a system is created that combines physiological and emotional processes, which affects the body's automatic learning process. This means that most animal learning occurs automatically, and the brain guides it according to past experience to give future action commands. Every time we need to learn something new as a result of new information, increased brain activity is required, which needs a lot of energy. The brain accordingly developed so that only when new information that cannot be ignored is presented does the brain go into intensive processing mode, investing time and resources. Creative thinking, which undermines existing models, forces the brain to act in a higher gear, therefore development and maintenance of creative thinking requires an investment of resources, which goes against the natural instinct for efficient brain activity.

The fact that emotional and physiological processes receive direct input from the cerebellum – where preliminary processing of the relationship between acceleration and delay occurs and acts on all systems, and only then receives orders from the cerebral cortex where secondary processing is performed – allows intermediate degrees of acceleration and slowing of motion signals. The cerebellum produces automatic commands, while the cortex produces commands which come from a combination of different areas. This explains why brain activity is so complex, dynamic and fast-changing that cannot be performed under conscious control, which is secondary to most brain activity. The development of the human brain, which does though allow conscious activity, facilitates the application of control in retrospect also with regard to non-automatic movements, which have become automatic habits. Conscious brain activity allows a long-term perspective, which is not possible in animals, however since it slows down brain activity, thereby endangering survival, it always occurs in retrospect – after automatic data processing and command generation have taken place. Despite the automatic activation of this complex system, humans can intervene in the processing of received stimuli. This possibility is realized via physical means which influence the range of stimuli and their intensity – increasing to dimensions (quantities and high intensities) that human mechanisms cannot tolerate. Conversely, we can reduce and weaken the range of stimuli – so as to completely cancel their effect on human physiology. This process is made possible due to the complex connectivity of the cell bridges, which produce complex links with the thalamus and different areas of the cortex, and extensive links with the brainstem and spinal cord. In this way, humans are able to influence some of the automatic processes once initial information processing and command generation have been completed. So, if we can influence automatic physiological processes, then we can certainly influence acquired physiological processes with deliberate training, and furthermore, it is possible to influence the psychological aspect via exaptation.

These two aspects – the physiological and the psycho-social – are connected by what is known as epigenetics [8], and so we can influence each one with targeted activity. This possibility can be seen in the change of genetic roles not just in the long drawn out evolutionary processes, as learned through Darwinism, but through fast genetic changes expressed via an epigenetic

mechanism called methylation [9]. The individual differences in this process are so great that they create differences in gene expressions even between identical twins as a result of exposure to different life events, even growing up in the same family, physical and social environment. In reality, the environment is never exactly the same, not even for the same person at different times, and certainly not for different people, even if they carry the same genetic material. Without this possibility, unique to man, there would be no basis to the argument that humans have the ability for conscious learning and choice, which are necessary conditions for all forms of targeted learning, which acts against the natural tendency to automatic brain activity. Awareness of this genetic flexibility requires recognition of humans' ability to develop and change more quickly than was previously thought. Later on, I will show how this ability can be developed at varying levels. In such conditions, man's creative ability – the ability to cope with a changing and sometimes surprising reality – becomes more vital than it seemed in a culture dominated by the scientific paradigm, and ensures an engineered reality that is seemingly stable and permanent, that if realized, will free man from the effort of perpetual learning. Creative learning demands a constant effort precisely because it is contrary to the direction of brain development.

In this process of flexibility to adapt to a changing reality, there are two sides to the genetic coin. On the one hand our genome manages to adapt to the environment we live in through expression and silencing of genes that allows us to react at any given moment to what we need, when we need it. On the other hand, we do not even think about the hundreds or even the thousands of genes that are constantly activated or silenced so that all of this happens smoothly until the automatic result is obtained. In other words, genetic flexibility is designed to allow adaptation to a changing environment and to find solutions to the same reality, as long as the changes are not too extreme, and the response received is expected. The automatic process becomes less and less flexible as the environment we live in changes less and less (becoming more engineered), at a slower and slower pace. Such flexible epigenetic choices would be superfluous if the brain were not sufficiently flexible to take advantage of them. Epigenetic ability is influenced by environmental events, which demonstrate the extent to which the brain is plastic and influenced by every unconscious intervention. Thus, targeted intervention would surely influence physiological and/or emotional aspects which subsequently affect the type of processing of data received in the human brain. Three mechanisms will be automatically influenced by such intervention: unconscious urges, conscious feelings and cognitive abilities. The reason for this is that brain activity is combined with circuits that are connected to complex connections between emotion and simultaneous and spontaneous awareness [10]. There are differences in the level of complexity of influence on these mechanisms and their flexibility to change the connecting circuits. These connecting circuits stem from the level of flexibility of human thought and behavior. Flexibility and complexity can be developed with appropriate education.

The influence on impulses is the simplest and most direct; the influence on feelings is more complex due to automatic internal feedback that occurs at this level, and due to the level of additional awareness via the neurons called spindle cells; and the most complex effect will be on cognitive mechanisms at different levels of abstraction. This latter effect on cognitive capacities will be especially marked from the beginning of the conscious-rational phase, since

from this time onwards there is the ability to review cognitive mechanisms and 'control' them to a certain degree. This is expressed in intervention through the automatic effect of impulse and feelings systems. Intervention is supposed to detach them from other mechanisms and to create critical reference, thought of as "objective" (compared to other mechanisms thought of as "subjective"), though they are never truly objective. In fact, it is impossible to completely separate these mechanisms, but we can differentiate between different stages of the cognitive process: the unconscious evaluation stage, the interaction between emotion (conscious but not controlled) and thought at the first conscious level – and at this stage conscious feelings and intuitions are produced through the spindle cells and through the conscious cognition stage. This is considered a fully conscious stage of the thought process, although it is in fact not so. In reality, research shows that even at the conscious stages, it is nearly impossible to distinguish between thoughts and feelings, for many reasons. The central reason is the high connectivity of the spindle cells to diverse areas in the brain, which connect all brain activity to emotional processing at high levels, as well as general brain connectivity created by the cerebellum.

We can see that the senses stimulate impulses, that is, the forces that motivate us to action and creativity. They activate the emotional system as a primary information processing system and the mental system as automatic mechanisms that control these forces. These processes are chemically mediated enabling a full continuum, rather than the total separation artificially created between body and mind [11]. This same continuum combines emotions and cognitive capacity, creating "emotional intelligence", an expression of the necessary amalgamation of feelings and logic which together form cognitive abilities, which though not widely accepted can be termed intuitive rationality [12]. At every level of cognition, even at the simplest level (which is thought to be devoid of feelings and so supposedly "objective"), unconscious emotions are involved in the brain's processing, and so enable intuitive activity at ever increasing levels of speed and accuracy. Kahneman described automatic processing as an intuitive brain system, which in the literature is defined as the number one system and very rapid, while logical thinking is the second system, and much slower [13]. The division between these three systems is then a fiction, since they influence each other and are automatically influenced. Only the differences in control capabilities of each system create the illusion that the cognitive mechanisms can act completely independently ("objectively") of impulses and emotions.

The associative communication system, which drives the emotional system and is driven by it via the associative cells, is both reinforced and restrained on a scale from general emotions to subtle nuances by the biochemical activity of more than 80 neurotransmitters. These affect brain activity in broad regions of the brain and in very precise locations at the micron level. The main reinforcement pathway in the brain is the mesolimbic pathway, which includes the nucleus accumbens, the amygdala and the hippocampus. One branch reaches the prefrontal cortex. The activity of this pathway is expressed by the neurotransmitter dopamine. The nucleus accumbens is fed by neurons, which release dopamine, found in the midbrain region known as the tegmentum, part of the mesolimbic pathway. The role of this system is to reinforce new stimuli which are interpreted as positive after processing [14]. They are reinforced by producing a feeling of pleasure, which encourages the repetition of the same behavior that produced the stimulus identified as positive. As certain bonds become stronger, the hippocampus releases to the same region of the brain stem cells that develop into neurons

http://dx.doi.org/10.5772/intechopen.79373

that strengthen communication based on neurons in the same region. This process can lead to addiction of behavior considered positive, such as eating which may become over-eating, or love that becomes addictive love. In contrast, serotonin can cause addiction to behaviors considered to be negative such as restrained eating to the point of anorexia, or love that turns to uncontrollable hate. The two systems work together to create balance – one encourages while the other suppresses at different levels of the scale from positive to negative, as the contexts change, and context is constantly changing. So, for example, curiosity can be interpreted as positive, but over-curiosity can cause damage by diverting resources. In addition, directing curiosity to a certain behavior is done at the expense of the curiosity required for other activities such as watching the landscape at the expense of caution against falling on a dangerous path, which is no less essential, and possibly more so. Therefore restraint is required using inhibitors. Exaggerated emotions or emotional suppression harms normal functioning, making balance very important between contradictory emotions as a condition for normal life [15]. In light of the dangers of addiction, research is now investigating the functions involved in addiction, loss of control and the loss of freedom at the physiological level (of the brain) and at the biochemical level that activates all brain systems. These affect the connections between the amygdala, which generates emotional-associative memory, and the hippocampus, where representational-declarative memory is reinforced in the process of consolidation [16]. These two act simultaneously, and while it appears that they are independent of one another, in fact there is constant interaction between them. However the emotional system is always stronger than the representational system, demonstrated by the fact that the nerve fibers which go from the cortical regions to the amygdala are infinitely weaker than those that go from the amygdala to the cortex [17]. Add to that the brain's ability to create chemicals which suppress cortical activity in the prefrontal cortex and the orbital-parietal cortex, which together create logical thinking which oversees and is supposed to restrain emotional activity. Due to the technological capabilities humans have developed, they created conditions which enable these same systems destined to cope with a natural environment (technology-free) to become addicted more easily to almost anything. However, since these are not one-way or binary processes, activation of the different supervisory mechanisms of the brain in a targeted way allows a degree of control via education. But in contrast to Western traditions, which see emotions as negative, or at best a motivational force, a learning perspective must change fundamentally if we understand that emotions are an inseparable component of the learning process, and particularly if we want to nurture creative thinking.

In order for unconscious brain activity to happen at high speed, the messages that are passed to specific regions of the cortex must already be "painted" as unconscious emotions. Direct interaction with the limbic system – the diencephalon – which includes the amygdala and both hippocampi, creates a process in two stages: in the first rapid process the amygdala defines the different activities on a scale from fear to terror and from confidence to arrogance. Without this characterization, there can be no awareness of the automatic response of the brain to different situations; the second process takes place more slowly, since it is affected by the multidimensional interaction created by the complex connections between different cortical regions. In this process, the hippocampi define the emotions in a more focused way

(a range of emotions – impulses – unique), and convert them into conscious feelings, which enables a fast and focused conscious control of feelings, although it is slow in comparison to the expression of feelings on the scale between fear and confidence, with anxiety at one extreme and arrogance at the other.

As mentioned, the two main systems responsible for emotional processing and making us aware of our emotions are the amygdala and the hippocampus, which are often referred to together as the limbic system. Studies, which investigated the addition and extinction of memories, attribute these regions to the formation of memories [18]. As I will show later, memories manifest themselves in the rate and intensity of information flow in the various axons, reducing associative communication as the myelin thickens, thereby increasing cognitive control over emotions. So the amygdala and hippocampus act both to accelerate and to wipe out memories – "memory engines". These small regions of the brain are not capable of containing all the information received by the brain, and certainly not it's processing into conscious and unconscious knowledge.

The main emotion created in the amygdala is the relation between fear and confidence. This is a relative scale affected by the circumstances in which the animal finds itself. Since this may involve multiple variables from multiple sources with conflicting information arriving via the senses, it is impossible to make an accurate risk assessment in the logical sense – a 'perfect' causal relationship only in a closed logic system. Therefore at any given moment, the brain has to evaluate the circumstances (feasibility rather than probability) and to constantly update its evaluation. This is the infrastructure for the entire emotional system. Since this involves joint processing of large quantities of infinite information, the brain has to make use of schemas to gather this vast amount of data, based on the 'principle of negligence' which omits a lot of information as if it were obvious and expected. This principle is created in reality and leads to the suppression of large quantities of information as 'irrelevant' to the event being processed. The result of this is that emotions are necessarily created first and even automatically activate cognitive mechanisms, whose response always comes later, and so initial judgment is carried out by emotions together with intuition and cognition as a basis for the ability to respond to surprising/unexpected situations (unexpected in a scientific – logical way). Only afterwards, if the person consciously desires, and through a large effort, can he activates complex cognitive abilities, which are also more abstract. Through this abstraction, the individual will improve his ability to control his emotions and the ability to create a more deliberate process of intuition. Therefore, the broadening of knowledge will be possible while expanding intuitive abilities through the expansion of learning circles and domains of knowledge, so the Western expectation of "purely logical" thinking is fictitious [19]. Added to that, when we use free will as a secondary motive of brain activity, and not as a result of external stimuli, the associative connections in the brain do not allow absolute awareness and control. This is because associations automatically involve an infinite number of brain variables, which are mostly unconscious. About 70% of brain cells are associative, and randomly stimulate multiple areas of the brain, and activate dormant memories, which continue to be activated. Science currently does not have the intellectual ability or the tools to learn about this communication system. Put simply, science cannot examine how information is processed in the brain, but only it observed results, and certainly cannot access the

associative communication in the brain that drives the entire emotional system, and about which current science remains in the dark.

Humans' ability to independently control emotions and feelings varies according to personal and environmental factors. It is this ability which creates the illusion that impulses and emotions are 'subjective' – arbitrarily, and that cognitive processes are supposedly 'objective' and able to be completely controlled. In reality, thought processes act automatically, and conscious thinking – as well as conscious feelings generated by the cortex – are activated in post-automatic stages. However, the amygdala (which automatically activates the emotional system and cognitive system in the right and left hemispheres) has infinitely greater control over the cortex than vice versa, which explains the difficulty of acting freely and the tendency to addiction. Education is aimed at developing and improving our ability to control these processes, although this control can never be absolute. Only in systems which are completely logic-based, there can be total control, through the creation of an artificial environment; and the more artificial it is, it becomes more detached from reality. In the same way, the more we give in to the automatic processing of the brain, out creative ability fades and brain activity becomes controlled more and more by our own personal brain history – both emotionally and cognitively. The brain works in this way since conscious activity consumes a large amount of resources. The brain therefore tries to regulate these relationships so that a sense of calm is created, which is in contrast to the conditions required for creativity. Small changes are ignored as negligible, but as the changes multiply and get bigger, it becomes necessary to activate the sense of fear, as a warning agent that increases alertness in the thalamus region and from there to the retinal configuration. This is important in order to allocate resources to the processing of new data. So when changes are small and slow the brain can adapt without raising the fear threshold to the highest levels, at which anxiety is produced, although this threshold differs between individuals. It is therefore not surprising that the level of anxiety present in the post-modern society is higher than in traditional societies, although it may appear otherwise, since people are exposed to many frequent changes. These changes have made psychology, psychiatry and dependence on technological applications into flourishing fields which are supposed to save modern humans from existential anxiety.

As described above, the hippocampus is directly connected to all the areas in the cortex characterized as sensorial processing regions – sight, hearing, tough, taste and smell [20]. The connection is bi-directional in that the information received is broken down by signal types and sent to the relevant lobes for information processing. In this way, the hippocampus sends stimuli and receives feedback. The more signals it receives, the more it produces feedback that serves as a constant stimulus for stimuli between processing areas. And since neuronal memory is expressed in the quantity and speed of flow in different neurons, as well as the extent of their wiring, the hippocampus has a central role in the creation and maintenance of memories. In other words, it serves as a kind of motor which stimulates the neurons. This stimulation causes the signals to move at different speeds according to the level of activity of the attracts, which develop in the various lobes, and are specialized in different activities. The longer this activity continues, due to additional stimuli, it activates a process of reinforcement created by the hippocampus, which turns memory in the axons and in the relevant synapses, which communicate together into attracts, from short-term memory to long-term

memory, which is stable [21] to the level of taming. This happens via protein molecules called CREB, which are responsible for switching between the two types of memory [22]. This is an inverse process which removes some information considered irrelevant, and gives priority to 'known' information. Only when information arrives which causes sufficiently strong feelings (a combination of frequency and power), influenced by the neurotransmitter acetylcholine [23], which improves the ability to remember, it will be possible to overcome the effect of the protein as an existing memory conserver, and enabling the transfer of the new information into the overall system of information processing as essentially unconscious knowledge, and only part of it will become conscious knowledge. We can then understand that basic physiological (biochemical) 'memories', which activate the relevant neuronal system more intensively, are retained for a longer time as a memory that characterizes the stability of the physiological system [24] to the level of creating automated habits and taming. In fact, if it is not impaired, it is constantly activated, both in the associative process and as ongoing activity, so physiological memory is more easily converted to long-term memory. In this system too, there are differences which arise from focused training expressed as expertise in the physiological sense: in musicians – the developed sense of hearing and operation of systems including hands, feet, mouth, etc.; in athletes – according to their sport and so on. However, these physiological memories, if they are not activated on a regular basis (referred to as the training regimen), waste and fade like cognitive memories, when we stop using them. Focused training, as well as content memorization, is an artificial (and planned) way of reinforcing memory, similar to automatic reinforcement, seen in savants where some areas of brain communication have been damaged, [25] and prevent creation of divergent thinking. The weakness of 'normal' humans is the need for continuous training or memorization as opposed to daily activity that activates these memories through relevant experiences, emotions and relevant cognitive activity. This process leads to reinforcement of memories through ongoing varied activities, which combine necessary repetitions with the expansion of associative connections that activate connected neuronal systems, which are interwoven with sufficient connections – and produce attracts to the level of taming. So in order to reinforce certain cerebral capabilities, as a condition for improved thinking and functioning, humans must inhibit the automatic processing of the brain, slow it down and take advantage of the processing of contradictory information to change the automatic preferences created by the brain, which are always possible in retrospect – after the automatic processing of the brain, and not in its place. Put simply, the automatic processing of the brain cannot be neutralized, but we can alter the involuntary prioritization which is automatically produced. On the other hand, automatic processing can be reinforced to the level of expertise or taming, which constitutes the main aim of the educational system.

'Spatial memory', an example of complex processing of memory in the brain, is dependent on the ability to simultaneously activate several areas of the brain. Every addition, such as voice, smell, sound and symbolic abstraction, stimulates and stabilizes the spatial memory. Those with a more multidimensional operation in the hippocampus will find this easier, and if necessary secondary stimuli may awaken the imagination, as a prerequisite for creating imagined pictures of the place. These processes are essential for the development of creative thought. The more we activate different areas of the brain, the hippocampi grow and enable

http://dx.doi.org/10.5772/intechopen.79373

the activation of more connections and the development of a more flexible memory. This process goes counter to the academic system of specialization and focusing on a narrow field to become an expert.

These procedures allow for the creation of finer distinctions between feelings (impulses) and their characterization as emotions, which are the abstraction of feelings. Accordingly we can see the midbrain in general, and the limbic system in particular, as an 'engine' for the activation of the various and unique brain memories. We can see that these systems transform the signals into emotions – impulses (accelerating) on different scales: hedonistic pleasure---masochistic pain; overconfidence---terror; boundless curiosity---emptiness/inanity; depression---ecstatic joy (manic depression); anger---calm; disgust/rejection---affection/attraction; satisfaction---wanting; excitement---indifference. All of these are commonly termed 'inner feelings'. All these scales work together at every event involving conflict or tension, and can be enlisted to exert conscious control over automatic emotional processes. Control over this range is indirect and difficult, requiring complex actions, the components of which are not always easily identifiable. So, for example, in many cases a person may find it difficult to explain what makes them afraid, or why certain things arouse their curiosity, why they are depressed or happy, angry, or why they feel affection or alternatively disgust. Why do they feel satisfaction in some circumstances, and in other situations which may appear similar they feel emptiness. This lack of clarity is because the system works automatically and associatively before conscious thought is involved, forming a unique brain history for each of us. The inability to obtain total control over these systems enables creative and intuitive processes to continue to act, but less and less so as control gets stronger in specific fields. The more a person specializes in a narrow field, their creative ability in that field improves up to a point, but it decreases as the level of expertise reaches the level of automatic brain activity that comes with taming.

Additional emotional abstraction through hippocampal activity turns general emotions into more distinct feelings (conscious impulses). But even these cannot always be explained clearly enough because of the multitude of contradictory information involved in their formation, yet the relationship between the circumstances and their arousal or inhibition is more targeted. This abstraction occurs with the help of activity in specific cortical regions, which specialize in focused information processing, and which convert emotions to more confined feelings, which operate on an internal scale of strength within each emotion, and on a scale of opposing emotions. This is contrary to the approach developed in Western culture which tends to characterize emotions dichotomously as good **or** bad:

Love---hate; revenge---forgiveness; jealousy---surrender; compassion---cruelty; generosity---greed; courage---cowardice; disappointment---surprise; responsibility---impulsiveness; shame---pride; embarrassment---impertinence; empathy---detachment; admiration---abuse; trust---suspicion; suffering---pleasure; tolerance---selfishness; patience---haste; desperation---hope; humility---arrogance; wonder---pettiness; boredom---activity; passion---control; guilt---renouncement; regret---vanity/arrogance; modesty---ostentation.

We could find more pairs. This pairing of emotions, as an expression of being on a continuous scale, is intended to illustrate the vague boundary between these couples, as well as the idea that

encouragement or restraint of one emotion occurs by encouraging or restraining its emotional opponent. The relationship is in fact much more complicated due to the effect of interaction between the pairs, which arises from the direct, indirect and associative connections between them which the brain as a single system creates. More abstract feelings are created, such as a relative sense of the scale between justice and injustice, fairness and unfairness, credibility and fraud, good and bad, which in different cultures have different and even reversed meanings, which is contrary to the dogmatic Western belief of categorical division between "good" and "bad". This calls for a moral education completely different to that which has developed in Western culture. In each such activity, the underlying emotions and processes of reinforcement and suppression of the system are involved in the brain's mesolimbic pathway, which reinforces activity perceived as successful, and this perceptions of success is influenced by different circumstances and a great deal of arbitrariness. So there is no room for binary judgments, as required in logic systems, even though mathematics does not have such a basic possibility, as Kurt Gödel's theory of incompleteness proves. This lack of possibility allows flexibility of brain processing and humans' changing responses by the millisecond. Changes are a necessary condition for dealing with surprises where the field of creativity is expressed. This capacity for flexibility can develop if these fields are not systematically relegated with repetitive habits, both on the physiological level, on the emotional level and the abstract level of thought, which are interrelated in their automated processing, created on the basis of mechanisms that enable the cultivation of expertise to the point of taming which suppresses self-learning and creativity.

Golemn presented psychological research which demonstrates that if we artificially activate emotions in different ways, a physiological response appears in the relevant involuntary systems, with concurrent expression in the relevant brain areas [26]. This explains our ability to affect the structure and taming of our emotional responses, and our ability to learn to 'control', to the point of suppression, the array of forces that control us, including the removal of unwanted memories [27]. Without this option, there would be no point in education or the discussion of 'freedom' and 'responsibility' and certainly we would not be able to claim flexibility of brain activity as a condition for creative thinking. However, it should be remembered that these possibilities provide educators with the ability to restrain and suppress the range of forces that spontaneously activate the various emotions, thereby suppressing the associative and creative abilities of the brain – to tame the animal, including humans. It follows that in order for these mechanisms to be effective in changing situations, a mechanism is needed that will create their flexibility of action. This same mechanism would enable them to act at different levels of power (response speed and strength of action) according to the changing circumstances. In order for this flexibility to exist, all human action mechanisms are activated by mutual restraint and relaxation. The more they are operated, their ability to operate – in the long-term – is impaired, and in the end the flexibility of the system is suppressed [28]. Thus, the greater the level of specialization or expertise, the more the capacity for creativity is suppressed. In order for the system not to be suppressed, it is necessary to take a break from the action – to rest. But resting too much leads to wasting of the system. Hence, the system's ability to operate depends on the ratio between its operation at appropriate and variable doses and breaks in its operation. At one end of the scale, there is an uncontrolled impulse to action, and at the other end this impulse is so suppressed that it can no longer stimulate

action. The effectiveness of the operation of the mechanisms is also dependent on the ability of the system to react at various intensities in accordance with the changing circumstances. If one of the human mechanisms of action – senses, impulses and emotions – is activated at a certain intensity, after a while, a stronger stimulus is required to activate the relevant sense, and consequently the impulses and feelings that accompany it. A lack of stimuli that activate a certain sense will lead to suppression of the impulses and feelings that accompany it. As these processes become more extreme – excessive frequency of the mechanism of operation or activation of excessive power – increases the possibility of addiction. Alternatively, the lack of activation of certain mechanisms will result in their total suppression. The outcome of this process is that we are less and less able to control our mechanisms of activation. Therefore, over-control – characterized by a high level of expertise to the point of addiction, and insufficient control over the content and skills – that characterizes laity, both reduce the brain's flexible processing capacity and creative ability.

2.2. Dendritic trees as a dynamic learning system

On the dendritic trees of the 100 billion neurons in the human brain, there are up to 30,000 dendrites and around 300,000 dendrites on the neurons in the cerebellum, which unify the brain and body into a single system. The structure of the dendritic trees and their way of functioning is the basis which enables the brain's ability to create changes in functioning according to the changing environment, including surprising changes of different strengths, as a necessary condition of survival [29]. In order for this system to truly function flexibly, it must work on the principle of 'weak contradictions' [30], of which the mathematical complexity upon which neurologists base their theory [31] is merely a superficial image. So, for example, there is a defining influence on information processing in the dendritic trees as a result of the structure of its representation as a geometric cone shape, the length and location of the synapses along it through which information arrives from other neurons. This influences the dynamic development and extinction of the spikes that form the surface of the tree [32] on the amount of information the dendritic tree receives from various sources, as a result of the level of connectivity and the hidden complexity of the unique activity within the dendritic tree, which in turn influences the information processing activity of the whole cell, which is critical to understanding brain activity.

Neurologists taking part in the Blue Brain Project decided that it is possible to convert the infinite complexity of the total functions which arise from the special structure of the dendritic trees, designed to deal with millions of conflicting sources of information every fraction of second. In order to propose a mathematical model, they simplified the complex structure of the dendritic trees to a 'pipe' model, in the belief that the level of detail they created would be sufficient. Orly Stettiner refers to this conversion in the following words:

> *For single neurons, there are mathematical models (the best known of which is the Hodgkin-Huxley model, which won the Nobel Prize for Physiology in 1963, which describes the electrical and computational activity in them), but a full and detailed mathematical description of a neural network (made up of a collection of hundreds and thousands of such cells) would require computing resources which are not feasible, and the networks that are currently available for modeling are over-simplified and approximated, as well as disregarding many biological specifications. [33]*

In reality the problem is much worse than the technical limitations presented by Stettiner. Attempts to create a mathematical model with information coming from up to 30,000 synapses from conflicting sources every millisecond is an over-simplification which shows neurologists' lack of understanding of learning because they are caught up in the prevailing paradigm of learning whose characteristics I will present below. Harel makes it clear that even a quantum computer would not be able to overcome the limitations of Thesis-Church-Turing. So even if quantum computers were invented, they would not solve the computational obstacles [34]. Thus, he confirms Stettiner's claims, as he explains that computational analysis cannot deal with logical contradictions in principle, which the information processing in the dendritic trees does deal with, and not incidentally. The dendritic trees are not designed to make binary decisions between contradicting information since the information, received in the fraction of a second, cannot be deleted as mistaken (as binary activity would do) because in the next fraction of a second, when information arrives contradicting the previous result, the brain will need the previous information which would have been deleted. Put simply, the way the brain conducts information processing allows it to contain contradictions and not to delete them in a binary fashion. Without this capacity, humans would be unable to survive. Furthermore, the synapses are located at different distances from the cell body, and at different levels of development due to having different histories of activity in each synapse, and so they dictate the quantity of information which passes through them and its power. These synapses are also divided into those that accelerate, around 80%, and those that delay, around 20%, where most of the delaying synapses are found close to the cell body, and can therefore slow down the results of the processing. This prevents the creation of a command to action, and its delay if it turns out that the result of the previous processing is now irrelevant.

This structure allows the brain to process information according to the feasibility principle, which is in contrary to the probability principle on which computers compute their statistical calculations, and through which neurologists assess brain functioning, and psychologists evaluate the range of human behaviors. So, for example, the way in which information processing occurs in the brain allows us to treat one-off events as important for learning in relation to future events, while from a statistical point of view, based on the principle of probability, such a single event would become meaningless in the framework of statistical calculations. Furthermore, no statistical calculation could replicate the processing of information in the human brain that combines a complex number of events with their varying intensity in every fraction of a second. This shows us that information processing in the brain's dendritic trees – or learning – is fundamentally different from statistical processing of information. Statistical analysis of information as a tool to evaluate human behavior was developed based on the fictions of rational-logical man and which Western culture adopted since Plato, turning it into the ultimate desire of modern man. This explains the results of Kahneman's research according to which not only laymen are affected by mistakes, which he referred to as heuristics. From similar studies carried out by experts in statistics and probability, who should have been better able to deal with such errors if the human brain were to process information in a probability manner, it would seem that they failed the tests just as laymen. Richard H Thaler, similar to Kahneman, also received a Nobel Prize on the basis of his theory of the irrational man who makes mistakes in general and regarding economic considerations in particular. In contrast to other researchers, he denies the possibility that humans can function in a

rational-logical way as modern scientific thought developed. In his book he presents humans as falling into the 'heuristic trap' – a rational prison [35], however he does not propose an alternative perspective for the rational man. Thus, the scale of the irrational man he refers to, though unconsciously, is the rational-logical person on which scientific research is based. An understanding of the information processing in the dendritic trees requires renunciation of the perspective of the logical-rational man which science has sanctified, which as I will go on to show, is by definition contrary to the principle of creative humanity.

Moreover, a statistical calculation is aimed at the average and gives a supposedly unequivocal mathematical result, thus losing the information which results from contradictory sources. These contradictory sources are actually processed through biochemical processes that enable the interactive expression of such contradictory information and is unique to each individual according to their own personal brain history in general and of the creative person in particular, when it comes to high levels of creativity. It follows then that no mathematical algorithm, as complex as it may be, is capable of representing it **in principle**. A logical algorithm is incapable of relating simultaneously to conflicting information without making a binary choice choosing between them. Biochemical interactions are able to do this, so the products of a neuron are mediated through biochemical processes in biological (not mechanical) structures that are translated into analog electrical signals rather than digital (monocultural) signals. Many neurologists, and particularly computational experts who work with them, are convinced that this information is superfluous [36], and that it is possible to convert these complex processes into mathematical algorithms without losing significant information. But it is just this conflicting information which is unable to be computed, which creates the special flexibility of the human brain, and therefore gives rise to multiple sources of information coming from different body parts and and their representation in the millions of cells in primary brain regions [37], and the secondary relationships that influence and are influenced by interactions of local networks and links between groups to expandable communication systems that act together with associative stimuli. The obvious conclusion is that no mathematical model is capable of representing these infinite and conflicting relationships, which occur in a fraction of a second. No mathematical model which purports to be logical, but which in principle cannot be so, and so has never yet been built, can be logical according to the Gödel's proof of incompleteness [38], to cope with conflicting processes while renouncing the option to decide between them in a binary manner. Despite such a model were built anyway due to the human need to refute the unexpected, it would lose the connection with the complicated and dynamic reality, in our need to be logical, as Godel showed in his theory about the absolute gap between logical structure and reality.

The picture of the contradictory relationships involved in any information processing in a particular neuron is even more complex and dynamic than the complexity involved in processing information in each dendritic tree in the cortex because each neuron in a particular sub-region, known as a cortical column, affects the total activity that occurs in each column. In fact, every neuron in the brain affects the entire brain's activity by means of a vast communication system which the cerebellum creates with all brain areas, and whose connections cannot fully be described here. This creates the possibility that any neuron present in a certain cortical column in a particular subset of the cortex affects the processing of information relevant to a minor subject, and that these linked columns can communicate and influence the overall decision the brain makes the brain's overall information processing. This means

that each specific learning process that the brain automatically generates affects all the learning processes that the brain produces directly or indirectly in a unique historical process for each brain. This is the result of changes taking place in the communication systems that routinely transmit the information processed in each of the billions of dendritic trees involved in information processing – automatic learning. The significance of the meeting of an enormous amount of information from conflicting sources in every particle of each of the billions of dendrites indicates why information that comes from digital electrical signals (spikes) undergoes a transition to chemical interactions converted to analog electrical signals created in the neuron cell fluid rather than through direct electrical transitions between the dendritic trees and the axon that passes the result of automatic learning outcomes as information to the next neurons. This process allows learning which is not deterministic, similar to the way in which computers process information. In fact, this is the transition of information processed by biochemical processing, also unlike the direct (linear) process that electric circuitry produces in artificial systems. Cellular information processing occurs through infinite interactions, which the dendritic trees send regularly and in contrasting ways (accelerating and inhibiting), but in varying doses every millisecond, to the cell body. Although the cell body and its activity are of interest, their contribution to understanding the brain's ability to create flexibility is marginal, and therefore I will not go into greater detail here.

It follows then that no electrical system – either analog or digital – is capable of operating the combined and conflicting processing which occurs so fluently in the dendritic trees, therefore only the chemical structure found in the dendritic trees and in the cell body, enables great flexibility of information processing sent by the thousands of synapses (which differ in power and direction – stimulating and inhibiting) in every fraction of a second without losing the infinite complexity in direct electrical processes. More simply put, the processing of information in each of the billions of dendritic trees in the brain, which contain vast quantities of conflicting and constantly changing information,, all the while processing the contradictions without canceling them in a binary manner, are those which allow the flexibility of information processing in the brain, and thereby **produce the flexible learning potential of the human brain** specifically due to the processing ability of the frontal pre-cortex which is evolutionarily unique in size and strength. No logical, mechanical or mathematical formula could characterize this processing of information without losing huge amounts of data which allows the animal a flexible and creative learning, certainly not at the level at which the human brain is capable of functioning. Therefore, all thinking that claims to be completely logical (this is impossible according to Gödels proof of incompleteness) with no contradictions, and the abstract models and technological tools upon which science relies, based on the dogmatic assumption that logical thinking and its mathematical and scientific extensions can describe the activity of the human brain and human learning methods, are completely baseless. Even more absurd is the belief that complex, and 'learning' algorithms could replace brain learning while overcoming the problems that the brain makes as a necessary condition for the flexible information processing method that it allows, and especially with the ability to deal with surprising – or unexpected – events, and to propose creative solutions which fundamentally could not be perfect – since a perfectly logical system cannot in principle enable creative learning. Hence the dogmatic claim of mathematicians according to which mathematical

calculations are the basis of all that is important to humans represents the central belief of standard science and rational-logical man, but it is fundamentally wrong based on Gödels proof of incompleteness. In fact, the things which are most important to us, which make us human and creative, cannot be computed mathematically. First, I will dedicate a section to the importance of subjective markers as an inseparable part of the flexible information processing and creativity specifically, next, I will present the potential for flexibility found in the intracranial communication systems, and the reasons for survival that make the brain itself limit the flexibility and creativity of the human brain.

2.3. Axons and synapses: from flexibility to mental fixation due to specialization and expertise

Communication within the brain between the billions of dendrite trees, each of which process huge quantities of information which is constantly changing, occurs via several interacting systems which allows the transfer of large amounts of information at the same time with a large degree of flexibility. In the previous section, I presented the basic associative communications system, which simultaneously stimulates multiples areas of information processing which are essential for emotional activity as a fast call to action. This associative communication system acts in parallel to the highly branched neuronal communication system, based on axons and synapses, which I call the direct communications system. These two systems of communication – associative and direct – are connected to each other, so that as the direct system grows stronger, or becomes more developed or trained, it reduces communication in the associative system in the specialized area and makes connectivity with other areas more difficult. One unique characteristic of the human brain is the amount of connections between each neuron in the cortex (30,000) which is by far the greatest number among animals. This enables great connectivity within each cortical column, which is an area for specialized processing of specific information, and at the same time enables the creation of more multi-system connections in humans compared to any animal through the neurons in the cerebellum, each of which can absorb about 300,000 data sources per fraction of a second and transfer the results to all areas of the brain. This means that all the dendritic trees in the human brain can receive every millisecond a much larger amount of information from conflicting sources than can any other animal. It is this multiplicity of conflicting encounters that allows the human brain to learn more flexibly than any other animal. Even more importantly, the abundance of connections gives humans a creative capacity at a level that no other animal possesses. This is because the multiplicity of connectivity connects vast amounts of emotional (primary and strong) and cognitive information (secondary and reinforced), which is an expression of the amount of information that turns all the information in the brain into a single processing system. The direct information processing system will be presented briefly below.

The emotional system is what makes the mirror neurons in the brain capable of imagination, and because of the amount of connected information in the human brain at every fraction of a second, the human imagination is incomparably greater than that of any other animal. Moreover, because learning always occurs when new information is received that contradicts the results of previous brain processing, the human brain, because of the greatest development

of the cortex in general and the forebrain in particular, is a logical control system for the emotional system, thus creating a contradictory collision of information that does not exist in any other animal. This collision of contradictions is unique to human beings, combined with the unique imaginative capacity of humans, and is what allows creative potential at such high levels not found in any other animal. The level of brain flexibility in humans is the most flexible of all animals to allow for creative ability that is the product of surprising connections designed to cope with situations so unpredictable that no other animal could cope with them. The level of brain flexibility, including in humans, decreases as the brain specializes as a result of the strengthening of the direct communication system at the expense of the associative communication system. This means that each specialization produces a more focused response system than those created through the associative communication system. As a result, the elasticity of data processing is reduced in those dendritic trees that are activated triggered by the same process of specialization. Thus, the more specialized the brain is in a limited field, the communication systems that operate for information processing in the dendritic trees intended for that narrow area will lose the flexibility of transferring information within them, thus providing the same dendritic trees with information similar to previous information received by the brain, which will lead to reduced information processing flexibility to the point of closing communication channels with other areas of the brain. In other words, specialization leads to tightening certain brain connections at the expense of flexible/associative connectivity with other brain regions. This process has obvious survival benefits that allow the animal to move as quickly as possible from a brain that learns flexibly to a specialized brain capable of coping with its current environment with increasing efficiency. This means that survival requirements cause the brain to begin its coping as a flexible system, as a necessary condition for its ability to exist in different and changing environments, but the brain will diminish its brain-flexing capabilities as it succeeds in existing with increasing efficiency in its habitat. The brain will do everything in its power to move from a flexible learning mode to fast, unconscious, automatic processes of operation that are characteristic of high levels of specialization/expertise similar to taming mode. In these automatic situations, the brain invests little energy in the unconscious processing of vast amounts of information, which as it becomes more automatic (unconscious), the learning process is reduced or even muted to zero. This endangers the animal when it encounters highly unpredictable changes. When events are more expected, the brain does not require learning that requires it to invest large amounts of energy by removing information that is slightly contradictory to brain expectations. This creates a lack of response to changes in general and especially to unpredictable changes, accompanied by a feeling of insecurity and anxiety associated with situations that are uncertain. As I will show later, Western culture, by sanctifying logical connections (expected connections that are supposed to be deterministic) as if they are the expression of a "true reality" free of error, has made specialization the pinnacle of Western culture. Therefore, in the Western education system, most effort is invested in memorization to artificially accelerate the stage of specialization at the expense of shortening the learning stage in general and creative learning in particular.

Direct wires (brain connections) are formed by the axons, which at the beginning of their operation enable flexible but more stable connections than the connections created by the

associative communication system that drives emotions and feelings. The intuitive communication system is affected by electromagnetic fields generated in areas of increased electrical activity in the brain in the direct communication systems. As stated above, the stronger direct communication becomes as a result of specialization, it reduces the other communication systems until they become meaningless for other areas of specialization because of the reduction of associative-connectivity with other brain regions. Mechanisms for reducing flexibility work so that the more an axon and/or group of axons are activated, the greater the amount of data transmitted and power at the expense of connectivity with other brain regions. The levels of information transfer in the axon are enormous, and can be described quite schematically on the following scale: starting with a **minimum activity** of one spike per second – which causes the axon to degenerate and stop transmitting information (a reversible process made possible by the creation of a new axon); through **sparse activity** – that allows for a small amount of information to be transferred. The level of randomness is high, and expertise is weak; and up to **a maximum level of activity** (up to billions of activations with increasing frequency), which causes an axon group to operate automatically, and even reaches a level of activity characteristic of overpowering and addictive specialization. When you reach the high levels of information transfer in certain axons, information transfer becomes increasingly uncontrollable even when the conscious activity of the brain arises in an attempt to restrain or inhibit the activity. An extreme example of this is autism, which is an expression of impairment in emotional communication, and Alzheimer's as an expression of impairment in motor communication. The brain's degree of flexibility and creative processing capacity lies in the range between great levels of information transfer and too much data transmission activity. Quantitative measures cannot be produced for the terms "great" and "too many," because they are relative to the different subjects and to each person's unique brain history.

In order for an axon to be able to transmit information on such a wide scale of flexibility – from deterioration to addiction – it must have a modified configuration, influenced by the activity generated within it and its biochemical and electrical environment. The axon is connected to the cell from which it receives the information that is processed in the dendritic tree. This connection is called an axon hillock, which collects the cell processing processes and transmits information by means of an electrical signal that has a common code for all the electrical signals in the brain, called a spike. The electric signal, as a potential for action, is created only if the processing of the information coming from many conflicting sources accumulates into sufficient biochemical action so that it is converted into an electrical signal that is passed on to another 30,000 neurons. The axon is built in the form of a cylinder with a central axis (the word 'axon', which is taken from Greek, expresses exactly the combination of a cylinder and an axis), and the electrical signals move in liquid. The pipe itself is made of a membrane encased in myelin, and the myelin is fragmented at regular intervals called the nodes of Ranvier. These spaces allow complex biochemical interactions with fluid found outside the axon. It is not necessary here to detail the structures and materials involved in this process, but to point out that their purpose is to ensure that the electric signal is always moving in one direction and with the same intensity throughout the axon and its extensions that connect to other nerve cells. The axon structure is such that it allows flexible reception in terms of data transfer speed, which changes the amount of information passing through the

axon. This elasticity varies from axon to axon depending on the number of nerve impulses per second that pass through it, called Rate Code, and their rate of appearance per second Temporal Code. The number of nerve impulses is affected by the amount of information of the same type that the senses pass for brain processing. The speed of transmission per second allows for a growing amount of the same information to pass through the axon. The combination of these is the neural code that characterizes the uniqueness of the data in one axon compared with the rest of the axons, and each unique combination transmits a command to a particular activity, which characterizes the different types of information that pass through each axon. This means that when an action order is generated for a particular area of the brain and/or for physiological activity in the body, it is the result of a meeting of tens of thousands of axons each with their own specific neural impulses, both in quantity and in the rate of their appearance.

As the processing of information in the axon multiplies, the myelin wrap changes and thickens the axon tube, and as it thickens, the axon tube becomes increasingly insulated from external interference created by the electromagnetic field that arises in that area due to increased electrical activity. As a result, as the wires become more insulated, they transmit the signals at a higher speed, and the faster the speed, the greater the amount and frequency of the signals, causing the myelin to thicken. In fact, there is an interaction here between the amount of flow of electrical signals in the axon tube and their velocity and the formation of myelin, and so forth. This means that as more information of a particular type is processed in the brain, making the owner of the brain an expert in a given field by repeated engagement in a particular activity and/or via deliberate memorization, the relevant axons thicken and create a preference for this information type over information coming from other sources. This thickening reduces external electromagnetic interference, but also reduces the activation of the associative communication system. This is the process that makes it possible to tame animals, including humans, and in this respect, there is no difference between them. This is because electrical signals are actually electromagnetic interference. However, the electrical signals moving inside the axons will be less disturbed as the myelin in them thickens and reduces the Ranvier intervals, which will reduce the interference resulting from activity outside the axons, especially the electromagnetic interference generated by millions of axons in their ongoing activity. Electromagnetic interference and their effect on the brain can be studied using transcranial magnetic stimulation (TMS), a machine which produces an electromagnetic field outside the skull that can paralyze specific areas of activity in the brain.

As a result of the myelin thickening process, which insulates the specific axon, the electrical signals within the more insulated axons will move more rapidly, so that the relative effect of the friction within the membrane fluid will decrease. Disturbances within the membrane are created by the fact that the electricity generated in the dendritic tree, which has not matured into a spike (the signal strength of the inhibitors is greater than the force of the impulses), must be released through the axon so that it creates electrical interference perceived as 'electric noise'. This means that competition is created between the spike transmitted by the axon and the electrical noise that passes through the same axon. The results of the specialization/taming of a particular axon array increases the amount and intensity of signals that come to certain dendrites as a result of the preference generated for the reception of certain

information (which it has become specialized in processing). This reduces the possibility that contradictory/inhibitory information will reach specialized/tamed dendrites. So, spikes will be more easily produced in those dendritic trees which will reduce the electrical activity that did not mature into spikes, so the speed and intensity of the spikes will keep increasing. As a result, the inhibitory electrical energy will decrease, which will result in decreased disturbances/noise within expert or tamed axons. The range of these changes will affect the areas of increased information processing because it gives preference compared to other areas of processing in the brain where less information is processed, even though they produce stronger electromagnetic fields than other areas of activity.

To sum up the interaction between flexibility and specialization/expertise, the relationship between extracellular electromagnetic activity and intracellular electrothermal activity, which has matured into spikes, will change in favor of an increased flow of spikes and at the same time the electromagnetic disturbances within the axon resulting from information processing in the dendritic tree that did not mature into spikes (information which will pass to the following neurons) will decrease. Information passing to the next neurons will be reduced. This process reduces the elasticity of information transmission in areas where it is highly active (e.g., areas of high brain activity in experts) because of the myelin thickening in the same brain area and the reduction of inhibition of contradictory information that can be processed in dendritic trees specialized to the point of taming. This process leads to the fact that the relative weight of nerve cells that are frequently activated in the dendritic trees to which they transmit information increases – both in areas of specialization in the cerebral cortex and in relevant dendritic trees in the cerebellum. This is because neurons in the cerebellum are linked to many areas of the cortex, allocating more resources to those regions as they specialize until the person becomes a well-trained – or in other words 'well-tamed' – expert. At this stage the activity in that area becomes more and more automated, less conscious and therefore less controlled. In this state, brain activity requires less energy, but it also reduces its ability to change – for learning in general and creativity in particular.

This is how expertise is formed, as the brain gives preference to specific brain activity over other brain activities. This can be demonstrated through all types of physical, cognitive or mental activity. The brain areas which create and send commands to the relevant muscles in a musician, who practises playing his instrument for many hours, will thicken, and simultaneously those muscles will become more developed compared to other muscle groups. It follows that the hand muscles and fingers of a professional piano player will be far more developed than a professional footballer, who will have much more developed leg muscles. Of course, there are exceptions who invest enough effort to become experts in both fields. This example can be applied primarily to topics that are mainly emotional, such as religious belief (or any type of belief), artistic specialization, etc.**, where logical abilities are minimally involved as inhibitors; with less intensity in cognitive fields**, in which a more balanced competition is created between emotional and logical capabilities; however, emotional abilities still dominate. The least intense competition between emotional and logical abilities occurs in subjects where expertise develops in different disciplines where scientific pretensions attempt to impose logical abilities to the extent of negating emotional capacities, perceived as disruptive to scientific understanding. The differences would of course be huge between

someone who has specialized in a certain field compared to someone who has not. As logical capabilities take over emotional capabilities via training/practice, which can take years, so the expert becomes more and more autistic (emotional capacities become suppressed) to a level close to autism, where the autistic person is incapable of activating the emotions required in order to understand reality, particularly social reality. These differences are expressed in the thickening of myelin in certain areas of the brain, which are exposed more to a specific type of information compared to other types of information; if it concerns information with dominant emotional content the person can become fanatical or addicted to the subject. In the same way, if the information has dominant logical content, the individual will become more autistic in their particular field, up to the point of being socially inept due to attempts to control emotions with logic. Most people are creative at a low level sufficient to cope with daily life since their emotional capabilities remain dominant. In contrast, creativity at high levels becomes less prevalent due to the need to combine high levels of logical abilities, which as mentioned impairs the automatic process of emotional and logical integration. Mainly because of the control of logic over emotions, the latter of which activate associative connections, imagination and intuition. As these abilities fade, the creative ability of the brain is diminished.

The process described above, regarding the decrease of flexibility in the brain due to strengthening of the direct communications system, also affects the degree of flexibility of information processing in the dendritic trees. The flexibility of the brain stems mainly from the fact that a command is created as a result of the relative weight (quantity and strength) of millions of sources of information, some of which support one another while others contradict each other, which are mostly charged with conflicting emotional abilities, and their emotional strength is stronger than the logical strength. The relative weight of the supporting and contradictory nerve impulses can change every fraction of a second, thus responding to the enormous amount of information that a reality full of contradictions provides to the brain. This is not a matter of binary decisions, but of the decisions taken by the relative weighing of the amount and intensity of information that reaches millions to billions of dendrites every millisecond simultaneously, and which process the same information and are constantly changing its relative weight. The more a person specializes in a particular field, the more he reduces his ability for flexible processing (adaptation to conflicting information) by the dendritic trees which process similar information, as a result of a preference created for the same type of information over other types, which therefore reduce conflicting forces and more easily create electric signals which support previous decisions. This is a result of the fact that information is prioritized in which the emotional contradictions are reduced as a result of the increasing control of the logical abilities over emotional abilities. This means that the acceleration of direct communication created by changes in the axons and synapses, which I will describe next, comes at the expense of reduced associative communication, which impairs the ability to activate the imagination and intuition and causes a continuous decline in the elasticity of brain processing in the dendritic trees, and consequently the brain's creative abilities. It should be remembered that the acceleration of direct communication is intensified not only as a result of the deliberate specialization that developed in human culture in general and in the West in particular – which reduces the flexibility of processing information in dendritic trees – but first and foremost as a result of the continuous experience of life in the same

http://dx.doi.org/10.5772/intechopen.79373

existential and social environment, which leads to over-thickening of axons where the flow of information is reinforced as they are more activated. This process creates a unique brain history for each person, which influences the direction of his brain processing to the point of expertise and taming.

The process in which axon connections are loose at the start of activity (they degenerate if they are not activated) and become tight connections with different neurons to which information is passed, involves the synapses. The Greek origin of the word expresses its function as a **connector** between the axon and around 30,000 dendritic trees of the subsequent neurons, to which it passes information. The structure of the synapse is such that one part forms the end of the axon, and the second part forms the entrance to the dendrite tree of the next neuron. On the axon side of the synapse, there are axon bulbs with different types of neurotransmitters which excite or inhibit the transmission of information, and on the dendrite side of the synapse there are receivers – each of which can receive a particular type of neurotransmitter which causes excitement or inhibition of the information transmission. Between these two parts is a gap called the synaptic cleft. When the activity of both parts of the synapse is repeated, these connections are interpreted as essential, and are therefore reinforced and stabilized through reducing the gap so that information can travel faster and in a more stable way [39]. Every transfer of accumulated information is interpreted as a success via a signal back toward the dendrites, called 'hand shaking'. As more series of nerve impulses are generated on the receiving end, the synapse receives more 'hand shakes', which move the synapse backwards reducing the gap and so making the transmission more efficient. This occurs as the returning signals multiply, and they cause the receptors to converge to the side of the synapse margin on the dendritic side and to approach the bulbs storing transmitters on the axon side of the synapse. Thus, a large number of neural conductors are used in any future electric signal that passes through the axon. This increases information transfer between the two sides of the synapse. As a result, the impact of synapses on the creation of information preferences in the next dendritic trees is intensified by the accumulation of connections that results from a large number of synapses working simultaneously, up to 100, or many more if at the same time inhibitory signals are applied. Add to this the constant change in the number of connections, caused by the creation of new synapses and the disconnection of others, this physiological flexibility [40] as preliminary potential decreases as the transition in some synapses becomes more efficient and more easily overcomes the electromagnetic disturbance created in the fluid (exocytosis) found inside the axon. This process affects short–term memory, and if the situation is maintained for a long period, may also affect long-term memory [41], combined with the 'passive flow' (minimum flow which exists even when there is no information transfer – one nerve impulse to the next) in the axon tube. If the number of 'hand shakes' decreases, this affects short-term memory first, both by preventing the formation of long-term memory and in the slow decay of the long-term memory created and by the weakening and disconnection of the bond between the two sides of the synapse. Each synapse is connected via a spine, a small bump (measured in nano-millimeters) through which the synapse connects to the dendritic tree. Even if a synapse comes from a particular axon which has degenerated, and in its place a new synapse has been created which connects new ports to another neuron, the spine maintains the strength of the memory that characterizes the receiving neuron. This

creates additional flexibility based on a change in the order of priorities between the various types of information as a result of the provision of new information and learning, which gives preference to certain information over the previous information to the level of expertise and taming through deliberate practice.

Axons which do not find new connections over time, and so become weak and degenerate, reduce the potential for information processing of the whole group of neurons wired together, which process information together, although in imaging it appears as a disorganized interaction not logically or linearly understood. Wiring between groups of neurons produces complex memories represented by expanding wires, the activity of which can become stronger or weaken in different doses, which affect the intensity of memories. In long-term processes, memories that activate very wide circuits can become stronger or weaker in varying doses. For example, even an expert who has not worked for many years in his field of expertise, who clearly has long-term memories stored in his brain, will find it difficult to function at the same level as when he was active in the field of expertise – both with regard to the volume of memories, and their power and accessibility. From this we can learn about the importance of the synapses for memory and learning and their level of flexibility [42], as those responsible for completing the process of creating and transferring information via the axons.

3. Fundamentals of Western thinking which lead to indoctrination and taming

We can learn about Western culture's relationship with learning from its attitudes to the unexpected [43], through the word 'unlikely', one of the meanings of which is unexpected or unlooked-for. The Merriam Webster dictionary gives two definitions. The first is described thus: 'not likely – used to say that something probably **will not** happen or is not true'. This definition suggests something that is not expected to happen, and therefore is not right/true.

The second definition is described in the following words: '*always used before a noun*: not seeming to be right or suited for a purpose'.

The meaning of this definition is that there is an expected or desired outcome and anything which is unexpected becomes 'not right/true or 'not suitable'. The beginning of this approach in Western culture was Plato's idea that in the face of an unexpected world which humans must cope with we can discover a perfect world where everything is expected, freeing humans from the terror of uncertainty. Plato invented the perfected 'logus' world, where everything works as expected, so those who discover such a world in its entirety would be able to accurately predict the 'real' or 'proper' future. This would allow a person (not any person but a philosopher who could see all the ideas in a perfect logus world) to completely distinguish between 'truth' and 'lie', 'good' and 'bad', and in modern terms, between '0' and '1'. This would allow him to predict the perfect future accurately. Plato's student Aristotle adopted his idea, but instead of a logus world and his theory of recollection, he proposed that the 'perfect'

or 'true' world is hidden inside the world we know. The problem of humans is that they do not discover the 'true' world – the 'objective' world – due to human weaknesses which arise from our subjective abilities, such as emotions, imagination, associations (random connections) and intuitions (imprecise estimates). While Aristotle believed that these attributes are important in daily life to cope with reality at a level he called 'phronesis', he argued that if one is careful to activate his logical abilities and simultaneously neutralize his subjective abilities, he will succeed by means of logical thinking to rise from the stage of 'phronesis' to the stage of 'sophia'. A stage at which the "objective" world – the "real"/"perfect" world – will be revealed, allowing him to distinguish between what is "real" and what is "false," and hence a distinction between what is "good" and what is "bad", a necessary condition to fully discover the 'truth' hidden within reality. Put simply, logic, for which he laid down the foundations, will allow a person to accurately predict the "real" future from the unexpected future, and only those who are strict in thinking logically can reach the 'knowledge of truth'.

In light of this, it is not surprising that logic was based on the assumption – which in 1930 turned out to be dogmatic – that "deterministic consistency" is a necessary condition for the "truth" of logic, which will necessarily lead to the discovery of 'true' reality. Accordingly, Western culture established the perception that whatever is unexpected is also undesirable, when the ultimate human desire is to achieve certainty, so concepts which express uncertainty are termed 'unlikely'. Since this involves what we 'like' and what we desire, like translates into 'want', 'wish' 'will', and these are supposed to 'please' us – which is also the common courtesy word in English (i.e., intended to please people). When we combine the meaning of 'like', as an expression of what we desire, to 'unlikely', which expresses the feeling that accompanies people in unexpected situations, it is clear that humans relate to unexpectedness as a negative state, that the brain accompanies with fear and anxiety.

Because learning occurs only in situations of uncertainty, where the unexpected is greater than the expected, we can understand the negative attitude of humans to learning, and the attempt to extricate themselves from this situation through training, which is supposed to lead the person as soon as possible from a state of uncertainty (more unexpected than expected) into a state of certainty, in which the "real" future can be accurately predicted and the unexpected – the "false" – which is improbable – can be avoided. As a result, the attitude toward learning in Western culture developed so that a minority are able to learn – to lead to the "truth" (philosophical or scientific) – and the rest will engage in imitation and practice of the "real" learning outcomes 'discovered' by the few.

Practice, in the Western approach to learning, has become the main focus of students in the education system, from nursery to university. As we know, little time is devoted to the learning stage – coping with the unknown, which is accompanied by a feeling of uncertainty and fear – which is in fact an imitation and not learning in the sense that I refer to learning. In contrast, the vast majority of 'learning time' is dedicated to training to improve memorization, which is really one step away from taming. So, in fact Western educational systems are mainly involved with taming rather than learning. A result of this trend is that the outcome or solution becomes the main point, especially if it is achieved quickly. Speed of finding the solution, in which most time is invested in Western educational systems at all ages, is achieved

through artificial practice and training using methods that train the brain to react as quickly as possible. This is of course at the expense of developing learning abilities and specifically creativity in different and diverse ways. While in some languages there is no difference between taming of animals and training of people, in English there are two distinct concepts, one for animals (taming) and one for people (training). This artificial distinction is meant to hide the fact that it refers to the same process whether for people or other animals. As we can learn from the structure of the brain and its activity, there is no difference between humans and animals regarding the changes which occur in the brain as a result of taming. With regard to the functions of the brain this is the process which causes thickening of specific axons and reduces the gap in the relevant synapses, which suppresses the ability to process information in the dendritic trees. This leads to suppression of associative abilities of the same brain region, and the ability for associative communication with other brain regions. A process which as it becomes more powerful, leads to expertise and additional reinforcement levels for taming. When we look at synonyms of the word "teach" they are: tame, train, acquire knowledge, learn, repeat, instruct, direct, show and other words that have little to do with leaning. In fact, the word 'teach' is not incidental in this context. A train consists of carriages – *students,* led by the engine –*professor*, − and at the different stations – *nursery, school, university*, they take on board cargo which the teachers/professors decide are important. The head engine is represented by the minority of professors who 'reveal' new knowledge – *additional stations where more information is loaded on the carriage/students* – when they believe that the rails on which they are traveling – *logical thinking and the tools formed on this foundation* – will lead to the final station – 'the truth' – either philosophical or scientific.

This culture of supposed 'learning' was developed on the basis of assumptions dating back 2500 years, and it continues to dominate Western educational systems today. This despite their coming to be seen as dogmatic in 1930 when Werner Heisenberg's uncertainty principle was published, which brought to the forefront Aristotle's assumption about the world being built on foundations of logic, that if we just stick to logical thinking, and develop scientific tools using logical methods, scientific 'truth' will be revealed. Which will once and for all remove uncertainty, and allow people to march consistently into the "real"/"perfect" future. In the same year, Kurt Gödel published his theory of incompleteness (he subsequently published two more theories of equal importance) according to which mathematics, which until then was considered completely logical, and also confirms the findings of science (was therefore termed 'the queen of sciences'), was proposed to be a system which is not perfectly logical. His proof makes it clear that there will always be mathematical theorems that cannot be proven, making it impossible to decide whether they are "true" or "false." This is not a temporary situation but a matter of principle. These two theories are sufficient to reverse all the assumptions on which the development of Western learning was based into a fundamentally refutable and dogmatic approach similar to the dogmas of monotheistic religions. Nevertheless, scientists have been going on in the same way for almost a century, as if nothing had happened in the scientific world. This is for two main reasons: the first would require all "scientists" to fundamentally change their modes of thinking and how they use the tools they developed. This is intolerable to the human brain, and to scientists who have invested their entire careers in this approach. The second reason for ignoring the implications of the

principle of uncertainty and the principle of incompleteness, is that the academic world in general and science in particular, which led to enormous successes in matters important to the human race, reached a hegemonic status. Like anyone who reaches hegemonic status, there is no chance that he will agree to give up his status to a new generation of educated people who will re-invent science [44]. Moreover, as the research on brain information processing activity has shown in the previous sections, the belief that a person can be "objective" is fundamentally unsubstantiated. As a result, Kant's mighty enterprise to prove the existence of a rational-logical man has finally collapsed. His attempt to prove the feasibility of synthetic – a priori theory to refute David Hume's argument that logic is a human product based on cognitive habits has finally failed. Not only is his proof based on dogmatic assumptions about science (a posteriori), and not only because of his inconsistency in relying on metaphysical philosophical assumptions (a priori), for which Kant's most important research characterizes him as "more dogmatic than Descartes" [45]. The principle of feasibility according to which the brain processes information, and the processing of the brain's automatic information before a person becomes aware of the results of that processing, puts an end to the person's ability to free himself completely from uncertainty and to be rational-logical as modernity expects him to. This puts above all else the assumptions and beliefs on which the perception of Western learning/training was based as leading people to finally be saved from the unexpected if they would only learn according to the training system that developed in the West.

4. Conclusions

The main conclusions to arise from this discussion are that in order to adapt to the environment in which it will be born into, the animal brain must meet reality equipped with the highest level of flexibility. For the same survival reasons, it must be capable of automatic learning of the ever-changing reality. In reality, the world overwhelms the senses with an infinite amount of information in every fraction of a second, which directed or aware learning would significantly slow down the rate of processing compared to automatic learning. At this stage, through automatic learning, the brain suppresses the vast majority of the information that floods it through its representative use of the brain's ability to create basic patterns which are then complemented through information already stored in the brain unconsciously. In this way the brain does not need to make an effort every time to convert all the information to brain information, flexibility enables the brain to avoid having to remember entire knowledge schemas but rather builds them again every nanosecond. This allows changing knowledge in the brain on an ongoing basis. This mode of activity allows the brain not to have to process all the information it receives every time, or even most of it. The more new information resembles information that was previously received, the brain will take it for granted as if it were exactly the same. This creates efficiency of attention to similar information, which requires a high investment of energy to relate to the difference from the 'known' information. Automatic learning shortens the process, as a necessary condition for the brain to turn to new learning, and especially to creative learning in which the unexpected (uncertain) information is far greater than in new learning in which the expected level is high.

In light of these things learning situations created competition between curiosity (the need to know) and the fears that accompany uncertainty which the need to know awakens. So, the brain naturally acts to move past the learning stage as fast as possible by creating a reasonable solution (satisfactory but never perfect) as if this is the only possible solution. This reinforces the sense of security as long as the solution that is obtained enables the animal to survive. As long as the brain successfully manages to deal with reality, the solution becomes an automatic solution through the "reward" that neurotransmitters give to successes that are never perfect, despite the illusion that they are. That is, the brain does not have to work hard to provide a new solution. On the other hand, neurotransmitters give "punishment" for failures that the brain cannot ignore even if they are repressed. Only when the solution fails drastically, or it leads to repeated failures, does the brain become aware and consciously activate learning abilities. However, learning is very slow and therefore in survival conditions it poses an existential danger. Each spate of learning activates all of the brain's abilities, of which the most dominant are emotional abilities, imagination and intuition via the associative communication system. At the same time, learning activates the critical/judgmental skills, which always involve emotional and logical criticism – combined automatically – and yet we remain unaware of most of the information even at the conscious stage of learning. Conscious learning, which, as mentioned above is very slow, makes it possible to increase the weight of logical abilities in the learning process.

Western culture, out of a dogmatic belief that dates back to Plato and Aristotle, adopted the assumption that logical thinking without emotions is possible, allowing the avoidance of mistakes by inventing an ideal, fictional reality (the true reality) which is supposedly completely logical. The discovery of this reality, which dogmatically was assumed with certainty to exist, will enable us to anticipate the future by eliminating its uncertainty. Understanding how the brain enables information processing that enables learning – coping with a changing world – cancels the possibility that the human brain could be capable of processing information in a purely logical way. On the contrary, the more a person specializes in a particular field, the brain becomes more and more autistic – complex social contexts are damaged as social circles expand. In fact, not only does the brain not process information purely according to logical rules, it does not even process information according to probabilistic rules, but according to the principle of feasibility. According to this principle, a statistically insignificant variable can be crucial in an existential sense because the brain is designed to deal first and foremost with immediate existential dangers in which a small detail can become critical. The brain therefore creates judgments that necessarily combine emotional abilities and logical abilities, and these are created automatically. A conscious judgment that tries to be more logical (it is never purely logical) is always applied in retrospect. The existential reason for the human brain working in this way stems from its inability to rely on the exclusivity of conscious logical thinking. This is both because it neuters our understanding of reality, and because conscious learning is very slow compared to the natural automatic learning of the brain. In terms of existence, humans would not survive if they had relied only on their logical abilities, even under conditions of accelerated technological developments, and certainly before the development of technology over the last century. Werner Heisenberg's uncertainty principle makes it clear that the world in which we live is not only highly contingent, but also fundamentally full of uncertainty. Kurt Gödel's incompleteness theorem makes it clear that we cannot create logical tools that will allow us to explain the whole of reality in a "perfect" way, and this inability is not temporary but rather fundamental. Humans will need their creative abilities in the future no less than in the past, but these abilities have been neglected.

As technology evolves, humans will increasingly need their creative abilities precisely because technology will perform essential activities more efficiently than the human brain. But this is not the main reason, and the main problem stems from the fact that as technology develops, especially since Galileo's use of the telescope, the level of uncertainty for the human race is only growing. Therefore, without developing man's creative potential, humanity will fade away. This decline will accelerate if democracy continues to develop based on the foundations of Western consciousness that sanctified logic, because the increased cultivation of logical abilities comes at the expense of cultivating emotional and creative capacities, which are essential in preventing the majority of people from becoming technicians whose autistic characteristics grow stronger and stronger, and their flexible learning skills become more and more limited until it is impossible [46]. In such a culture, the democratic consciousness of many is flawed even though they live in democratic administrations.

In light of all of this, the defining features of Western learning – which is largely concerned with training – must be fundamentally changed, and the sooner the better. The question is, how do we change the concepts of teaching so that learning becomes the main focus, and taming takes a back seat? Which will lead to a change in the modes of thinking required for an era in which creative thinking is the lifeblood. Learning that will turn people more and more into self-learners who can independently assess the world, and reduce their dependence on others to manage their thoughts through demagoguery, "scientific" information overload and providing rituals and applications for every aspect of their life. The way in which we can encourage and nurture such learning is discussed elsewhere [2].

Thanks

Special thanks to the neurologist Dr. Tal Gonen, who read the hand-written draft of my book "Saving the Mind's Potential for Creativity" on which this chapter is based.

I would also like to thank Beit Berl Academic College which assisted financially with the translation of this chapter.

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Chapter 6

Disciplinary Measures: A Survey from Selected Primary Schools

Welcome Mswazi Kubeka

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.77992

Abstract

Corporal punishment as a disciplinary measure has been abolished in South African schools since 1994. The chapter is about the views of the teachers on the different disciplinary measures they use as alternative to corporal punishment at the selected primary schools in Tembisa, South Africa. It used a descriptive research design, and it is quantitative in nature. A population of 100 teachers who are based at Tembisa was considered. Probability sampling techniques were used, whereby 28 teachers were sampled. Data were collected by means of a structured questionnaire. Data collected were analyzed using descriptive statistics. The findings revealed that the majority of teachers had not received any training pertaining to the management of discipline after the abolishment of corporal punishment in Tembisa schools. Teachers view poor academic performance of learners as affected by the lack of proper discipline.

Keywords: alternative to corporal punishment, corporal punishment, discipline, disciplinary measures, punishment

1. Introduction

According to the annual report of the South African Department of Education [1], some of the reasons for the improved performance of learners are improved management in schools; improved discipline in schools; more time spent on tasks, including teaching and learning on the first day of the school year; and fewer disruptions in schools and additional curriculum support for teachers, including formal in-service training.

Before 1994 various forms of discipline were administered by teachers in South Africa to discipline learners in schools. These included picking up papers, standing against the wall,

watering school gardens, being kept indoors during break, and corporal punishment. These various forms of discipline were applied so that learners could change their behaviors.

After 1994, South Africa adopted a new constitution by passing legislation outlawing corporal punishment in schools as a disciplinary measure [1]. The banning of corporal punishment was also witnessed in other African countries such as Kenya, which banned corporal punishment in its schools through Legal Notice No. 56 of Kenya Gazette Supplement No. 25:199 of 30 March 2001 [2]. It is reported by [3] that an increasing number of cases of learner indiscipline in Kenyan schools is a matter of concern. In some cases, such indiscipline resulted in the destruction of property in schools, violence, and substance abuse. The school authorities have indicated that this indiscipline has reached an unmanageable level. For the South African school context, [4, 5] acknowledge the prevalence of learner indiscipline, particularly violence in some schools, which have resulted in learner deaths as well as serious injuries within school premises.

South Africa is a signatory of the *Convention on the Rights of the Child*, which compels countries to pass laws and take social, educational, and administrative measures to protect the child from all forms of physical and mental violence, injury or abuse, neglect or negligent treatment, maltreatment, or exploitation including sexual abuse [6]. The abolition of corporal punishment in South African schools is underpinned by the Constitution of South Africa which states, inter alia, that:

> *Everyone has the right to freedom and security of the person, which includes the right not to be treated or punished in a cruel, inhumane or degrading way* [7].

The South African Schools Act No. 84 of 1996 is also clear on corporal punishment. This Act states that:

> *No person may administer corporal punishment in school to a learner, and any person who contravenes this act is guilty of an offence and liable on conviction to a sentence which could be imposed for assault* [8].

Even though corporal punishment has been abolished in South African schools and there is appropriate legislation in place, teachers in schools persist in using corporal punishment as a disciplinary measure. A teacher found guilty of hitting learners' faces anything from a caution and a fine to suspension and being stuck off the roll of teachers. This study sought to investigate the views of the teachers on disciplinary measures in the selected primary schools in Tembisa.

This study was guided by the following sub-questions:

- What form of disciplinary measures is applied by teachers in the selected primary schools in Tembisa after the abolishment of corporal punishment?
- What are the views of teachers on disciplinary measures in the selected primary schools in Tembisa?

1.1. Area description for the study

This study was conducted in Gauteng Province, South Africa, in the city called Ekurhuleni Metropolitan Municipality. Ekurhuleni Metropolitan Municipality has nine cities with their accompanied townships. Hence, this study took place in Tembisa, which is in Kempton Park city.

http://dx.doi.org/10.5772/intechopen.77992

In South Africa, the primary school career consists of three phases, namely, foundation phase (Grade R–3), intermediate phase (Grade 4–6), and senior phase (Grade 7–12). Grade 7 is housed in primary schools, and the remaining grades from 8 to 12 are based at secondary schools.

2. Literature review

Disciplinary action may be positive or negative. Negative discipline entails inflicting punishment, while positive discipline aims at influencing the person to behave differently. For effective teaching and learning to take place, the learning environment should be free of disruptive behaviors from learners; hence, discipline is of the utmost importance. It is argued by [9] that discipline and the possibility of effective teaching go together. In this regard [10] mentions that numerous schools experience increasing incidents of poor discipline that impact negatively on academic performance. According to [11], both learners and teachers need to be disciplined to ensure effective functioning of schools.

The disciplinary problems are defined by [12] as disruptive behavior that significantly affects fundamental rights to feel safe, to be treated with respect, and to learn. It is common knowledge that discipline is a serious problem in the South African school context, but various research studies have also indicated that it is a universal concern.

Discipline is important for the maintenance of order and harmony in the school and classroom [13]. According to [14], discipline should be reasonable and cooperative rather than autocratic and must not be seen by learners as a display of power by teachers. Disruptive and antisocial behavior can have a deleterious effect on teaching and learning. In order to promote good behavior, it is necessary for schools to have a school discipline policy, which should include details of school rules and expected behavior, as well as the consequences of deviation from school rules [15].

Some of the school-related factors which may lead learners to engage in disruptive behavior are negative school climate, teachers' professional incompetence, overcrowded schools, and ill-kept physical appearance of the school [16]. According to [17], the disruptive behaviors may also be experienced due to poor infrastructure that may lead to learners' frustration especially, whereby there is overcrowding which could lead to learners to have a limited space for moving around. McHenry as cited in [16] is of the view that examples of violence propagated in the media and witnessed or experienced as victims in society may have influence that could heighten learners' possibility to engage in disruptive behavior. It is also indicated by [18] that learners who are unable to understand or follow a lesson presented to them, due to the fact that their linguistic capital is low, tend to show disruptive behavior in order to receive attention.

It is stated in the South African Schools Act No. 84 of 1996 Section 11 (2) that discipline should be corrective and nurturing. The Act further recommends in Section 3 that the school governing body should involve all stakeholders (parents, teachers, learners, and nonteaching staff members) in the school, to contribute when drawing up a code of conduct and school rules [8].

It is the opinion of [19] that the indiscipline that learners display in schools is a reflection of what is happening at their homes. Whereas [20] are also in agreement, they maintain that lack of parental involvement is the biggest cause of disciplinary problems in schools. In addition [21] argued that schools are not receiving the full support from parents with regard to learner misbehavior management. Not all parents respond positively on receiving reports that their children have been corrected for misbehavior [22]. Factors such as divorce, poverty, and physical and mental abuse do negatively affect the learners' ability to function properly [23]. It is also indicated by [24] that learners who are from dysfunctional families face enormous adjustment problems in school, and this has an impact on their self-concept. They (learners) feel that they are deprived of attention and not being loved; hence, they seek this attention in schools, in such a way that they misbehave in the classroom [24].

According to Maree (1995), as cited in [25], corporal punishment is defined as physical punishment distinguishable from pecuniary punishment or a fine and any kind of punishment inflicted on the body or the infliction of pain by a teacher or other education officials upon the body of the learner as a penalty for doing something that has been disapproved of by the punisher. Corporal punishment is a form of contrived punishment in which physical pain or discomfort is intentionally inflicted upon an individual for the purpose of trying to get that individual to regret having displayed a particular form of behavior [26]. On the other hand, [6] states that corporal punishment is any deliberate act against a child that inflicts pain and physical discomfort to punish or contain him or her. This includes, but is not limited to, spanking, slapping, pinching, paddling, or hitting a child with a hand or an object and denying meals, drink, heat, shelter, pushing, or pulling a child with force or forcing the child to do exercise. In this case the researcher defines corporal punishment as a disciplinary method by teachers at schools to inflict bodily harm on a child or a learner with the primary aim of altering disruptive behavior.

It is argued by Murray (1985) in [18] that corporal punishment does serious emotional damage, affects the self-esteem of learners, and has a negative impact on the academic performance of learners. They further argue that respectful relations between teachers and learners are impossible in a context where corporal punishment is administered. It is pointed out by [27] that corporal punishment is part of a wider web of violence that fuels antagonisms and hatred among the youth who grow up as hardened and insensitive members of the society.

According to Bitensky (1998), cited in [28], learners who suffer corporal punishment are often left with physical evidence of the abuse. Learners who experience psychological abuse because of corporal punishment or other forms of abuse may suffer from sleep disturbances including the reappearance of bedwetting. They may also experience nightmares, sleep walking, and fear of falling asleep in a darkened room [2]. It is furthermore mentioned by [29] that corporal punishment decreases a child's motivation and increases his or her anxiety. As a consequence the ability to concentrate is inhibited, and learning is poor.

Ref. [6] argues that corporal punishment is not a solution, since it does not build a culture of human rights, tolerance, and respect. It does not stop bad behavior in difficult children because these children are punished over and over again for the same offenses. Furthermore,

it does not nurture self-discipline in children or make children feel responsible for their own actions. It is clear that corporal punishment is not the solution because it makes children worry about being caught, instead of being aware of their personal responsibility. It also causes some learners to brag about being beaten; therefore, it is a badge of bravery or success. In addition, it stands in the way of proper communication between the teacher and learner and obscures the real problems that need to be tackled, such as trauma, poverty-related problems, and conflict at home. Finally, it has been shown to contribute to truancy and high dropout rates in South African schools [6].

Given all these arguments against corporal punishment, teachers responded by arguing that without corporal punishment, discipline could not be maintained in schools. In South Africa, [6] has noted that some of the common arguments against the banning of corporal punishment by some teachers are that children will neither show them respect nor develop the discipline to work hard unless they are beaten or threatened with being beaten. They also feel that their powers as teachers have been taken away from them, because they are not able to use corporal punishment. Teachers also indicated that corporal punishment is quick and easy, and other methods of discipline require time, patience, and skill that teachers often lack. It is their strong belief that unless children are beaten, they will think they have "gotten away with" wrongdoing and will repeat their misconduct. Teachers think that the only way to deal with difficult or disruptive learners with behavioral problems who do not respond to other disciplinary measures is to beat them. Finally, since teachers themselves experienced no harmful effects from having been beaten as children, they believe that there is no reason why they should not use this method of punishment too.

In South Africa [6] published a document on alternatives to corporal punishment 4 years after corporal punishment in schools was abolished [30], through a qualitative analysis that was conducted in some schools in KwaZulu-Natal, confirmed that a document on the alternatives to corporal punishment was handed out, but no training was supplied, or workshops were held to implement the guidelines. If no clear guidance on the implementation of a policy is given, no effect will be noticed in schools.

This study was conducted 2 years after the Department of Education in South Africa released the document, *Alternatives to corporal punishment: A guide for educators*, in 2000. In this guide, the Department of Education of South Africa explains why corporal punishment is banned in South African schools and what alternative measures could be used in disciplining learners instead of corporal punishment.

Some of the alternative disciplinary measures to corporal punishment are outlined by [6], as:

- Establish ground rules.

The teacher should set ground rules with the learners at the beginning of the year; these may be reevaluated on a continuous basis.

- Be serious and consistent about the implementation of the rules.

The rules should apply equally to everybody in the class. The principle of reasonableness and fairness should be applicable.

- Manage the learning process and the learning environment enthusiastically and professionally.

The teacher should always be prepared.

- Be inclusive.

The teacher should cater for the diversity of the class by using materials, pictures, language, music, posters, magazines, and other sources; this will ensure that no leaner is left out.

- Give learners the opportunity to succeed.

The teacher needs to treat the learners in the class equally. Avoid favoritism and celebrate a broad range of student achievement.

- Allow learners to take responsibility.

Provide space for learners to be responsible.

In addition to these alternative disciplinary measures suggested by [6], some authors mention the following alternative disciplinary measures.

- Motivate learners through reinforcement.

Learners can also be disciplined through motivation instead of punishment. According to [31], reinforcement in the classroom can occur in two ways, namely, *positive* and *negative* reinforcement. *Positive reinforcement* occurs when teachers use a rewarding stimulus to motivate some action or behavior. The reward may be something tangible or intangible such as free time, praise, educational games, or free reading. *Negative reinforcement* involves removing learners from an unpleasant stimulus, such as detention or the threat of punishment.

Ref. [32] identified the following five types of reinforcements: (1) *Oral reinforcement:* it occurs when the teacher follows a learner's action or response with some type of positive comment, such as "good" or "excellent." (2) *Nonverbal reinforcement:* this refers to the use of some physical action to send a message of approval of some learners' actions or responses. This could be in the form of eye contact, a nod, or a smile. (3) *Vicarious reinforcement:* people learn by observing others. If they observe others being reinforced for certain actions or behaviors, they tend to act in the same way if the reinforcement is desirable. (4) *Delayed reinforcement:* teachers usually reinforce learners immediately following desired actions. Lastly, (5) *qualified reinforcement* occurs when one reinforces only the acceptable parts of a learner's action or the attempt itself.

3. Research methodology

3.1. Population and sampling

The primary schools in Tembisa are divided into two streams, which are East and West. For this study, a population of 100 teachers who are based in Tembisa West was considered. In the

sampling of 28 teachers, probability sampling technique was used, in which every member of the population has a chance of being selected [33]. In this sampling, the strata were equally represented according to teachers' positions that they occupy in the selected primary schools as follows: seven principals, seven deputy principals, seven heads of departments, and seven teachers (not occupying managerial positions).

3.2. Data collection

The study adopted the descriptive research design. The data was collected through a structured questionnaire. The final questionnaire was divided into two sections, namely, Section A, which was devoted to biographical data, and Section B, which dealt with the participant's reactions to the presentation and content of the subject that was investigated. In Section B, a Likert scale of 4 was used, whereby the participants had to indicate whether they (1) *totally agreed*, (2) *agreed to a certain extent*, (3) *disagreed to a certain extent*, or (4) *totally disagreed* with the given statement. The collected data was analyzed quantitatively and presented in frequency tables. The purpose of the study was clearly explained to all participants, and they were also informed that their participation was voluntary.

3.3. Content validity

The study used content validity. The researcher arrived at content validity through the results and comments of the pilot study, which was conducted among teachers in another primary school. Items that failed to measure the variables they were intended to measure were modified, and others were discarded completely. The school that was used in the pilot study was excluded from the main study.

3.4. Ethical considerations

According to [34] ethics has to do with preventing harming or wronging others, promoting good, being respectful, and being fair. The interest of participants was promoted; in both data collection instruments, the researcher indicated that the respondents need not provide their names. Confidentiality and anonymity were assured during the data collection process through the distributed questionnaires. In order to avoid deception or misrepresentation, the researcher indicated in both quantitative and qualitative data collection instruments that the data collected would be used for the purpose of this study only. All participants were expected to give informed consent; hence, they were provided with a consent form to sign. Consent to conduct the research in the selected primary schools in Tembisa was sought from the Gauteng Department of Education.

4. Results and discussions

In this section, the participant's biographical details as well as participants' responses to disciplinary measures are discussed.

4.1. Section A: biographical variables

Table 1 on biographical details shows that there is no fair gender distribution. The majority (70%) of the participants are females, whereas 30% are males. Most (48%) of the participants had 20 or more years of teaching experience, and this posed a great challenge, since most of the participants had acquired their qualifications before the introduction of the guidelines on alternative disciplinary measures. An overwhelming majority (74%) of the participants had not received any training pertaining to the management of discipline after the abolishment of corporal punishment in South African schools. To support the importance of teacher training, [1] in their annual report indicated that some of the reasons for the improved performance of learners includes improved discipline in schools and additional curriculum support for teachers, including formal in-service training of teachers. This revelation may have serious consequences since this implies that these teachers have started their teaching careers during the times when the use of corporal punishment to learners was still not a punishable offense.

In addition, 63% of the participants had not studied any literature on other forms of disciplinary measures. It is clear that, if teachers could invest some time and study various literatures on alternatives measures as discipline, they could have another perspective about the effects of harmful punishment to learners. This will assist the teachers not to base their assertion that they do not see anything wrong with not banning corporal punishment since they have also experienced it, they were also beaten as children, and they see no reason why they should not use it as a punishment method too [6]. Overwhelmingly, majority (96%) of the participants use disciplinary measures in their classrooms.

Biographic variable	Description	Number	Percentage (%)
Gender	Male	8	30
	Female	20	70
Teaching experience	0–3 years	8	29
	4–7 years	3	11
	8–11 years	0	0
	12–15 years	2	8
	16–19 years	1	4
	20 years and above	14	48
Training received pertaining to the management of discipline after the abolishment of corporal punishment	Yes	7	26
	No	21	74
Literature on other forms of disciplinary measures studied by participants	Yes	10	37
	No	18	63
Teachers who use disciplinary measures in their classes	Yes	27	96
	No	1	4

Table 1. Biographic variables.

4.1.1. Forms of disciplinary measures applied by teachers in the school

Teachers were requested to indicate the various forms of disciplinary measures that they administer in the school.

The data in **Table 2** revealed that teachers use predominantly positive reinforcement (68%) as a form of disciplinary measures. Very few teachers are opting for negative reinforcement (32%) as a means of disciplining learners in their classrooms. In this regard [31] mentions that negative reinforcement involves removing learners from an unpleasant stimulus such as detention or threat to punishment.

Even though corporal punishment has been abolished, some teachers are still inflicting it on learners (7%), and this poses a challenge. The data also revealed that the majority (54%) of teachers uses oral reinforcement as a form of disciplinary measures. The use of nonverbal punishment (36%) is also evident as a form of disciplinary measure that is applied by the teachers in the selected primary schools in Tembisa.

The positive revelation of the data is the use of positive reinforcement as a means of disciplinary measure; hence, this contributes to mold and reinforce good behaviors' from learners. Such a finding confirms an assertion by [31] that positive reinforcement occurs when teachers use a rewarding stimulus to motivate some action or behavior and this reward may be tangible or intangible. These positive reinforcements could also be used exchangeably with oral reinforcement by giving positive remarks. The literature by [32] states that oral reinforcement is one of the five types of reinforcements that can be applied, whereby the teacher could follow a learners' action or response with some type of positive comment such as "good" or "excellent."

The negative point about the results is that there are still teachers who are using corporal punishment when disciplining learners even though it has been abolished and alternative disciplinary measures are available. The continuous use of corporal punishment has everlasting scars to learners on whom this has been administered too. Continuing to apply corporal

Form of disciplinary measure	Frequency (f)	Percentage (%)
Positive reinforcement (praise, free time, free reading)	19	68
Oral reinforcement (good, excellent)	15	54
Nonverbal punishment (eye contact, nod, smile)	10	36
Negative reinforcement (detention, threat)	9	32
Oral punishment (tongue lashing)	9	32
Withholding privileges (not participating in sport)	5	18
Exclusion from group	4	14
Corporal punishment	2	7

Table 2. Forms of disciplinary measures applied by teachers in the school.

punishment as a disciplinary measure to learners is also contrary to the assertion of some authors such as Murray (1995) cited in [18] who argues that corporal punishment does serious emotional damage, affects also self-esteem of learners, and further has a negative impact on the academic performance of learners. To support this argument, [27] argues that corporal punishment is a wider web of violence that fuels antagonisms and hatred among the youth who grow up as hardened and insensitive members of the society.

It is clear that some of the South African teachers who want to perpetuate the use of corporal punishment when faced with learners' indiscipline will justify themselves. These are some of the arguments brought by these teachers in South Africa who are against the banning of corporal punishment in the schools in which children will neither show them respect nor develop the discipline to work hard unless they are beaten or threatened with being beaten. They also feel that their powers as teachers have been taken away and corporal punishment is quick and easy, whereas other methods of discipline require time [6].

4.1.2. Factors that affect the behavior of learners

These factors that affect the behavior of learners are summarized in **Table 3**.

Table 3 lists the various factors that affect the behavior of learners. These factors may be classified into three categories as depicted as those which top the list, those which are in the middle of the list, and those which are at the bottom of the list. Factors such as family problems (89%) and lack of parental attention (68%) are on the top of the list as indicated by the participants. Other factors, such as drug abuse (57%), the financial status of parents (54%), television programs (54%), and violence (50%), also have a role to play in how learners behave in schools; hence, they are in the middle of the list. It is therefore not surprising that at the bottom of the list, factors such as the educational level of parents (46%), lack of food during school hours (43%), and imitating role models also proved to have prominent influence on learners' behavior at schools.

Type of factor	Frequency (f)	Percentage (%)
Family problems (divorce, separation)	25	89
Lack of attention from parents	19	68
Drug abuse	16	57
A shortage of money	15	54
Television programs	15	54
Violence	14	50
Educational level of parents	13	46
Lack of food during school hours	12	43
Imitating role models	11	39

Table 3. Factors that affect the behavior of learners.

The findings concerning factors that affect the behavior of learners revealed a number of drawbacks in the selected primary schools in Tembisa. These drawbacks as indicated by the majority of the participants as top factors that affect the behavior of learners are the family problems such as divorce, separation, and lack of attention from parents. This is consistent with the findings of [24] that factors such as divorce, poverty, and physical and mental abuse do negatively affect the learners' ability to function properly. According to [20] the lack of parental involvement is the biggest cause of disciplinary problems in schools.

At the middle of the list, the findings from the participants revealed that factors such as drug abuse, shortage of money, television programs, and violence affect the behavior of learners. The findings are supported by the views of [3] who alluded that there is an increasing number of cases of learner indiscipline in Kenyan schools, in which some of those cases of indiscipline resulted in the destruction of property in schools, violence, and substance abuse. The same sentiment is shared by [4, 5] who also acknowledge that there is prevalence of learner indiscipline in some South African schools, which in some cases have resulted in learner deaths as well as serious injuries within school premises.

Factors such as the educational level of parents, lack of food during school hours, and imitating role models feature predominantly at the bottom of the list. The findings confirm the argument posed by [35] that the educational level of parents does have an impact on learners' disruptive behaviors, especially in cases where parents in rural areas speak very little or no English at home. It is a common knowledge that learners from this background often lack the English conversational experiences to extend their vocabulary to study some of the school subjects through English as a medium of instruction. In addition [20] states that learners who are unable to understand or follow a lesson presented in English, due to the fact that their linguistic capital is low, tend to show disruptive behaviors in order to receive attention.

4.2. Section B: views of teachers on disciplinary measures

In order to establish teachers' views on disciplinary measures, participants were provided with predetermined responses through which they were expected to indicate whether they (1) *totally agreed*, (2) *agreed to a certain extent*, (3) *disagreed to a certain extent*, or (4) *totally disagreed*. Data are summarized in **Table 4**.

The data presented in **Table 4** reveal that the overwhelming majority (86%) of the teachers are of the views that learners need to be punished for their undisciplined behavior. The findings are consistent with [11] who contends that both leaners and teachers need to be disciplined to ensure effective functioning of schools. In addition [9] points out that discipline and the possibility of effective teaching go together.

It is also clear that even though teachers agreed that learners are to be punished for their undisciplined behaviors, most (56%) of the teachers are of the view that the process of applying disciplinary measures should not be autocratic. Investigation on the statement revealed that the views of teachers are in disagreement. According to [14] discipline must be reasonable and cooperative rather than autocratic and must not be seen by learners as a display of power by teachers.

Statement	n	1 (%)	2 (%)	3 (%)	4 (%)
Learners need to be punished for their undisciplined behavior	28	60	26	7	7
Learners should be involved in deciding what type of disciplinary measures should be applied	28	37	37	7	19
Teachers should adopt an autocratic style in applying disciplinary measures	28	15	22	7	56
Learners should be entrusted with the management of discipline	28	37	37	19	7
Learners should be allowed to participate in determining a consequence for a specific behavior	28	48	29	4	19
High enrolment figures resulted in disciplinary problems	28	41	33	4	22
Lack of discipline affects the academic performance of learners negatively	28	85	7	4	4
Teachers should be informed of disciplinary measures that could be applied in schools	28	96	4	—	—
Parents should be involved in assisting school with the discipline of learners	28	96	4	—	—
Discipline is important for the maintenance of order in the school and classroom	28	100	—	—	—
In drawing up the school code of conduct, all stakeholders should be involved, i.e., learners, teachers, parents, and interested parties	28	92	4	—	4

Table 4. Teachers' views on disciplinary measures.

In addition, the majority (74%) of teachers are also of the views that learners should also be involved when deciding the type of the disciplinary measures to be applied. In cases where learners are allowed to participate in determining a consequence for a specific behavior, it results in them taking ownership. These findings support the argument by [15] that in order to promote good behavior, it is necessary for schools to have a school discipline policy, which should include details of school rules and expected behavior, as well as the consequences of deviation from school rules.

The data further revealed that the majority (74%) of teachers are of the view that learners should be entrusted with the management of discipline and also be allowed to participate in determining consequences for specific behaviors (77%). The study also revealed the positive views on the statement that learners should be involved in deciding what type of disciplinary measures should be applied. This finding assert the position by [6] in the document on "Alternatives to corporal punishment: A guide for educators" that teachers should allow learners to take responsibility through providing space for learners to be responsible.

It is not surprising that the majority (74%) of the teachers indicated that disciplinary problems are the results of high enrolment figures in the selected primary schools. These findings correlate with the argument by [16] who indicates that factors such as negative school climate, inadequacy of teachers as role models, teachers' professional incompetence, overcrowded schools, and ill-kept physical appearance of the school may lead learners to engage in disruptive behavior. In addition [17] adds that the disruptive behavior may be the cause of poor infrastructure which may lead to learners' frustration especially where there is overcrowding which leads to learners to have limited space to move around in.

Parents should play a role in assisting schools with the discipline of their learners as alluded by the views of the overwhelming majority (100%) of the teachers. The findings showing the views of the teachers on parental involvement in assisting schools with the discipline of teachers were consistent with opinions of [19] together with [20] who contends that ill-discipline that learners display in schools is a reflection of what is happening from their homes. They further maintain that lack of parental involvement is the biggest cause of disciplinary problems in schools.

The data also revealed that the overwhelming majority (100%) of teachers are of the view that the academic performance of learners is affected negatively by lack of discipline and also teachers are to be informed of disciplinary measures that could be applied in schools. These findings are in line with the argument posed by [10] that numerous schools experience increasing incidents of poor discipline that impact negatively on academic performance. The sentiment shared by [15] is that disruptive and antisocial behavior can have a deleterious effect on teaching and learning. Since there was overwhelming agreement by the teachers' views that teachers should be informed of disciplinary measures that could be applied in schools. This is also justified by [30] who contends that the document on the "Alternatives to corporal punishment: A guide for educators" has been provided to some schools in KwaZulu-Natal, but no training was provided let alone workshops on how to implement the guidelines.

From these results, it became clear that the overwhelming majority (100%) of the teachers are of the views that for maintaining order in the school and in classrooms, discipline is important. The findings were inconsistent with the argument posed by [13] that discipline is important for the maintenance of order and harmony in the school and classroom.

Finally, it became evident that the majority (96%) of the teachers agreed that all stakeholders should be involved in the drawing up of the school code of conduct. The teachers' views are in alignment with the point stated in the South African Schools Act No. 84 of 1996 of Section 3 that states that school governing body should involve all stakeholders (parents, teachers, learners, and nonteaching staff members) at the school, to contribute when drawing up a code of conduct and school rules [8].

5. Conclusions

The purpose of this study is to determine the views of the teachers about the different disciplinary measures they use as alternative to corporal punishment in the selected primary schools in Tembisa. It also looked at the views of teachers on disciplinary measures in the selected primary schools in Tembisa.

The study concludes that even though there is a lot of available learning material from which teachers could learn how to discipline learners, some teachers are still subjecting learners to corporal punishment as a measure for correcting unwanted behavior of learners.

Teachers still believe that corporal punishment is an easy and quick way to be used for disciplining learners, and they (teachers) sees nothing wrong with inflicting corporal punishment on learners, since they too went through that in their early years. These perceptions are in conflict with global trends associated with children's rights and safety school environments.

The study also concludes that, despite the availability of a document entitled, "Alternatives to corporal punishment: A guide for educators," teachers have not read it, let alone being trained or attending workshop on how to implement it in their schools. It is imperative for the Gauteng Department of Education to train teachers on alternative mechanisms to be used in dealing with disciplinary problems in schools. It is also crucial for the Department to monitor schools on a continuous basis to ensure that learners are not abused through the infliction of corporal punishment, since it has negative developmental effects on them.

The findings of the study are of limited scope and cannot be generalized due to the sampling of teachers. This study, however, provided an indication of teachers' feelings toward the abolishment of corporal punishment in the selected primary schools in Tembisa. In this study also the teachers' views on disciplinary measures became evident, as well as the alternative forms of disciplinary measures applied by teachers in the selected primary schools in Tembisa.

6. Recommendations

In the light of the findings of the study, the following recommendations are made:

1. Ongoing continuous training on learner discipline, with the emphasis on management of discipline after the abolishment of corporal punishment.
2. Avail learning resources such as literature or booklets on other forms of disciplinary measures that may be applied in the schools.
3. The schools need to share and engage with the parents about the crucial factors that affect the behavior of learners in schools.

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Chapter 7

Hiding Techniques in Physical Education – Categories, Causes Underlying and Pedagogy

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Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.77983

Abstract

Previous research shows that some pupils find physical education (PE) demanding and difficult. Some pupils then use strategies to avoid participation in PE when this is the case. The chapter aims to illuminate and describe strategies used by pupils to avoid negative self-perception in difficult situations and activities in PE classes. This behaviour, called hiding techniques, arises out of the need to protect self-perception and save academic or social face in the PE subject. Research findings show that hiding techniques are experienced and practised in many different ways and that there is a wide range of causes behind them. Pupils' hiding techniques are categorized into main types, and the causes underlying them are summarized in the chapter. In the last part, pedagogical issues are discussed in the light of research findings.

Keywords: physical education, hiding techniques, participation, pedagogy, teaching, self-perception

1. Introduction

The aim of physical education (PE) in school is to help pupils experience moving their bodies in a positive way. Pupils should enjoy and be inspired by being physically active. The PE curriculum for the Norwegian school states that the teaching in the subject shall help pupils to experience joy, mastering and inspiration through taking part in various activities and interacting together with others (Norwegian Directorate for Education and Training, 2015). Contributors to international research literature on PE assert that the joy of movement is a value in itself in PE classes and that physical activity and body movement have a special experiential quality, for example, see [1–13]. Some researchers also claim that physical activity

gives the basis for positive self-esteem, among others (see [12, 14]), and that motor competence strengthens self-perception [15].

The way pupils express joy of movement in PE classes contrasts other behaviours in class, such as in pupils who are not happy with the class or the teaching. This chapter discusses PE for pupils who may feel that the subject is difficult and problematic and who can exhibit other behaviours than pupils who the experience joy of movement and inspiration. Some of these pupils express a negative attitude to the subject openly and directly, and the teacher, who observes the behaviour from the outside, cannot misunderstand their behaviour in class. Other pupils may attempt to hide what they feel and experience, exhibiting another type of behaviour, which is not so obviously interpreted and understood. In this chapter, I call the behaviour of these pupils *hiding techniques*. Here this term means that pupils who find PE difficult and problematic may use methods to hide what they experience in PE classes, as it may not be to their advantage to acknowledge openly that they do not experience well-being, for example, when worried about their grade [16, 17]. These pupils may stage their position in the class and protect their own self-image by adopting a role as in a stage play [18]. The pupils stage their performance for teachers and classmates to protect a particular self-value and to avoid losing academic and social face in the PE class.

First, I will describe joy of movement and hiding techniques as contrasting concepts and then discuss factors that put pressure on self-perception in PE class, as well as circumstances that regulate a pupil's self-perception in the subject. Then I will examine and explain other concepts that resemble hiding techniques in PE before describing various forms of hiding techniques found in research literature. In the final section of the chapter, I will discuss pedagogical issues relating to hiding techniques, including strategies a teacher can use to prevent pupils from using these techniques in PE class. Here a self-protection perspective to understanding hiding techniques will be integrated in the discussion in relation to the teacher's role [18, 19], as well as I will include a constraint-led perspective on learning in PE [20].

2. The joy of movement

In contrast to the hiding technique in PE, pupils can also experience joy of movement in the subject. The pupils can express this in different ways. Some will reveal this immediately, unambiguously, and directly and are unable to avoid expressing their positive emotions. They feel PE is fun and PE activities are enjoyable [21]. The joy of movement may vary depending on the situation pupils are in and which activities they are participating in. In some situations, the joy of movement may be high, for example, when pupils learn new skills in PE class. In other situations, it may be experienced in ways that are more subdued. This is related to how physical activities and physical exercise offer different *subjective* experiences. The joy of movement may be perceived on a scale between relatively low and very strong emotions. For example, learning to swim is a special experience. To suddenly succeed at floating in the water, swimming forwards and actually mastering the water, compared to no floating or forward movement, is a special feeling. This swimming experience is an immediate bodily experience, arising at the instant when the swimming movement is successful and floating

and moving forwards in the water are achieved. Learning to swim means mastering water in a new way and to feel a completely new sense of floating, moving and effortlessly gliding. Enthusiasm and joy of movement are experienced at the same time. For some pupils it is difficult not to express the joy of movement in such situations, simply because it is perceived so strongly [22].

This joy of movement is primarily an expression of the value of the skill itself. This means that bodily exercise and the acquisition of physical and sports skills are important *per se*, with no connection to anything else [23]. This is the intrinsic value of bodily movement. The typical movement experience in PE classes is an immediate and sensory exploration of the possibilities and limitations of body movements. Situations with body movements create more of an opportunity to acquire and utilize new insight about oneself and the surrounding world. The experience pupils have of bodily movement has strong non-verbal bodily dimensions [12]. When going deep into an activity in body movement, pupils generate power and become aware of their abilities and opportunities related to their body and physique but also their limitations. They realize and assert themselves at the same time-as physical, bodily subjects and individuals, but also as individuals in a greater social circle [14]. The pupils tackle something physical and master this and see themselves in the light of *being able to do* something while also gaining knowledge about the social world around them, as what they are able to do is captured, given importance and responded to by others, such as the teacher [23].

3. PE can also lead to other emotions

3.1. Hiding techniques in PE

Not all pupils in school experience PE as positively as above. Quite a few studies find that PE can be difficult and problematic for some pupils [24–33]. A study of approximately 2000 youths in Norway shows that 12% do not like PE, while 32% find PE good but that they do not like how it is taught [33]. Almost half of these youths thus appear to be uncomfortable with how the PE subject is taught in school.

A study by von Seelen in the Danish school system [29] suggests that pupils who do not experience PE teaching in a positive way are characterized by uncertainty, which becomes known in various ways. von Seelen observed that pupils who feel uncertain in PE class may resist participating, for example, when the activities feature games with body contact or when the focus of an activity is on winning. Uncertain pupils may also dislike participating in activities where other pupils may dominate or in activities where achievements are recorded, for example, using a stopwatch. They may also hesitate at participating if the teacher's instructions are imprecise and difficult to understand or if they do not get the opportunity or are unable to negotiate with other pupils and the teacher about which activities they will focus on or how they are to be carried out. These pupils may also resist participating if the values of fair play and being a good classmate are not embedded in the social environment and in the activity taking place.

Pupils who find PE difficult and problematic may at times use methods-hiding techniques-to conceal what they experience in PE class. When pupils choose to use hiding techniques, it is because their self-perception is under pressure in situations they find demanding [17]. In general, an individual may feel the need to protect his or her self-value and self-perception in the demanding social situations [18, 19] that may arise in PE class. A study by Fisette [28] illuminates how pupils in PE use methods to avoid pressure on their self-perception in difficult situations by making agreements with each other and operating together against the others in the class in ways that hide their discomfort in PE class. They may show that they are apparently enjoying PE, but in reality, the opposite is true. These pupils give a false impression of what they think about PE and who they actually are in class because they do not want to display that they are uncomfortable or do not like PE. Fisette believes that some pupils may conceal their entire bodily identity from trusted classmates in PE class to avoid pressure on their self-perception. Fisette observed that difficult situations could be experienced when changing clothes or showering. One strategy for reducing a negative experience may, for example, be that pupils help each other when changing into workout clothes. They may hold the towel to hide another pupil, and in the locker room, they may help each other to avoid being seen without their clothes on. Fisette believes that they do this not only to avoid being displayed without clothes but also to avoid being naked in a transferred social sense.

Pupils' self-presentation in PE thus varies according to how vulnerable or uncertain they feel in the various situations they experience in the subject. Pupils may experience the same situation in different ways and then act in each on their own accordingly. The perception and behaviour of girls and boys may differ even if the situation they experience may be more or less the same. Earlier research has shown that expectations as to how girls and boys should preferably behave in PE are different and that their behaviour is characterized by different expectations as to what it means to be a girl or a boy. Studies of hegemonic perceptions of what it means to be a girl or a boy in PE influence their participation, engagement and behaviour [27, 28, 34, 35]. Hegemonic perceptions of how boys should behave, for example, influence how they act with muscle strength and physical force and when it comes to sports skills and competitive attitudes in class [35], while girls may feel that they are restrained by dominant views of how girls should behave, such as not being sweaty in class, not wearing makeup and preferably not dressing in workout clothes in PE class [34].

Pupils thus experience that behaviour is regulated by external expectations, and they may feel that their self-perception is subjected to pressure in many situations in PE class. To counteract the sense of stress, the pupils play roles and act differently to avoid the pressure. Depending on the situation they are in, whom they are with and what they want to accomplish, or avoid, they play their roles. Their behaviour is regulated through the social interaction with the others in the class, and their self-perception may be supported, maintained and hurt in the PE subject. Self-perception is also influenced by what pupils believe others think about them. Another contributing factor is that pupils will see themselves in the light of characteristics in areas where they consider themselves skilled and competent, while self-perception is not regulated as much by reflections in areas where they consider themselves less competent [26]. However, it may be difficult for pupils to devalue important areas of the PE subject, such as sports, and disregard the importance of sports achievements in class, even if they consider

themselves less skilled in this area. This is because sports achievements are an important part of the teacher's assessment and grading in PE. All of this makes the pupils vulnerable. It becomes difficult to overlook one's "weak" qualities. Some pupils will therefore go far to make sure that their weak qualities do not "surface" in the hope that they can avoid the discomfort one would feel from losing academic and social face when they feel that their skills and knowledge are inadequate compared to what the others are capable of.

3.2. Self-handicapping and defensive pessimism

In other earlier research literature, the constructs self-handicapping and defensive pessimism, which resemble hiding techniques, have also been used [17]. Self-handicapping and defensive pessimism are terms that also refer to protection strategies:

> *Self-handicapping involves drawing attention to a possible impediment to performance so that it can be blamed if failure should occur. […] By means of self-handicapping, in which failure can be blamed on a number of factors, such as having been up late the night before the test or that they were disturbed by fellow pupils before taking the test, pupils may manage to save face* ([17], p. 183).

Self-handicapping may be behavioural or self-reported. Behavioural self-handicaps are genuine obstacles that have been wilfully created by a pupil to restrict his or her performance. Self-reported handicaps refer to verbalized excuses for poor performance that are declared before or during performance [36]. Defensive pessimism involves evaluating possible worst-case scenarios prior to a performance and setting low expectations [36]. The two facets of defensive pessimism protect the pupil's self-worth by reducing the standards by which the pupil is judged.

Both self-handicapping and defensive pessimism allow pupils the opportunity to control the importance of possible unsuccessful attempts in PE or sub-standard performance, hence minimizing the perception of weakened self-perception and the accompanying low sense of mastering. In the short term, pupils may be able to maintain their self-perception using such strategies. In the long term, however, the effect will be weaker self-regulation and self-handicapping, and in much the same way as hiding techniques, defensive pessimism will stand in the way of engagement in the subject and constructive learning activities in the PE subject.

3.3. Descriptions from research literature

The concept of hiding techniques, which refers to pupils' techniques to protect their self-perception against external pressure, has been studied and categorized in earlier research literature. Some pupils act as so-called wallflowers [35] or skilled bystanders [37]. The terms wallflowers and skilled bystanders mean that pupils place themselves on the periphery of the activity that is taking place and let others be more in focus in, for example, a team game. Other forms of hiding technique have also been described, such as pupils clowning or joking to cover up the fact that an activity is too difficult or socially demanding [38]. An example of this is illustrated by the following statement from a teacher in a Norwegian school, which was told in a study where data was collected by means of individual interviews and focus groups:

> *I can remember some examples about the leap-frogging activity, that some don't dare or manage. Then they would do some cavorting or clowning instead, to camouflage that they could not manage. Then everybody laughs.*

This teacher was talking about pupils who find it scary to leapfrog in gymnastics, or who feel the activity is too difficult, and therefore try to mask it by clowning while the others watch. The clowning is seen as an attempt to make light of the issue and turn attention away from what is difficult. The teacher adds that at times it may appear that the reason pupils start clowning around is that it is easier to deal with a scolding for bad behaviour than it is to deal with attention on their inability to master an activity in PE class.

Another hiding technique is to play tough, rambunctious and somewhat violent in class when one's skills do not measure up [38]. Some pupils also pretend to be injured or to be in pain to avoid PE. Some may also bring a note from home to excuse them from having PE without having any real reason for not participating. Another hiding technique is to do what one is asked to do, apparently participating well, but without putting any real effort into the activity, for example, running along the wall bars-"rib-wall running". This means that the pupil will be running up and down the floor by the wall bars on the long side of the gym when the class is playing a ball game. (Norwegian gyms in schools usually have bars along the long walls of the gym.) The pupil will then run up and down as the game is played from one goal/basket to the opposite goal/basket but never anywhere else. The pupil thus appears to be in the game but is only pretending by being where the rest of the players are, in both offence and defence. The pupil follows along in the game like he or she is supposed to but, on the outer periphery of the game, rarely if ever touching the ball. These rib-wall runners do not want to demonstrate that they dislike ball games; they would rather show that they are being conscientious and performing the tasks the teacher has given them. They do not want to lose face in the social situation they are in, neither to their classmates nor the teacher. The construct "rib-wall runner" is similar to the "wallflower" and "skilled bystander" approaches [35, 37].

Another interview study elaborates on types of hiding technique [39]. Here, data were collected by means of individual interviews only. The following excerpt from this study shows that pupils may practice what is called reverse queue jumping. This is how it appears in gymnastics class, illuminated by a quote from an informant in the study, a former pupil in PE:

> *I felt that I managed the basic activities well, but when it came to doing somersaults, I needed to back out. I didn't dare to try. I didn't want to try them when I wasn't comfortable doing it. So, I rather snuck to the back of the line. […] I tried to be nice and let the more agile classmates go before me in line.*

Pupils may also use special techniques in team games. A pupil stated in one of the interviews in the study [39] that she used a special technique when playing cannonball. (This game is played by having players of two opposing teams in different halves of the gym try to hit each other with a ball, hence the name cannonball.) She made sure she was among the first to be hit, for a particular reason:

> *My strategy was to be hit as early as possible. My tactic was to stand close to the middle line (between the two halves), making me a simple target for the opponents. Then I would be hit early, and would be sent off and be able to stand outside the game for long stretches.*

She added:

> *I did not like being hit by the ball. When I got sent off, I would not be hit anymore […].*

She also said:

> *Nobody asked how I was doing in the PE class, because I pretended I was doing well.*

http://dx.doi.org/10.5772/intechopen.77983

Another informant related about a technique where she would seek out the blind side of the other pupils and the teacher in PE class:

> *It was no fun when we were tested in something I was not particularly good at, such as agility, and would get poor results. I didn't feel very cool in those situations. I tried to wait until as few as possible were watching. […] If there were many of us to be tested, I tried to the best of my ability to disappear or get lost in the crowd. The teacher didn't always remember who had been tested.*

She felt that she did not have the skill to perform well in the tests, so she attempted to avoid attention and being called to do the test by moving on to her classmates' and teacher's blind side. She also stated that it was embarrassing to do the tests in front of classmates, particularly the boys who were good.

Another informant in the study related about a similar strategy she used in football. The teacher had instructed the class on how to get out of the so-called passing shadow when playing football (soccer). She attempted the opposite, to move into the defender's virtual shadow and to avoid eye contact with the player with the ball. Thus, she tried to do the opposite of what the teacher said. This also needed to be done discreetly to avoid being found out. When asked about the reasons for this, she stated:

> *It was because of the uncool reactions, which often came if I didn't perform well enough in the eyes of the others, for example when I lost the ball to an opponent. There was this huge focus on winning. I was petrified that I would hurt my team. So, I didn't like getting passes, because I might not be able to control the ball. […] Therefore, I tried to place myself strategically on the field so I wouldn't land in difficult situations.*

Another informant told us how she exploited situations where a classmate was injured in PE class. She wanted to escape from the PE class activity if an occasion turned up, and she offered to be the first-aid provider and caregiver when a classmate was injured:

> *There was this girl who fell down and hurt herself. […] I wanted to help her, because then I didn't have to be in the PE class, if I let this situation drag out.*

Often this strategy worked, and she was able to use it to trick the teacher-and her classmates-so she could escape the PE activity.

One of the informants (former PE pupils) who took part in this study told us that one of her classmates in lower secondary school was not as good as the others at football (soccer). This co-pupil participated in the activity, but not because he thought it was fun or because he was interested in learning something. He participated to avoid being bullied:

> *One of the boys was laughed at because he was not very good in football. He was more or less bullied for it […]. He didn't like football, but joined because he […] didn't want comments from the other boys.*

Hagen et al. [39] show, together with other research [16, 38], that pupils who use hiding techniques find it difficult to see themselves in a good light in PE class. They may be left outside the social interaction in class. Their learning processes in the subject are impeded. However, hiding techniques are not a general tendency among pupils. The decision to use a hiding technique is triggered in specific situations, such as when activities or ways of teaching are changed. The underlying causes of the use of hiding techniques appear to be that pupils do not master an activity, are afraid to perform an activity or are in poor physical shape. Other causes

may be that pupils are bored or simply not motivated for PE. Pupils also use hiding techniques to reduce the danger of losing social acceptance and to avoid social defeats in PE classes. They may also fear that some activities require much courage, toughness or effort, and they may fear experiencing pain in some activities, such as being hit by the ball in ball games. Pupils may also fear being bullied by classmates in PE and therefore participate to the best of their ability to counteract being pushed around or bullied. On this point, classmates play a key role.

3.4. Constructing a room behind the PE stage

According to theory of social becoming [18], pupils who use hiding techniques construct a space behind the "PE stage", i.e. private space which allows them to remove the "mask" and be completely themselves. Here they disconnect from the teacher and classmates and reflect in private on what goes on in PE classes. Such private space illustrates that their self-perception is regulated by the teachers' and classmates' opinions about PE or at any rate the perception teachers or classmates believe about PE. A constant underlying factor is the need for social recognition, which is important for most pupils. If there is a great discrepancy between public behaviour and reflections in the private space, there is reason for concern for a PE teacher. The reason is that over time this discrepancy may lead to a negative attitude to PE in the pupils. This may particularly occur if the discrepancy is present over a long time. Long-term discrepancy means that the pupil repeatedly feels uncomfortable in PE classes and covers the feeling of PE being difficult and problematic by using hiding techniques. For these pupils it may be demanding to develop-or preserve-a good self-perception over time, and they may exhibit a propensity for not taking part in PE.

Thus, this contrasts with pupils who exhibit joy of movement in PE classes, as described above. In PE classes, most pupils will feel a need to master activities and feel competent, and they wish to have positive experiences from the teaching. A pupil's perception of his or her own competence greatly affects self-efficacy and his or her actual participation. A pupil who feels that activities are difficult will often attempt to make the consequences of possibly failing as small as possible. This is especially the case if one expects to fail. Expectations of failing in achievement situations threaten one's self-perception [19], and this will affect how much one is really involved in the learning activities. Not making a real effort opens for the opportunity to attribute an expected poor performance to little effort rather than lack of skill. Psychologically it is better to fail in PE if this can be explained by lack of effort than by poor skills. This is linked to how effort normally is perceived as a controllable factor, i.e. a factor for which the pupil is in charge and which may be simple to regulate, while it is difficult to disregard poor skills.

3.5. Only unmotivated and uninterested pupils?

It is easy to believe that the reasons for hiding techniques originate in the pupils' poor performance in the subject and lack of motivation. It is also easy to believe that these pupils lack the resources to solve challenging tasks in PE and that they have inadequate strategies for dealing with demanding situations both at the school subject and social levels. Some may also claim that these pupils are somewhat lazy [35]. But there may be reasons to consider this from a different angle. Based on general social psychology theory, a pupil's behaviour

http://dx.doi.org/10.5772/intechopen.77983

may be understood as an active endeavour to protect his or her self-perception in PE against assumed destructive forces [19]. The pupil resists experiencing failure and humiliation in PE classes because most pupils want to avoid failure and humiliation in this setting. The young person who uses hiding techniques may thus be perceived as a pupil who mobilizes and offers resistance against threatening situations in PE. In such a context, hiding techniques may be understood as actions taken to make it through PE class in some way or another where the pupil otherwise would have experienced failure and humiliation [16].

A pupil's behaviour may also be regulated by environmental constraints [20], such as social factors like peer groups and social and cultural expectations in PE. Such factors are of particular relevance for pupils, whereby their behaviour, learning and knowledge acquisition are strongly influenced by group expectations and the presence of critical group members such as the teacher and classmates. An important factor is also task constraints, which comprise the goal of the tasks in PE classes, rules of the activities, the learning location and the implements or equipment used during the learning experience [40]. Task constraints are typically controlled by a teacher in a professional role related to learning design. The proficiency with which PE teachers can manipulate task constraints like modifying the size of playing areas, setting relevant task goals in games or enforcing specific rules for performance can shape the emergence of pupils' behaviour in PE [20].

Thus, hiding techniques may be a reaction to demanding academic and social situations in PE class. Here it will be important for the teacher to analyse whether the behaviour occurs in situations the pupil has construed herself/himself or whether hiding techniques are used in situations construed by others. All pupils are expected to participate in PE, and teaching in PE relatively often consists of assigning activities where a pupil has no opportunity to choose another activity or to choose alternatively, because the class plan has been determined in advance. Hence, many situations are not necessarily construed by the pupil in PE but rather by the teacher himself/herself. At times, the activities determined by the teacher may be very difficult, even for pupils with good PE skills. Findings from earlier studies show that hiding techniques in difficult situations are often actions that are well thought out and practised, where the intention is to reduce the sense of inadequacy and prevent a potential failure [16]. Thus, hiding techniques should not necessarily be understood as expressions of poor subject skills, poor motivation and/or laziness, but may at times rather be construed as deliberate actions that permit the pupils to avoid involving themselves in situations where they will likely experience a defeat or lose face [35]. Behind hiding techniques there may be active agents taking control over the social setting in PE classes rather than passively allowing the oppressive social setting to overpower them. Pupils may have *developed* strategies for handling difficult situations and for making it through PE classes with their self-perception intact. Pupils may also have *developed* an ability to play a social game in PE, usually in relation to the teacher, to avoid losing face and to reduce the pressure on one's self-perception.

This may mean that pupils choose the type of hiding technique according to the teacher's behaviour in class and what a pupil believes the teacher knows about him or her. If the pupil suspects that the teacher is unmasking his or her hiding techniques-thereby revealing that he or she does not like PE particularly well-the hiding technique will be adjusted. Earlier studies show that some pupils may be good at varying their hiding techniques quickly, which makes it difficult for the teacher to interpret their behaviour [16].

3.6. Which pedagogical strategies are suitable for avoiding hiding techniques?

Researchers have also discussed the teacher's role in preventing pupils from using hiding techniques. Tischler and McCaughtry [35], for example, propose that teachers may contribute to student disengagement instead of engagement if they do not understand the underlying reasons for it. Teachers should therefore use a self-critical lens to understand better the underlying reasons for student disengagement. Enright and O'Sullivan [27] point out the importance of teachers relating to having compassion for pupils and having the ability to read their emotional connection to activities in PE classes to influence positively on their participation.

The findings from a study of PE teachers in Norwegian schools show that good didactic planning and communication with the pupils are important measures [38]. Here, data were collected by means of individual interviews and focus groups with teachers in elementary school. Findings in this study show that it is important to acknowledge the pupils well, speaking with them and motivating them. One teacher stated that she helps the pupils to dare to try and to join the activities even if something is difficult. It is also important to be aware of the need to find activities reluctant pupils will be able to manage, and this is usually quite feasible. The pupils must have a sense of mastering in class. Another teacher found it important to talk to the pupils in a positive way, to treat them well and establish a dialogue with them. Moreover, teachers must accept that pupils are different: "I'm of course unable to make them all love the subject. I never actually believed I could do this anyway", another teacher stated. One teacher said: "It's important to talk to the pupils about what they like doing, and build on this. Varying the activities is also important. Moreover, it's important that pupils who are good in the subject are not allowed to dominate, because this holds back the other pupils".

Another teacher also believed that participating in the physical activity together with the pupils could have a positive effect. The pupils communicate in a different manner when the teacher is active together with them, and the communication often works better than when standing on the outside. "The pupils find it easier to address me as the teacher, and the communication opens up, also to the benefit of those who are liable to use hiding techniques", he stated. Another teacher said that he tried to influence the pupils into becoming so-called positivity agents in relation to the other pupils in class. She wanted to encourage skilled pupils to act positively with those who were poorer in the subject and to support their learning processes, for example, in activities where some pupils are beginners. This teacher also emphasized that it is important to make classmates good in PE and that pupils should praise each other when someone does something good.

The teachers interviewed in the study of hiding techniques [38] also believed that it is important to have long-term aims when working with the class environment to limit hiding techniques. It may often be time-consuming to get pupils to participate with engagement and interest when the point of departure is difficult for them, and different pedagogical measures must be applied to prevent hiding techniques. One teacher mentioned a special case, which had nothing to do with PE, but it was rooted outside the teaching situation. One pupil did not want to participate in the teaching because he would need to change clothes in the locker room together with the other pupils. This pupil would often not bring training clothes with him to school for this reason. In reality it was not the activities in the classes, which constituted the problem; rather it

was the dressing situation. The solution for this pupil was that he changed into training clothes before he came to school and that he would not have to shower after the PE class. This was a solution that worked well for the pupil, who participated more in PE after this decision.

Other scholars also discuss pedagogical strategies for preventing pupils from using hiding techniques. PE should be more focused on learning skills and less on achievements, according to Ommundsen [17]. Task orientation means that teachers should focus on teaching the pupils technical solutions and interaction skills and not attach so much importance to performance achievements in PE class. The teaching should feature stepwise progression in the learning. Other researchers similarly find that PE should focus more on the stepwise learning of skills, for example, Tischler and McCaughtry [35]. A good understanding of the concepts of decaying and emergent constraints can help teachers to construct PE lessons that are attuned to an individual's current developmental status, Renshaw et al. claim [20]. An important role of the teacher may be to manipulate task constraints through rigorous learning design to guide learners in adapting their movements to overcome specific learning challenges [40]. Task constraints should be manipulated so that information-movement couplings are maintained in a learning environment that is approximate to a real performance situation [20].

Moreover, importance should be attached to cooperative and interaction abilities, as well as effort and exertion in the subject, while competition and achievements on the elite level should have less focus. Focusing too much on competitive sports and elite achievements will be detrimental for some pupils because their needs, learning abilities and interests are pushed too far into the background. Focus on achievement and high skill levels puts pressure on self-perception and may result in a poorer self-image for the pupil.

Bearing all this in mind, it is still difficult to define and describe a particular method which would work better than any other at preventing hiding techniques in PE [38]. There is no ready-made, easy-to-use methodological recipe to help teachers to stop their pupils' hiding techniques. This is because the causes underlying hiding techniques vary from one pupil to the next and individual considerations must always be made when a teacher assesses measures against hiding techniques. However, a constraint-led perspective in pedagogy is promising, because working with-and modifying-environmental constraints (to shape a nonthreatening environment) as well as manipulating task constraints (e.g. setting relevant task goals for individuals, who tend to use hiding techniques) will reduce the pupil's feeling of not seeing him- or herself in a good light in PE and to be left outside the social interaction in class. It is also important that the teacher establishes a good relationship with the pupils and helps and supports them if PE classes are experienced as difficult. Another factor is that many things can complicate the social interaction between a pupil and a teacher in PE class, such as how pupils may send varying signals to the teacher without expressing what they actually think and feel. It may appear as if things are working well for a pupil in PE class, but in reality, the opposite is the case. Moreover, not all attempts made by the teacher to find the underlying cause of the pupil's problems will lead to a clear conclusion as to what he or she thinks and feels. Not even several conversations with the pupil and focused work over a long period will help the teacher to determine what needs to be done to alleviate a difficult situation for the pupil [38]. It is also often possible to misinterpret the pupil's actions even if the experienced teacher has

learnt to "read" the pupil's situation quite well. Some pupils are also good at varying their techniques, making it more difficult for the teacher to interpret their behaviour, and they may have a kit bag of techniques, a repertoire of sophisticated "social deception techniques".

4. Conclusion

Hiding techniques in PE are indicators of the pupil's poor self-confidence in the subject, which will adversely affect the learning process and learning outcome. The pupil may be more concerned with mastering a socially demanding situation in PE class than learning relevant knowledge and skills. For many pupils, PE is linked to a fear of displaying and presenting oneself to others. This is in contrast to the joy of movement in PE. Pupils who use hiding techniques probably experience little joy of movement, and they are at risk of underestimating themselves in the subject, developing a negative attitude to PE and possibly avoiding taking part in the teaching.

On the other hand, it is possible to prevent hiding techniques in PE with the teacher's good didactic planning and communication skills. The teacher will also have to practice other pedagogical skills to counteract hiding techniques used by the pupils and must strive to have good social interaction with the pupils. "Rib-wall running", reverse queue jumping, staying in the passing shadow and other forms of hiding techniques of course do not create good learning processes in PE, and it is doubtful whether the subject's intention of joy of movement, and learning versatile movements can be satisfied under such conditions. For some pupils the causes underlying hiding techniques are complex and deep-seated, as earlier research has also shown, not least when it comes to the social area. The research shows that some pupils may have relatively complex social problems that are the causes behind hiding techniques, while for others the causes may be more superficial. Insight into the causes behind the hiding techniques and the teaching skills to avoid them will thus be important knowledge for teachers.

Teaching PE in all school cultures and countries should be a safe area for all pupils. Pupils who use hiding techniques in PE should be seen and followed up in the class by the teacher at a deeper level than just to observe their physical-motor skills and sports achievements. The need for a pupil to use hiding techniques should be analysed and prevented. Different pedagogical tools must be considered-and used. Being seen also relates to how the teacher establishes a good relationship with the pupils, caring, helping and supporting them if PE classes are experienced as difficult. It is thus important to give concrete feedback to the pupil about developments and the learning of skills, but not least, it is also important to give clear signals to the pupil that she or he is acknowledged above and beyond the skills displayed. This may be particularly vital for pupils who are prone to use hiding techniques.

Conflict of interest

There is no conflict of interest.

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Chapter 8

Professional Development and Physics Teachers' Ongoing Learning Needs

Isaac Buabeng, Lindsey Conner and David Winter

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.78711

Abstract

This study sought insight into the professional learning and development needs of physics teachers in New Zealand high schools. It used a mixed methods approach that comprised a national survey of high-school physics teachers as well as interviews with high-school physics teachers and physics teacher educators. Data from the teacher survey were analysed using descriptive statistical methods. Audio recordings from interviews were transcribed, analysed and used to triangulate and add depth to the survey data. Findings indicated that physics teachers were dissatisfied with the lack of formal physics-focussed professional development opportunities available to support their professional growth. Instead, teachers tended to rely on personal critical inquiry and infrequent practitioner meetings to inform practice. Suggestions for how to support the professional development needs of physics teachers better are discussed.

Keywords: professional development, content knowledge, teacher learning, teaching as inquiry, physics teaching

1. Introduction

It is irrefutable that to maintain excellence in their practice, teachers need to continually develop their knowledge and skills through professional development (PD). However, teacher PD may seldom live up to expectations or provide the knowledge and skills teachers are seeking. In response, there has been a call for a shift from professional development to professional learning and development (PLD), which is capable of promoting ongoing teacher and student engagement, learning and well-being (Timperley, [1]). This process examines teachers' practices and allows them to take control of their own professional learning through reflection on evidence of how changes to teaching have influenced students' outcomes [1].

A national study investigating the main reasons why teachers left the profession in the United States [2] found that teachers thought teaching was too complex. This study showed that about one-third of teachers left the profession within the first three years and about 40-50% left within 5 years. Mizell [3] also found that teachers were challenged by subject content knowledge, new instructional methods, advances in technology, and increasing student learning needs. PLD has the potential to support teachers to build their knowledge and capabilities for creating changes necessary to comply with changes in standards and/or curriculum requirements.

The results of the 2013 Teaching and Learning International Survey (TALIS) also highlighted that teachers' roles are changing and that their existing knowledge and skills may not match new needs and expectations. The 2014 Organisation for Economic and Cooperative Development (OECD) report [4] emphasised the point that teachers provide the most important influence on student learning, yet they are often not developing the practices and skills necessary to meet the diverse needs of today's learners. Both reports highlighted the importance of collaborative professional learning for teachers, as those participating in such activities, reported being significantly more confident in their teaching [4]. Since teachers are expected to prepare students to become lifelong learners, they also need to learn and participate in continuous improvement throughout their career.

In the present study, part of a larger project [5], PLD was viewed as the body of systematic activities to prepare teachers for their job [6], including initial teacher education, induction, in-service activities, and ongoing professional learning. A mixed methods methodology enabled an investigation of professional learning and development opportunities available to high-school Physics teachers in New Zealand and an evaluation of how well these activities were perceived by teachers to serve their needs.

2. Literature review

Probably, the most important way for teachers to excel and improve is through professional development. For example, Mizell [3] argued that the acquisition of new knowledge and new ways of improving performance is often attributable to participation in PLD. Borko [7] also suggested that ongoing PLD opportunities are vital to enhance and augment teachers' understanding and appreciation of the subject matter. According to Mizell [3], university and college curricula do not adequately equip pre-service teachers to gain sufficient confidence to be effective teachers. Mizell [3] viewed teacher learning as ongoing and a process in which they learn through experience and reflection/action cycles—as well as through more traditional course work or activities led by an expert.

The need for revising what kind of PLD teachers have access to has been extensively reported in the literature. In the USA for example, reports from the 2000 National Survey of Science and Mathematics Education revealed that the majority of Science teachers were not adequately equipped to be adaptive to their students' needs by adopting and shaping classroom activities appropriately [8]. The authors found that about 60% of elementary

and middle school teachers indicated their need for professional learning that focussed on inquiry-oriented teaching and learning approaches. Among middle school teachers, 67% reported a need to deepen their own Science content knowledge, and 71% reported a need to deepen their understanding about integrating technology into Science learning experiences. Despite these indications, many of the projects funded by the National Science Foundation (NSF) and the US Department of Education focussed on improving teachers' knowledge and skills [9] rather than on inquiry approaches or the integration of technology.

So, what should PLD focus on? Reporting on what makes PLD effective, Garet et al. [10] indicated that PLD activities for Physics and Mathematics teachers that focused on content knowledge had an important positive influence on changes to teaching practice. Similarly, Banilower et al. [9] commented that professional development programmes that focused on subject-matter knowledge as well as identifying student learning within that subject were more likely to improve student learning. Further, they found that providing teachers with opportunities to deepen their content and pedagogical knowledge when simultaneously accompanied by high-quality instructional materials, improved teaching. Other authors have also stressed that PLD that equipped teachers with the pedagogical skills to teach particular types of content, positively influenced practice and student learning and achievement [11–14]. In a review of 25 PLD programmes for Science and Mathematics teachers across the USA, Blank et al. [12] found that 22 of the programmes focused on content knowledge, but they were also positively rated by teachers for also providing useful pedagogical content knowledge.

2.1. Professional development for teachers

In multiple studies, PLD that focused on teacher subject-matter knowledge and pedagogical skills was shown to have a positive impact on student learning and achievement [9, 10, 12, 13]. Research has linked the amount of PLD teachers receive positively to an improvement in student learning outcomes [15]. Short-term workshops or one-off events do not necessarily produce the intended changes in the teachers' practices and results for students' achievement [9, 10, 16]. These researchers found that PLD activities that spanned a longer time period with a greater number of contact hours (an average of 8–14), and that required ongoing reflection were more likely to bring a positive and more enduring change. In view of this, Darling-Hammond and Richardson [13] advised that schools should devise a coherent PLD strategy rather than that of the "traditional one-shot workshop" (p. 48). They added that disparities sometimes exist between what teachers learned in professional development work and what they can in fact, put into practice in their classrooms, because of constraints of curriculum, resources or assessment. So, to avoid this situation, professional learning opportunities must be linked with the current curriculum, assessment and standards.

Physics is one of the subjects in which students have to master complex knowledge, skills and reasoning processes that are essential for scientific literacy. In order for this to be realised, teachers need to feel competent to create appropriate Physics learning environments for their students. Timperley et al. [17] outlined the effective contexts for promoting PLD opportunities

and their impact on a range of student outcomes; more generally, these ideas can be applied to PLD for Physics teachers as well. For example, the authors identified that there was a need for a paradigm shift—to move the focus from facts, procedures, and memorization to a process of developing pedagogy that supported student inquiry and the development of students' conceptual understanding. They provided examples of how there was a link between teachers perceptions of their roles in being an effective teacher and how students learned most effectively in Mathematics and Science. Teachers' conceptions about their role in teaching and learning often needed to be challenged before they could shift their focus from what they teach to how they teach, and especially on how these changes in teaching approaches might lead to enhancing student outcomes [18].

2.2. Do Physics teachers need professional development?

Professional development is viewed in this study from the point of view of [6] as the body of systematic activities to prepare teachers for their job, including initial training, induction, in-service training, and continuous professional development within school settings. The most frequently used analytical variables when attempting to explain why some teachers were more effective than others were mastery of subject matter and pedagogical knowledge. Additional components sometimes included were the appropriate use of teaching materials and media, as well as strategic knowledge about the application of teaching strategies for teaching specific content (PCK) [6, 19, 20].

Krauss et al. [20] defined three main components of PCK: knowledge of tasks, knowledge of students' prior knowledge and knowledge of instructional methods. These authors measured PCK by an assessment centre approach, where teachers rated real-life teaching scenarios in Mathematics classes. Their results gave a basis for the hypothesis that teachers with more pedagogical content knowledge displayed a broader repertoire of teaching strategies for creating cognitively stimulating learning situations. Another interesting outcome was that PCK was highly correlated with subject matter mastery, thus suggesting that deep knowledge of the subject matter is indeed the critical precondition for PCK. Even though the study was conducted in Mathematics, the findings are by no means limited to that discipline alone.

But which professional activities can improve teachers' practice effectively and which teacher learning needs should be addressed? The literature has indicated that keeping up to date (collecting new knowledge and information), experimentation, reflective practice (giving and asking for feedback), knowledge sharing and innovation are all very important PLD activities [6, 19–22]. Teacher collaboration aimed at improving instruction and education was also shown to matter [23]. Co-operative and friendly collegial relationships, open communication, and the free exchange of ideas may be sources of emotional and psychological support for teachers of Physics in promoting their professional learning and development [24]. Furthermore, teachers' participation in decision-making, where they are more argentic in decision-making about what and how they teach, can have positive effects on teachers' motivation and commitment to change [19, 25].

http://dx.doi.org/10.5772/intechopen.78711

3. Methods

3.1. Design

This study employed a two-stage convergent parallel mixed methods design [26] using both survey and case study techniques. In the first stage, a survey questionnaire was given to Physics teachers throughout New Zealand and in the second stage, Physics teaching and learning were examined in more detail using a series of case studies. The purpose was to move beyond the perception-based data obtained in stage one and gain more in-depth insights into the reasons why teachers felt the way they did. Creswell [27] indicated that the use of multiple data sources and cross comparisons to gain an understanding of a phenomenon ensured trustworthiness and credibility of the interpretation of data. Also, triangulating methods have the advantage of potentially gaining deeper understanding of the issues under investigation [28–30]. Thus, a mixed-methods approach was used in this study.

3.2. Sample and sampling technique

Senior high-school Physics teachers and other stakeholders in Physics education, including initial teacher educators were the participants for this study. All secondary school Physics teachers in New Zealand who were affiliated to two teacher associations were invited to complete an online questionnaire. No accurate information about the total number of Physics teachers in New Zealand was available. However, in New Zealand, the majority of teachers do belong to teacher associations, so they were deemed a good source for recruiting participants.

The participating teachers had a wide variety of educational backgrounds and experiences. Their educational qualifications ranged from Bachelor of Science degrees to PhDs. All teachers had a diploma in teaching and learning or a postgraduate diploma in education, since this is a requirement to teach in New Zealand. The age of the teachers ranged from 21 to 50 years and above, with teaching experience, averaging between 17 and 30 years.

Three state high schools in Christchurch, New Zealand were purposefully sampled as a convenience sample for ongoing observation [27] and used in the case studies. These schools were included due to accessibility and willingness by the school leaders and staff to engage with the researchers. Physics teachers at these schools were interviewed and observed while teaching Physics. Also, one private (fully independent) co-educational school was purposefully selected as an additional and alternative case study. The Physics teacher at this school was a biologist who had taught Biology for many years but later changed to teaching Physics. He was selected as a case to provide some insight as to why multiple teachers have done this in NZ and what their specific issues for professional learning might be.

Three teacher educators, from three universities, were also interviewed to gain their perceptions about what was currently provided in initial teacher education qualifications and what they thought the needs of physics teachers were. This information served to triangulate the information provided in the teacher interviews and from the national survey data. The time

scale of when teachers undertook their teacher education qualification was taken into account when comparing current with previous initial teacher education provision.

3.3. Procedure

The online survey questionnaire was developed and distributed using the Qualtrics survey platform. The link to the online questionnaire was posted on three local websites commonly accessed by New Zealand Physics teachers. In addition, the national Physics teacher association mailing list was used to send an email message to secondary school Physics teachers, inviting them to participate in the study.

The participants based in Christchurch were interviewed at a face-to-face meeting and the video communication application Skype was used to interview participants based further afield. All the interviews were conducted at dates and times convenient to the participants. All participants volunteered to be part of the study. The anonymity of participants was assured, and the research ethics approval obtained from the University of Canterbury was adhered to.

3.4. Data analysis

Data from the survey questionnaire were analysed using descriptive statistical methods (including percentages, means, standard deviations and graphs where appropriate). Qualitative data gathered during the interviews were used to substantiate findings from the survey data. Audio recordings from the interviews were transcribed and coded into nodes which provided easy retrieval of the themes that emerged. Quotations were chosen according to how well they were representative of the statements of most of the respondents. The production of accurate and verbatim transcripts was integral to establishing the credibility and trustworthiness of the data.

4. Findings

4.1. Teacher characteristics

A total of 138 Physics teachers started the online survey, with 104 completing it, a 75.4% completion rate. Incomplete responses were discarded from the analysis. The majority of the Physics teachers who participated in the study were males (67.3%). Approximately, 60% were above 40 years of age and about 57% of the teachers had been teaching Physics for more than 10 years. About three-quarters of the teachers were qualified in Physics and it was their first-choice of teaching subject. The remaining one-fourth were qualified in another subject and had switched over to Physics in the course of their teaching career. Their reasons for doing so were job availability and a lack of Physics teachers in New Zealand.

4.2. Areas of professional learning

The study sought information about pertinent areas of professional learning that Physics teachers currently engaged in and what they would like to engage in to support their teaching.

In the online questionnaire, the teachers were asked to indicate how important they thought professional learning was in a number of areas: the use of technology in Physics instruction; the use of inquiry/investigation-oriented teaching strategies; understanding student thinking in Physics; assessing student learning in Physics; their own content knowledge; and knowledge of *The New Zealand Curriculum*.

On a five-point Likert scale from 1 (not important) to 5 (very important), the teachers reported a substantial need for professional development in all of the areas. As can be seen in **Figure 1**, the areas of the highest perceived need for professional development were as follows: understanding students' thinking in Physics (95.2%) and deepening their own content knowledge (93.3%). Professional development about assessing student learning, the use of inquiry/investigation-oriented teaching strategies, professional learning regarding the use of technology in Physics instruction and knowledge of *The New Zealand Curriculum* all ranked highly.

Similar perceived needs were recorded in the areas of professional development for teachers whose first choice teaching subject was Physics and those who changed to Physics. **Figure 2** shows the distribution of percentage scores for both groups answering 'very important' and 'important'. Almost all the teachers in these groups perceived that they needed moderate or substantial professional development in all of the areas. Both groups of teachers reported a significant need for professional learning in the areas related to understanding student thinking in the subject and deepening their own content knowledge.

The types of professional development activities that teachers had previously engaged in are presented in **Table 1**. The most common form of professional development for qualified Physics teachers was meeting with a local group of Physics teachers on a regular basis to discuss issues about Physics teaching. For teachers who had switched to Physics after being a teacher in another subject, the most common PLD was engaging in self-study to deepen their subject matter content knowledge. This was not surprising given Physics was not the subject they had chosen to start their teaching careers.

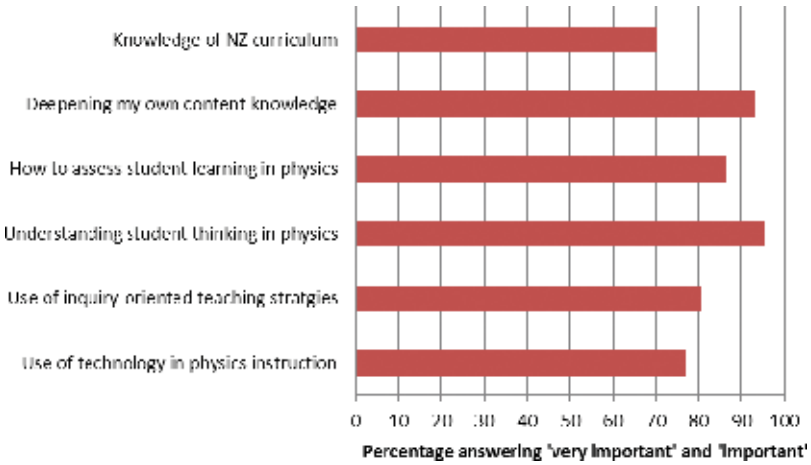

Figure 1. Percentage of teachers rating "very important" and "important" for areas of professional learning.

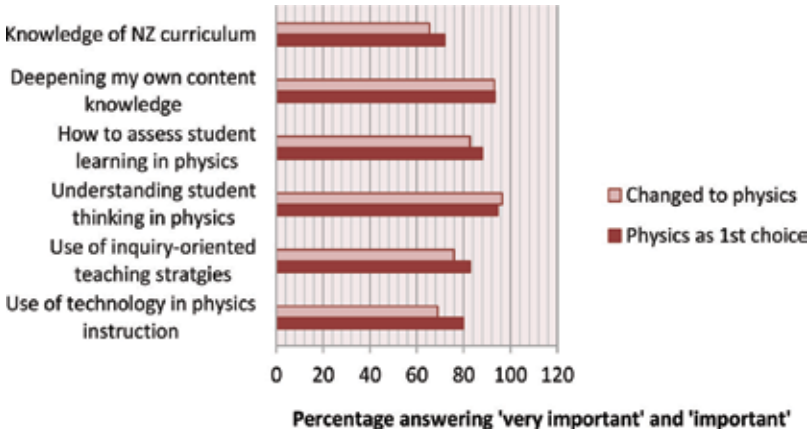

Figure 2. Comparison of teachers' rating "very important" and "important" with areas of professional learning.

Professional development activities	Percentage responses			
	Physics as 1st choice teaching subject (N = 75)		Teachers who switched to Physics (N = 29)	
	Yes	No	Yes	No
Learning how to use technology in Physics instruction	43.2	56.8	34.5	65.5
Learning how to use inquiry/investigation-oriented teaching strategies	74.7	25.3	72.4	27.6
Understanding student thinking in Physics	48.0	52.0	24.1	75.9
Learning how to assess students' learning in Physics	64.0	36.0	58.6	41.4
Deepening my own Physics content knowledge	77.3	22.7	79.3	20.7
Observed other teachers teaching Physics as part of teacher's professional development (formal or informal)	53.3	46.7	58.6	41.4
Met with a local group of Physics teachers on a regular basis to study/discuss issues about Physics teaching	78.7	21.3	69.0	31.0
Collaborated on Physics teaching with a group of Physics teachers at a distance	49.3	50.7	44.8	55.2
Served as a mentor and/or peer coach in Physics teaching, as part of a formal arrangement that is recognised or supported by the school	42.7	57.3	10.3	89.7

Table 1. Types of professional development activities teachers have undertaken.

5. The case study teachers

The case studies provided further insights into the professional learning experiences of the Physics teachers.

http://dx.doi.org/10.5772/intechopen.78711

5.1. Background and experience

Philip was a Physics teacher in co-educational School A. He was above 50 years of age and had 30 years of teaching experience. He had a degree in Physics and a graduate diploma in education. Philip was the assistant head of Science and the teacher in charge of senior Physics and Electrotechnology, taught as separate subjects in the last 3 years of schooling. He retired from teaching soon after participating in this study.

Nick was a Physics teacher in all boys' state School B. He was aged between 41 and 50 years. He had a PhD in Physics and a graduate diploma in teaching and learning. He had been teaching Physics and Science for about 12 years and was head of Physics. At the time of the study, Nick was teaching 20 h per week, although his normal teaching load was 17 h per week.

Vicky was a Physics teacher at School C, an integrated Catholic girls' school. She was aged between 31 and 40 years and had been teaching for 10 years. She had an honours degree in Physics and a Diploma of Teaching and was the assistant head of Science. Vicky was the only Physics teacher at School C and was employed on a part-time basis.

Bernard was a Physics teacher in a co-educational private School D. He was above 50 years of age and had over 30 years of teaching experience. He was both head of Science and head of Physics. Bernard was purposefully selected as a teacher who had switched Science disciplines. He had a bachelor's degree in Biology, a master's degree in Marine Biology and a Diploma in Teaching and Learning. He had taught Biology for almost 10 years before switching to Physics, which he had taught for 25 years.

5.2. Professional learning experiences

Philip highlighted the need for more professional learning opportunities for teachers. He had participated in several professional development experiences within the last 5 years. He said:

> *In physics, I have only had one professional development opportunity in the last twelve months, and it was on literacy in senior physics and I have got to say that I did not find it particularly useful. I did not find it useful at all, and I was quite disappointed. But in the last twelve months I have had lots of professional development here at school but it's mostly about Junior Science. No (external) professional development, apart from that one on physics. (Philip).*

Philip considered professional learning that he had initiated himself, to be valuable. He had undertaken self-study using inquiry-based reflection to understand his own teaching practices, analysing tests, exams and experiments to find better ways to help students with their learning.

> *I do my own professional development. I am always looking at different experiments, different ways to present material, and I am always analysing tests, exams to see if there's a better way to get the ideas across. I am doing that constantly, and all the time. For example, at the moment I am looking at a way, a better way to measure Planck's Constant using LED's because in the past we have done it with the photoelectric effect. Though it gives a good result, there is another way that I have discovered with LED's. (Philip)*

Philip believed that this form of PLD was far more effective than other types of PLD. He indicated a preference to spend more time doing this rather than attending short-term facilitated workshops, which seemed to focus predominantly on assessment issues and which he perceived as having little value.

Most of Nick's PLD in Physics had been through personal reading and attending conferences. He used Facebook and subscribed to New Scientist, Scientific American, and Physics Today. This material helped him to focus on content and innovations that he was either personally interested in or that he could use to promote student interest. He described how effective this had been in the following statement:

> *So, this year for example, while I was teaching Nuclear Physics, there was a paper in New Scientist about measuring the mass of a proton and the two different ways of measuring it gave two different values where the uncertainties did not overlap. And I was teaching uncertainties to my Year 13 students at that time, and what we used them for. Why, if you want two numbers to agree, the uncertainties have to overlap. And so, this was good timely professional development for me, to know this was what was going on and be able to use that with my students. To say well this is why we are learning how to do uncertainties, because without them, you are just guessing. (Nick)*

Vicky expressed concern about the lack of PLD available to Physics teachers. She had attended meetings for in-service teachers organised by the local university and described these as "really good". At these meetings, which she stated were held infrequently, teachers shared resources and discussed teaching strategies that they had found to be effective in promoting learning. Vicky had also attended several PLD workshops run by the government crown entity responsible for overseeing qualifications and was disappointed that these focussed entirely on assessment.

Vicky had occasionally inquired into her own teaching practice through personal reflection. She had been trying to improve her Physics knowledge and to better understand potential teaching approaches she could use. She did this by giving herself challenging questions to answer and by using contextual scenarios with her students that encouraged them to ask deep, searching questions. She viewed this "minds on" approach as a way to promote critical thinking.

Bernard, who began his teaching as a biologist and switched to teaching Physics, considered that PLD had played a vital role in progressing his career. Much of the PLD he had engaged in had been workshop-based and was organised by his school. This focussed on pedagogy, enhancing student literacy and the effective use of ICT. Bernard emphasised that engaging in inquiry through personal reflection was an essential part of his teaching practice. He considered that this form of PLD had enhanced the effectiveness of his teaching greatly. He often shared his findings with colleagues, which he thought, supported their thinking about their effectiveness as teachers as well. Bernard strived to stay current with the literature related to education and to his teaching subjects. When he was able to, he attended education and Physics conferences. He remarked:

> *I try to go to those as much as I can, and I find they are very valuable. I find they are invigorating, you get some good ideas, you get to network with other physics teachers and they have been great. (Bernard)*

He remembered one particular conference that had a profound effect on his teaching. It had been about managing cognitive load for students and he subsequently referred to it as his "thinking conference". The experience had changed his ideas about what is important in Physics teaching and how Physics should be taught. He had embedded these ideas into his practice and claimed they had led to very positive results.

Overall, Bernard described the PLD he had experienced as "valuable" and he felt lucky he was employed by a school that valued PLD. He stated:

> *I have got the advantage that our school values professional development. I think that it's kept me enthusiastic, it's kept me wanting to improve, it's kept me wanting to do better, it's kept me questioning my own technique in the classroom, more than just the straight teaching of physics. (Bernard)*

6. Initial physics teacher education

Three initial teacher educators responsible for preparing Physics teachers undertaking a teaching qualification were interviewed as part of this study. All were university-based academics who had considerable past experience teaching in high schools. The teacher educators were at three different universities, and each delivered their Physics course as part of a one year full time teaching qualification programme. The Physics course focussed primarily on developing PCK for Physics and had been designed to comply with the requirements of the Education Council of New Zealand/Matatu Aotearoa for initial teacher education qualifications. The teacher educators had little time in their courses to cover subject content knowledge in their postgraduate teaching qualification courses and they relied heavily on the first degree that students undertook, to provide this subject-specific knowledge. They stated that students who enrolled in their Physics courses were often weak in some areas of Physics content knowledge. If time constraints permitted it, the teacher educators would try to address these deficiencies while they undertook the pedagogical instruction. As an example, the teacher educator at University B stated:

> *The students that come to the physics course are often quite rusty in terms of content knowledge, and that's a concern and the comment has been made in the past by associate teachers in schools that the students need to better know their physics. They do not come to our physics course with the intention of learning physics, we want to teach them to be physics teachers. But we invariably end up spending some time looking at content. (Teacher Educator, University B)*

The teacher educator at University C stated:

> *Where there are gaps in their own knowledge we give them time and resources and they interact with each other to try and fill those gaps. But there's not an emphasis on trying to actually remedy any changes in their subject content knowledge. (Teacher Educator, University C)*

Asked about the provision of professional learning programmes for in-service high-school Physics teachers, the three teacher educators responded that they played a minor role in this and to do more would be challenging, given the academic requirements of their universities

for teaching and research. Their primary responsibility was the preparation of new teachers and all considered they had heavy academic and administrative workloads. To become more involved in providing in-service teacher professional development would compromise the effectiveness of their existing teaching. However, all of them were connected to subject teacher associations, and often attended conferences designed for teachers.

7. Discussion and implications

We are not disputing that PLD is very important for teachers. What was surprising in these results was the information provided by teachers about the kind of professional development the participant Physics teachers currently access, what they view as important and what they find most valuable to enhance their teaching and student learning outcomes.

The teachers in this study indicated there was a lack of regular and readily accessible organised PLD in Physics. Centralised government-funded professional development was viewed by the participants in the survey and case study teachers as being largely ineffective. It was evaluated as being infrequent and largely focussed on assessment. This is likely due to the focus in secondary schooling on a standards-based assessment system that had been introduced and revised over the last 12 years.

The teachers perceived that their most beneficial PLD was when they critically reflected on their own practice through personal inquiry. This activity has been promoted for all teachers generally by Timperley [1] and found to be effective by other New Zealand Science teachers [18].

In the survey, teachers reported (**Figures 1** and **2**) a need for PLD in a number of areas. These were as follows: deepening their own content knowledge; understanding student thinking in Physics; the use of inquiry/investigation-oriented teaching strategies; the use of technology in Physics teaching and knowledge of *The NZ Curriculum*.

Schools in New Zealand have considerable autonomy and teachers in each school develop their own planning and units of work. The national curriculum statement requires schools to develop and deliver their own curriculum to address the needs of their learners, as well as meeting the requirements of a national standards-based assessment system. Teachers need to be aware of and use a wide range of teaching approaches and resources for the students they teach. Teaching practice is generally very student-centred where teachers deliver content that is relevant to their students' learning needs. This requires teachers to identify what individual student needs are and how these might best be addressed. This is in contrast to previous notions of teaching whereby the same content was taught in the same way to all students. This change of focus is in line with the [4] reporting that teachers now need to be prepared for a much broader range of tasks and approaches to enable learning at all levels. The teachers in the survey and the case study teachers all identified the need to be supported better to further develop their skills and practices for the betterment of their students.

Among the case study participants, Physics teachers' meetings were the main source of collaborative PLD that they engaged in, except for Bernard who also attended Physics conferences as an external source of inspiration for his teaching. The meetings were usually organised and resourced by the local university or by the Physics teachers themselves.

Physics teacher educators indicated that they were responsible for preparing Physics teachers entering the teaching profession. They all belonged to and supported Physics teacher or Science teacher associations and supported in-service teachers as much as they were able. But the Physics teacher educators were not responsible for in-service teacher career development; as in New Zealand, this is mostly developed through independent contracts with the Ministry of Education. Within the requirements of their academic roles, they neither have the workload capacity nor the funding resources to provide in-service development for Physics teachers in a regular professional learning community model. However, there was scope to consider how working with teachers on a range of improvements to teaching Physics, could lead to potential collaborative research opportunities which would then help the teacher educators to meet their university academic requirements.

Findings from the national survey and the teacher and teacher educator interviews revealed that the provision of PLD for content and pedagogical knowledge for teaching Physics, needed to improve. In a previous study in New Zealand, Science teachers believed that PLD should support teachers to deepen their technological pedagogical content knowledge (TPACK) to make learning for their students interesting and relevant [31]. TPACK is about teachers selecting pedagogy that is appropriate for specific content including useful forms of presentation using multi-modal technologies, analogies, illustrations, examples, explanations and demonstrations that make the learning of specific topics more accessible for learners. That is, appropriating pedagogy to content. Owusu et al. [31] indicated that in-depth knowledge about integrating content and pedagogy were crucial for teachers to be able to effect and enhance learning.

Comments from the case study teachers emphasised that they valued continuous PLD to sustain their ongoing improvement and development, thereby enhancing student learning. Continuous self-study or teaching as inquiry [1, 18] had impacted significantly on the case study teachers—for example, Philip, Nick, Vicky and Bernard. Bernard attributed much of his success to his self-study and participation in PLD opportunities, where he networked with other Physics teachers who he could contact for support and ideas. Perhaps because he realised he lacked background in Physics, he actively sought interesting Physics content and interesting ways to teach for understanding Physics, since he was grappling with understanding it as well. Philip, in his reflective inquiry to understand his own teaching practices, had analysed tests, exams and experiments to find better ways to help his students with their learning.

Physics teachers indicated that they needed to be supported through induction, mentoring, and opportunities for collaboration so they had the capability to effectively deliver the best possible Physics instruction. Futernick [32] and Hodapp et al. [33] reported that in the United States, strong collegial support had a significant influence on Physics teachers who decided to continue teaching. As a form of support for teachers, the PhysTEC institutions in the United

States have been providing induction and mentoring services to graduate teachers through the use of experienced teachers and/or teachers-in-residence (TIR) programmes [33]. This idea could be picked up and developed in the New Zealand Physics teaching context.

Perhaps there is scope for Physics departments and Physics teacher educators in New Zealand universities, the New Zealand Institute of Physics, and others with Physics expertise to collaborate more effectively to create a Physics learning community to support Physics teachers' ongoing learning. Many institutions and organisations in the United States have collaborated in this way and have achieved excellent results [33, 34].

Cochran-Smith and Lytle [35] identified three types of knowledge needed by teachers: knowledge-for-practice; knowledge-in-practice and knowledge-of-practice. The third type of knowledge, knowledge-of-practice, results when teachers learn from their teaching experiences, issues concerning learning, knowledge, and theories leading to the development of local knowledge of practice. As a result, teachers produce their own knowledge which works in their classroom situations and may not necessarily be generalised to other situations. Teachers may not be able to generate this knowledge by themselves and therefore need to collaborate with others as part of the inquiry process [18]. In view of this, it is suggested that any professional development organised for teachers in the future, should enable them to take ownership of the learning process through reflecting on their practices, identifying their own needs and connecting their practices with relevant theories, as well as connecting together in professional learning groups. This was exemplified by the collaborative meetings, which the participants in this study found particularly useful. As Conner [18] reported, when teachers find professional learning is directly relevant to their practices, there were more chances of transfer of their learning to their instructional practices and ultimately translation of their teaching approaches to successful students' learning outcomes.

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Edited by Vimbi Petrus Mahlangu

Reimagining new approaches in teacher professional development is the focus of this book. It looks at different perspectives of teacher professional development. Most chapters directly or indirectly present and discuss new approaches in teacher professional development in general. The purpose of the book is to inform readers that there are new ways of developing teachers professionally, and to equip readers with the skills needed to teach or behave in a professional manner. The book aims at providing new knowledge about professional development to academics, universities, education authorities, teachers, parents, and governing body members. The authors have diverse perspectives about the issues or aspects pertaining to teacher professional development.

Published in London, UK

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ISBN 978-1-83881-838-8
9 781838 818388