Implementing Montessori Aspects
in a Conventional High School Chemistry Classroom in India

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Dedication

I would like to dedicate this thesis to the inspiration for both the research and my life, my little daughter Adithi for her cute smile, words, and hugs during hard times. The great seed of thought for my paper was from her, and so the paper would not have been accomplished without her. Also, I would like to dedicate this thesis to a very special person in my life, Arun, my husband, who always supported me in chasing my dream and offered a helping hand during my writing days. I am so blessed to have them.
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Abstract

This thesis is a first step to my vision of combining alternative as well as traditional educational approaches within a high school chemistry conventional classroom in my home province, Kerala, India. The study explores the different aspects of an alternative educational approach, namely, the Montessori system, which can be implemented in a traditional high school chemistry classroom within its limits. The answers for the research questions, “What are the aspects of the Montessori system that can be implemented in a conventional classroom?” and “How is it possible to implement Montessori aspects in a conventional classroom?” were established through interviewing experienced Montessori teachers. The paper also analyses the high school sample chemistry topics in which these aspects could be implemented and explores learning materials that could be used in a classroom. A sample lesson plan that portrays the theme of the paper has been demonstrated in the last chapter. The study foresees the opportunity for a passionate teacher to actively engage students in a high school chemistry classroom, thereby nurturing students’ learning.
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Chapter One: Introduction

We are students of words: We are shut up in schools, and colleges, and recitation-rooms, for ten or fifteen years, and come out at last with a bag of wind, a memory of words, and do not know a thing (Quote by Emerson, as cited by La Pierre, 1998).

Personal context

I am a soft-spoken and enthusiastic person who believes in individual differences from the southern part of India (Kerala). I am a post-graduate in chemistry and a graduate in education, and I taught high school children mathematics and chemistry for four years. I was brought up in a family where everyone was given equal space and voice, which encouraged me to follow my dream and passion. This is why I am here in the field of education even after getting an opportunity to do research in chemistry. I am passionate about teaching and being with children. I love to be in a class of vibrant children who would like to express their ideas and views equitably.

I want to be an educator and a learner who can make difference in our society. My teaching and learning experiences help me better understand the educational areas and challenges around me. I believe my research will guide me to enhance my skills to shape myself as a better teacher. I believe in John Dewey’s quote, “Education is not preparation for life, it is life itself.” I believe education and learning are life-long processes and that our circumstances motivate us to learn. I also believe all children are unique and their development is different. Every child has a natural curiosity to know and learn. The natural environment is one factor that enhances the learning skills of a child. One of my motives is to create the natural environment of learning in my classes.
Statement of Problem

The traditional educational system originally followed in India, the Vedic system, was considered one of the valuable educational systems in which the teacher was given more importance and utmost respect. There was learning of basic subjects like math, science, language, and history. The basic skills were taught, as well as some rote memorizations of Vedas. But as a part of colonialization and educational change, the teleporting of Western education took place, and the essence of the ancient educational system was lost. They followed the teacher-centred instruction in which students were considered the objects of assistance, and which inhibits creativity (Freire, 2000). This banking model of education needs to change. Although visionaries tried to implement new educational approaches, they were just teleporting other educational approaches, thereby losing the essence of our traditional educational system.

This situation is where, being a part of educational change, my role as an educator lies. My vision is to combine the positive aspects of the traditional education system with new educational approaches to create a new system of education that is truly student-centred and meets individual needs. The objective of the new system of education is to prepare students in ways that not only give them the school curriculum but also enable them to keep learning throughout their lives. The big questions for me from walking out of the present system of education and walking on to a new educational system are: (a) “What are the aspects of the traditional educational system that I could hold on to? (b) What are the aspects of the new educational approaches around the globe that can be implemented in the traditional system? (c) How is it possible?”

Motivation for the Study
Last year, I got a chance to read and know about Montessori system of education, which is an alternative approach to traditional educational system. Having personal experience in a traditional educational system and being aware about the educational changes taking place all around the world and a part of this change, I was interested to know more about the alternative approaches especially Montessori system. Montessori education is purely student-centred where a child learns from his/her nurturing natural environment. The philosophy and methodology fascinated me to know more about the system as it relates to my thoughts and philosophy.

Through my daughter (5 years old, who is in Montessori nursery class), I have come to realize that the impact of Montessori classroom is quite different from the traditional classroom I had followed. The Montessori system emphasizes student’s interest and their psychological, emotional, physical, and moral development.

**Research Questions**

For my research, I chose to focus on how to implement the Montessori approach or strategies in a traditional classroom in my province Kerala, India (the first state recognized to be completely literate in India). Also, I wanted to better know the opportunity or scope of implementing this approach to a traditional regular classroom.

My research question centered on how I might implement the strategies followed by Montessori approach of education in a traditional regular classroom or a non-Montessori classroom; or, more specifically, ‘What aspects of Montessori system of education can be implemented in a conventional classroom within its limits?’

I believe this research question is relevant in this era of educational change because many educationalists and scholars are discussing and researching the various dimensions of changes in education. It is important to know different approaches that could be used as alternatives to
traditional educational systems. As a part of this educational change, a few public schools, for example Ladysmith Secondary School, Pacific School of Innovation and Inquiry, and High Tech High, engage students’ interests as a priority and follow a curriculum which supports and encourages the experiential or student-centred learning. They follow learning-by-doing methods where students learn by engaging in practical experience in their topic of interest and following their natural curiosity.

The Montessori approach believes in a philosophy that a child does not lose interest if he or she can follow his or her natural curiosity to know and learn. The natural learning environment is created in a classroom for children to follow their natural curiosity. In this environment, children will be more enthusiastic to discover and less fearful of failing. They try to solve the problems using their own experiences. As I saw Montessori in action, I came to believe creating natural learning environment in a classroom is one aspect of a Montessori approach that could be taken to a traditional classroom.

**Organization of the Study**

To start my research, I completed an article and web search on the background of Montessori system of approach. This background helped me gain a more thorough understanding of Montessori system of education and will become a foundation for my research. I also went through articles to know whether any studies have been done in the same field before and to identify the public schools that tried to adapt the basic idea of Montessori or “learning by doing” philosophy. Then, as a parent, I visited Montessori schools to observe their classes. I came to better know the curriculum they followed in their classes. I hoped to better experience and understand the methods and strategies followed in the classroom by visiting Montessori schools.
I chose to do my research in Canada (probably in Nanaimo) because, in my home country, the Montessori system mostly functions only in preprimary schools whereas, in Canada, Montessori schools function until grade ten. In this study, I hoped to learn more that would help me know more about the student psychology or behavior so as to better see the growing stages of a child in a school and the impact of nurturing learning environment for a changing mindset during a child’s developmental stages.

I collected my data by interviewing Montessori teachers because I believed they had the insights and experience to answer my questions about the aspects of Montessori approaches that might be implemented into a regular traditional classroom – especially, in my case, at my home in India. I wanted to know their interest in choosing a Montessori system of education. I believed these Montessori teachers could also speak about the relation between the learning environment and the students’ learning performances and could also explain the role of Montessori teacher in a classroom. I wanted to ask about the challenges they faced during their classes because these involved a mixed-age group and emphasized the independence and freedom within limits of children. I also believed that, as teachers, they could also talk more about the challenges they could face on implementing these approaches in a traditional setting, such as my own. Basically, I hoped to seek their help as teachers working with another teacher to implement their ideas within a new geography and within a curriculum that was not already engaged in the pedagogical work they lived and valued.

Being an action researcher, I believed the answers to my questions would suggest how to implement successful aspects of Montessori education into a traditional regular classroom. As a part of educational change and by being a passionate educator who believes in individual
differences, I am truly interested in bringing those aspects of Montessori approaches into my own classes within my own country.

**Definition of Terms**

The conventional educational system, in my context, is defined as a system with teacher-centred instruction in which standardized tests and grades are given more importance. The system has a single unified curriculum that is taught for all students regardless of interest or ability, and the instruction is based on lectures, textbooks, and individual written assignments. In this system, little attention is given to the independent learning and social development of students. The natural learning environment can be defined as providing experiences and opportunities to children, through which they can be empowered in learning. Or, children can discover their environment guided by curiosity and answering their questions collaboratively.
Chapter Two: Literature Review

Introduction

In Chapter One, I outlined my goals for this research study. In Chapter Two, I outline the pertinent literature that helps me inform my own work. This literature is broken into themes that best represent areas of my own interest in preparing to conduct this research.

Traditional education offers a teacher-centred curriculum, which focuses on paper and pencil activities, reiteration, and reinforcement (Ward, 1992; Castellanos, 2002). Children are expected to work quietly and individually (Vander Wilt & Monroe, 1998). These habits challenge theories of child development, which highlight hands-on activities (Pyszkowski, 1991). Bybee and Sund (as cited in Ward, 1992) stated that, according to Piaget, when children are given the flexibility to seriously shape the materials in their environment, their learning flourishes. Research exposes that, when children are given opportunities to adopt and employ an activity that is intrinsically relevant, their self-concept is encouraged (Stone, 1995); nevertheless, this pedagogy is not prevalent in traditional classrooms (Ward, 1992). With that in mind, in my role as an educator, I started thinking about alternative approaches in education.

In this study, I was interested in exploring alternative educational approaches that could substitute the drawbacks found within my own conventional system of education. The Montessori system (an alternative approach actualized by Maria Montessori, an Italian physician) is purely student-centred and meets the interests of a child. It also fosters the social, emotional, physical, and psychological development of the child. To find the different aspects of the Montessori system that can be implemented in a conventional classroom within its limits is the challenge and the question I attempted to answer. This literature review overviews a few
aspects of the Montessori system of education, namely the physical and learning environment, imaginary play, physical activity, inquiry science, and mindfulness; my hope in this study was that these aspects could be implemented in a regular conventional classroom in my own country.

**Physical and Learning Environment**

The importance of the physical and learning environment was discussed in many articles, which I believe are important aspects of a Montessori system of education. “Montessori education is grounded in the idea that children learn best in an environment where they are given the freedom to develop their natural abilities through direct interaction with the environment” (Rinke, Gimbel & Haskell, 2013, p. 1520). The quality of the physical environment significantly affects child achievement, attendance, well-being, and motivation (Al Selda, Sari, & Kahya, 2012). These educators emphasized the constant interaction between the child and the environment, which increases the intellectual curiosity, excitement, and discovery. To create this environment, learning materials are used in Montessori classrooms. Montessori children work with self-corrective materials that provide immediate feedback on their accomplishments (Williams, 1999). They realize their own errors and are able to correct them (Phillips, 1977).

Lillard (2011) acknowledged that the increase in learning materials in a classroom increases the concentration of a child. Soundy (2009), Rinke et.al (2013), Krogh (1982), and Al et al. (2012) agree that the learning environment in Montessori schools fosters independence and responsibility and develops the natural ability through direct interaction with the environment. Providing the classroom with real tools for cleaning and maintenance indicates an implicit acceptance of children’s acceptance. Each child feels respected and learns selflessness, responsibility, and self-discipline (Krogh, 1982). I agree that, when children feel they belong, they personalize their environments and are directed toward dignity and self-respect. According
to Al et al. (2012), these characteristics reflect solid education principles and respect children’s natural psychological development. Rinke et al. (2013) emphasized the importance of student communication in Montessori learning environments.

**Imaginary Play**

Play activity is important for social development and strengthening social interaction among children. Through play, children develop cognitively, socially, emotionally, and physically. In any case, play is not an essential activity in a conventional school. Many traditional educators sacrifice play for the sake of teaching predetermined goals (Stone, 1995; Ward, 1991). Soundy (2009) explained the role of imaginary play as an aspect of the Montessori approach. “Stories are a powerful way for humans to learn, as we tend to represent experiences as narratives” (Bruner, 1990). Lillard (2011) and Soundy (2009) have supported the idea that imaginary play helps children face their lives as they experience practical life activities in their classroom. It develops sensory training, a spirit of kindness, and respect for oneself and others intellectually, socially, and emotionally in children.

**Physical Activity**

Physical activity can be considered an aspect of the Montessori system of education, which can be implemented in a regular traditional classroom. “The Montessori system is based on child-centred learning, a key aspect of which is encouragement of children to move about the classroom” (Pate et al., 2014, p. 720). Children in Montessori programs learn through action and self-discovery. They choose activities, move about freely during the day, and are positively influenced by their physical activity. Lillard (2011) signifies physical activity as a functional goal. Krogh (1982) emphasizes the lack of a teacher’s desk in a Montessori classroom, which
increases children’s movement and physical activity in the classroom. It also promotes their self-confidence, freedom, and directed learning.

**Inquiry Science**

As explained by Rinke et al. (2013), both inquiry science and Montessori approaches follow constructivist approaches in which learning emerges from a child’s interaction with the environment. “Inquiry science is grounded in the cognitive and sociocultural foundations of teaching and learning that constitute constructivist pedagogy” (Piaget & Inhelder, 1972). According to Rinke et al. (2013), inquiry science aims to foster concrete understandings both about the natural world and the process of science, whereas Montessori education strives towards humanizing as its core goal. Mentoring, guiding among peers, and co-investigating increases the communication about science and provides meaningful opportunities to explore science together.

**Mindfulness**

Lillard (2011) talked about mindful practices, which are considered aspects of a Montessori approach that can be implemented in a conventional classroom. Focused work can develop mindfulness. According to Lillard (2011), concentration is highly valued, and it leads to the psychologically healthy state called normalization, which is the most important outcome of focused work. When the work is absorbing, challenging, and self-directed, young children engage in deep and sustained concentration for long periods. Montessori education includes many practices and values whose goals and structures are consistent with mindfulness (Hanh, 1999; Kabat-Zinn, 1990). The close connection with body and mind is respected. There is an emphasis on deep concentration as a source of personal development, leading to balance and joy and, by extension, to healthy relationships with other people and the environment (Lillard, 2011).

**Analysis**
Analysis of my literature review reveals the possibility of actualizing my vision to combine the positive aspects of traditional education with a few facets of a new educational approach, the Montessori system, in a conventional classroom. In my opinion, the physical and learning environment can be considered primary aspects of the Montessori approach that can be taken into a traditional classroom. Several articles appreciated the interaction of children with the physical and learning environment that establishes the conditions for children to promote their abilities from their own interests, which is maintained in Montessori classrooms (Rinke et al., 2013; Al et al., 2012). In contradiction, some people misunderstand the Montessori method as playful learning, whereas it is said to be guided play and free within limits (Lillard, 2013).

Imaginary play is another aspect that can be taken into consideration, as noted in articles. Physical activity improves the physical as well as mental development of a child. The Montessori system, based on child-centred learning, encourages children to move about the classroom. The classroom management and instructional methods used in this approach can provide and promote physical activity in classrooms. Both inquiry science and the Montessori approach display a constructivist path in which learning arises from the synergy of the child with the environment. Teachers should play facilitators’ roles to encourage learning in a community oriented and collaborative context. Most of the articles I read show evidence of fostering the psychological health of a child by incorporating the mindful practices used in the Montessori system in a conventional classroom (Lillard, 2011; Hanh, 1999 & Kabat-Zinn, 1990).

My Research Paper

With rich evidence from the literature, when I shaped my question towards my vision, I could understand the challenges I might face as a conventional teacher working to implement a new educational approach within the four walls of a traditional classroom. But to make a big
difference in my context, I came to be aware that I should make a small step of initiative and believe that my research work will push me towards it. In conclusion, a few aspects of the Montessori approach I will be working on are the physical and learning environment, physical activity, imaginary play, inquiry science, and mindfulness will be taken into consideration for implementing in the unit plan of a regular high school chemistry conventional classroom.

Chapter Two outlined the literature that was foundational to my own research and that helped me shape my work. In Chapter Three, I will outline how I conducted my research study.
Chapter Three: Methodology

Introduction

I have a vision for educational change. To hold onto the past and embrace the challenges for a better future in education is my dream and goal. The first step towards my dream is a thorough background study of both traditional and new educational approaches and building a sound pedagogical and curricular theory. These principles have led me to my research proposal in this Master’s program. I have been truly inspired from my little daughter’s preschool education, as she has engaged a Montessorian philosophy; and, as I expressed in Chapter One, her engagement has fueled my hunt for Montessorian aspects. A concrete demonstration for those aspects from different authors around the globe was explained in Chapter Two, which I hope gives a solid foundation to my thesis. In Chapter Three, I explain the plan for my research for the reason that these strategies or methods have charted my research path.

Chapter Four outlines the methodology I used to engage my research question, “How can aspects of a Montessori approach to education be used in a conventional classroom in Kerala?” This chapter discusses my research approach, my recruitment of participants, and the instrument I used to collect data. It also discusses how my data was analyzed.

Research Approach: Qualitative Research Approach

As a researcher, I adopted a qualitative research approach. For me, it was important to understand the implications and challenges of the Montessorian system in order to combine traditional as well as Montessorian educational approaches. According to Merriam (2014), the qualitative researcher intends to know what and how people describe their experiences. Denzin and Lincoln (1994) contended that this approach enables researchers to view the socially constructed reality and conceptualize how social experience can be created and interpreted.
Specifically, conversational interviews, as indicated by Limerick (1998), were used in this study because interviews are powerful ways to gain access to participants’ interpretations of their personal experiences. During these interviews, the questions I posed built on responses to previous questions asked. My interview provided a space where a healthy discussion could explore Montessori education. Indeed, a breadth of different Montessorian aspects was engaged during the conversational interview I held with these teachers.

Patton (2002) explicated the logic for using a qualitative approach by noting that qualitative approaches favour the detailed examination of the small-scaled samples. This choice worked especially well because Nanaimo has a relatively small number of elementary Montessorian teachers. As such, my choice of methods cohered to gain insights about these teachers’ experiences and consider them in depth. Thus, a qualitative approach was used in the present study, with a strong basis of contention by proponents.

**Recruitment of Participants**

The study was conducted at the Discover Montessori School, Nanaimo, British Columbia, Canada, and it involved primary as well as elementary teachers who were trained under a Montessorian system, which served as both the ethos and the teaching method used within that school. As such, these Montessorian teachers were the population of interest I believed could help me best answer my research question.

The teachers were selected because they had come from a traditional educational background but had trained under a Montessorian system and taught in a Montessorian school. Their experiences were important because these experiences enabled them to know the differences between both the systems and helped me as a researcher distinguish the differences
while integrating both approaches. I was able to recruit this willing group of teachers with the help of the principal of the Discover Montessori School in Nanaimo. One delimitation was necessary: As a researcher, I chose to omit teachers who were not trained under the Montessorian system. I engaged in this research delimitation because I believed these teachers might not have the profound knowledge about the philosophy of the Montessorian system, which was a crucial factor in my study.

**Sampling Method**

It was difficult for me, as a researcher, to use random sampling to find the participants for the interview because Montessori-trained teachers were limited. Thus, a non-random/non-probability sampling was used to identify interviewees because it allowed the recruitment of the number of volunteers I needed for my interviews. These teachers contributed and became a convenient sample, which made it easy to access study participants (Patton, 2002). Patton (2002) considered convenience sampling to be the technique that is the least desirable, yet most common because purposeful sampling allows the researcher to save money, time, and effort. I was able to include five participants identified from the school who fitted my requirements.

**Interview**

The data were collected by interviewing the teachers at the Discover Montessori School, Nanaimo, British Columbia. A conversational (often called unstructured) interview was conducted with five teachers who had a thorough knowledge and passion about teaching, especially the Montessori approach. During my preparation for my research study, I came to believe that unstructured interviews would best serve my purpose because I was asking these five teachers to respond to my general research question: How can aspects of a Montessori approach to education be used in a conventional classroom in Kerala?
Basically, during my interview, I shared that my daughter’s engaging and successful educational experience with Montessori education had impressed me as both a parent and as a teacher; and, as a teacher, I had been encouraged to consider how aspects of this system might be engaged and translated into my own teaching at the secondary school level in science education. I had no idea what these experienced Montessori teachers might say, but I was hopeful that – together – we might come to some mutual ideas, might explore these ideas together, and that I might complete the interview more able to explore these ideas in my own context. Together, my hope as a researcher was that we might converse about this topic and that the findings of this research conversation might allow me to become more informed and efficacious as a teacher/researcher.

Similar to other conversational interviews, the interview that took place began with only a few interview questions. It progressed in a manner similar to a normal conversation; however, the research focus drove the conversation. During this conversational focus group interview, I shared my own experience and attempted to establish a rapport and comfort with the participants. I then probed participants so as to obtain rich and in-depth information about their own experiences and ideas. I was seeking to gather both information and participants’ narratives during the conversation, only directing the conversation as questions came up or if the conversation veered away from the research question I wanted to explore.

This interview format was helpful because it allowed me to direct my study and, as the interview progressed, I gained a better understanding about both the system and the focus of my questions. Participants were invited to take part in this study by the school’s principal. The interview lasted approximately 120 minutes, and it depended upon the extent and pattern of each participant’s responses to the interview questions posed by the researcher. The interviewees were
given the opportunity to view and edit transcripts prior to the researcher including them in the study. Overall, the interview and follow-up were completed during January 2018.

In summary, during the period of data collection, I conducted conversational interviews with five teachers. This conversational interview acted as a discussion platform for teachers and me, and it helped answer my research question because each participant was able to add points that everyone could explore together. Thus, I engaged five different experiential perspectives as they addressed the same questions I asked as a researcher. The interview was conducted in the school classroom after the school hours. This location helped assure that participants felt comfortable enough to be open in contributing their experiences. This location also allowed teachers easy access to the venue.

In the beginning of the interview, as the researcher, I introduced myself to participants. Then I explained my background, the purpose of the study, and my passion towards the vision. I granted participants an opportunity to ask questions, which let me clear up any doubts. I next shared the consent form with participants and allowed them time to read, sign, and submit it back to me. Every participant signed the consent form. During the conversational interview, participants’ responses were audio recorded to allow for authentication of data. These responses were referred for accuracy and details. Audio-taping was a helpful tool for me as a researcher because it allowed me to focus on the interview. This way, I did not waste time, nor was I distracted from the process (Yin, 2009).

At the start of the interview, the participants were given a set of questions and time to think and respond to these questions. They were asked to write notes that highlighted their initial thoughts. These questions were basically open-ended questions with invitations to use these as discussion starters. This initial process helped participants formulate ideas about what they might
say during the interview as well as brainstorm their thoughts both individually and alone. I hoped this time would allow each individual to decide what he or she would say during any discussion, rather than allowing the discussion to ensue and follow the path started by the first participant respondent.

The conversational interview also helped to build a rapport between the participants and researcher before the interview. After writing their responses on pieces of paper, I started by asking which open-ended questions each teacher considered and responded to, one after another. Each participant’s comments invited an active, and generally nonstop, discussion where the responses of one question led to other questions. In accordance with Bogdan and Biklen’s (2003) proposition about the use of open-ended questions during an interview, the questions seemed to stimulate teachers to in-depth responses and conversations. The open-ended questions also allowed participants to openly share their experiences, respond to the interview questions from personalized perspectives, and explore the idea of combining the traditional and Montessori approach within the four walls of a classroom. Conclusively, the conversational open-ended questions allowed the addition of meaning and detail to participants’ commentaries, which enabled me as a researcher to understand and experience participants’ experiences first hand (Bogdan & Biklen, 2003).

As a researcher, I was pleased with the choice of conversational interviews as an instrument for my data collection for the following reasons: First, these conversational interviews helped participants to express their personal feelings and insights freely. The choice also helped to communicate details and probe or follow up with questions. I believe, in my research, the conversational interview allowed healthy discussions where participants spoke their minds without interruption.
In line with Merriam (2014), getting valid data from interviews is reliant on querying felicitous open-ended questions that can be investigated with probes and requests for more detail. Therefore, as a researcher, I was cautious in preparing interview questions. I attempted to create very basic and simple questions (probes) so that it was easy for the participants to think from scratch and build upon each other’s conversations in more depth.

Yin (2009) indicated that other people’s perspectives are meaningful and that interviews can enable a researcher to obtain direct quotations from participants about their feelings, experiences, knowledge, and opinions. The audio-recorded interview helps the interviewer to quote the participants’ words and interpret their connotation. The method also helped me collect detailed information from a small sample effectively (Morse, 2000).

**Situating the Researcher**

As a researcher, it was an excellent opportunity for me to interview Montessori teachers. The interview helped me maintain a link with the participants, which was the strength of this qualitative approach, as identified by Shrigley (2009). Having started a discussion about their experiences with traditional educational systems, I could relate to their experiences with a familiarity that was useful in helping me develop understandings and provide affirmation of facts contributed by the participants during the interview sessions. The research method, which was basically a conversational interview between teachers, allowed me to engage a footing for interpreting specifically and accurately the overtone of participants’ outlooks and observations. During the interview, I was able to cogitate on my own personal experiences with a transparent interpretation of participants’ anticipated expressions and look for distinctness and likeness. My experience as a high school chemistry teacher who was interested in exploring different teaching methods in the classroom coincided with the participants’ teaching strategies. Most of the
pedagogical and curricular ideas they used in their classrooms were ideas I had been looking forward to hearing about for a long time. These correlations, as teachers, even though we came from different global contexts, age levels, and subject areas, allowed us to share insights. As we conversed, our words and thoughts allowed us a shared space for engaging in a discussion specifically about this study.

In conclusion, the chapter spoke about the methodology adopted for collecting primary data in this study. The chapter also spoke about the research approach and design, the interview pattern, and how the data was investigated. This chapter paves the route for the Chapter Four, which will be the analysis of the data collected.
Chapter Four: Data Analysis

Introduction

Chapter four displays the results of the research I engaged in relation to the implementation of Montessorian aspects in a conventional classroom and how those aspects might translate to work in another context. It is a response to the research question highlighted in chapter one: “What Montessorian aspects can be implemented in a traditional classroom?”

The first section of the chapter contains a detailed discussion of experiences and insights outlined by the Montessorian teachers who were participants in my interviews. The second section of this chapter outlines a small number of high school chemistry topics where Montessorian aspects could be incorporated. The last section of this chapter explores the connections between the teachers’ reported experiences and the possibility of incorporating those experiences and insights into those selected chemistry topics using resources. As in Chapter Three, this chapter synthesizes the findings into a holistic case.

For convenience and continuity, the findings were grouped under the key themes identified in the literature review section and other emerging themes. The categorized themes are (a) teacher as a guide, (b) physical and learning environment, (c) multi-age classroom, (d) freedom within limits, (e) imaginary play, (f) inquiry science, (g) mindfulness, and (h) challenges when incorporating Montessori approach in a conventional classroom.

As indicated by Hatch (2002), data analysis involves designing the process of collected data, investigating that data’s content, and translating what has been learned. In line with this definition, data collected through interviews was analyzed by grouping them. Statistical analysis and computer software programs were not used during this study, considering the fact that data used in this study is based upon a small sample.
Patton (2002) did not support the use of statistical analysis in case studies design because that statistical data proposes a concise sketch of patterns; however, narrative inquiry provides detailed, individual, and in-depth meaning. Accordingly, I transcribed the audio recordings from the interview and transcripts shared with participants to ensure precision and accuracy of data. I read the transcripts several times and searched for those themes and patterns that emerged from participants’ responses during interview.

As stated by Creswell (2003), each theme would contain a piece of information or one idea. This approach of labeling data and creating a data index from it was used in this study (Patton, 2002). By using this approach, I could interpret relations between participants’ experiences and their meaning. I carefully extracted and used suitable quotations from teachers’ narratives, which served as evidence to support the findings and themes. Participants’ names were changed to assure anonymity.

Teacher as a Guide

The first question of the interview, “Why did you chose to work in Montessori system?” was an icebreaker for the teachers, which also asked them to think deeply about their roles in a classroom. Among the teachers in this study, choosing to become a Montessori teacher had been influenced by the circumstances in their life. Most participants were inspired by the Montessorian philosophy, which they expressed was the main reason they chose to teach in a Montessori school. A feeling of satisfaction was expressed in their words.

“This is the way the children should be treated” (Teacher C).

Teacher B stated, “It changed my life, and it is a more respectful way to teach and to be taught.” However, teacher A recounted, “I disagreed with what I saw in traditional classrooms. I could connect easily with the independence of the child and the child-centred philosophy.”
These positive remarks refer to the subjective choice of profession mentioned by Huberman (1993, p. 24). The role of a Montessori teacher in a classroom was well explained by the participants. Everyone had the similar opinion that a teacher acts as a guide who facilitates the learning in the classroom. As teacher A stated, “He/she guides the children, helps set expectations in regard to work done, behaviour in class, treatment of materials, and sowing the seeds of interest providing lessons for students as needed.”

The role of a teacher is as a facilitator where he/she demonstrates the material to children and allows children to discover its secret. Teachers assist the children’s motivation to learn. Teacher D believed that one could not become a Montessori teacher merely through pedagogical education. Thus, these teachers expressed a strong feeling of obligation, dedication, and accountability as Montessori teachers. They commonly shared a philosophical approach about how and what they believed an effective Montessori teacher should be and do.

**Physical and Learning Environment**

Unsurprisingly, the responses for narrating the requisites for the physical and learning environment were believable. As mentioned in Chapter One, I believe in individual differences and utilizing a constructivist approach as a pedagogical foundation. This belief coincided with the thoughts and experiences of participants regarding the learning environment. Teacher A stated, “Having a prepared learning environment in a manner that is arranged such that students know exactly where their resources are helps facilitate learning smoothly.”

The resources or learning materials given in the classroom played an important role and made the classroom a natural environment. As explained by Teacher C, self-corrective materials help students construct their knowledge with first-hand experiences. Students used a trial-and-error method to use these materials and to learn concepts in class. They also helped create self-
awareness and get chances to explore in their own fashion so as to integrate knowledge. The study materials were constructed basic-to-complex, based on the age level and learning capacity of students in a classroom.

**Multi-Age Classrooms**

Teaching in a multi-aged classroom was one foundation of the Montessori system that stood apart from conventional classrooms. Teacher B was excited to speak about the mixed-aged classroom because he believed it helped children learn from watching each other. He recounted, “In a mixed-aged classroom, the social cohesion between the students increases. They develop the skill to deal with a multi age world, as we have nuclear families with less socialization.”

I also agree with the point Teacher D expressed during our conversation that multi-age groups in one classroom helped in role modeling in two ways: (a) Looking up to older students and (b) looking down to younger students, not only in the case of learning, but also in the case of behaviour, empathy, etc. Students are aware of the social responsibilities and their social behaviour in a classroom. Peer-tutoring as a result of mixed-aged grouping is an important factor in the Montessori classroom because it enhances the learning in students. There is no stigma if children are falling behind; in fact, there is no falling behind.

**Freedom within Limits**

Independence in a Montessori classroom is an often-misinterpreted term. The teachers as a whole suggested the use of guidelines in the classroom. Students are expected to follow the guidelines, especially during their individual work. According to Teacher A, freedom is given to students to choose their learning materials and activities. When asked about the challenges they faced when a multi-age group comes into a classroom with independence, Teacher A explained
with the help of incidents that happened in her classroom: “Sit back in hand, something amazing is going to happen.”

The students tried to figure out the solution for the conflicts between the age groups because they were aware that they should respect each other. Teachers also explained about the strong safety guidelines they follow in the classroom, which are related to discipline. Teachers also allow children to be set free to discover themselves by discovering the solutions for the activities.

**Imaginative Play**

Imaginative play is a tool used in a Montessori classroom for instruction. According to Teacher C, imaginative play is well used in language classes. However, Teacher B added to Teacher C’s note that imaginative play could also be used in science classes. “The concepts in science, chemistry, for example, the history of the periodic table can be explained like a story or demonstrated like a play.”

Equal participation of students and selected roles in each play helps achieve advanced learning of that particular topic for each student.

**Mindfulness**

The Montessori system can be called a form of mindful education. All the activities in which students engage are related as ways to increase the focus of children, thereby developing personal qualities. The participants were enthusiastic to explain how they were trained to become focused, mindful teachers during their training. They also explained how they carried it to students to develop mindful practices in education. Teacher A described, “The hands-on materials used to learn concepts helps in respecting the connection of body and mind of students.
The activities are organized in such a way that body and mind work together to solve interesting problems.”

As mentioned by Teacher C, mindfulness is important for a student’s physical and mental development. The Montessori learning environment provides the prospects for mindful practices in the classroom.

**Challenges in Implementing the Montessori Philosophy in the Traditional System**

According to the participants, I might face a number of challenges while implementing the Montessori philosophy in the traditional classroom. Specifically, the teachers noted that I might face (a) openness from management, (b) class size (student-teacher ratio), (c) issues with resources, and (d) deadlines for the completion of topics. My initial thoughts were that, considering science, especially a chemistry classroom, the first-hand learning resources (learning materials) would be challenging because these have to be prepared according to the learning capacity of students.

In total, the Montessori teachers collectively noted that the following five ideas might be transferred from their work to a traditional classroom. These ideas include: (1) using first-hand learning materials to create a natural learning environment, (2) using the concept of multiage/multi levels of learning capacity in grouping of students, (3) giving freedom within limits to discover themselves during classroom activities, (4) using meaningful context in the classroom while lecturing, and (5) using inquiry science and imaginative play wherever necessary as a tool of instruction. These above-mentioned themes that emerged during the research conversation I had with the Montessori teachers helped me to answer the research question, “What Montessorian aspects can be implemented in a traditional classroom?”
High School Chemistry Topics

This section demonstrates a few high school chemistry topics, which I believe can be taken to incorporate Montessorian aspects. The traditional educational approach to science teaching makes the assumption that a student’s mind is a blank state and that each student is a passive consumer of information, an empty vessel waiting to be filled with scientific parts (Popper, 1972; Osborne & Wittrock, 1983; Driver & Bell, 1986; Cleminson, 1990). Consequently, much of the traditional science teaching I have experienced as a teacher and a student consists of textbook instruction where “assign, study, discuss and test” exist (Welch, Klopfer, Aikenhead & Robinson, 1981). Therefore, students tend to view scientific knowledge as “finite, isolated bits of information” rather than developing scientific reasoning skills (Dewey, 1910; Pode, 1966; Driver & Bell, 1986; Cleminson, 1990; Stinner, 1992).

I have chosen three chemistry topics from the high school Kerala state board curriculum. From my experience in teaching chemistry for years in high school, I have seen students struggling to learn the concepts that I believe, because of the rote-learning methods, they follow without any first-hand learning experience. These topics taken are the basic topics that are fundamental to the high school chemistry chapters. I have chosen these topics because I believe that, once our foundation is strong for students who are learning science in India, it would be easier to build upon this strong foundation. The basic concepts should be clear for students so that they feel effortless to learn advanced concepts. The topics I chose are (1) basic constituents of matter from grade eight; (2) acids and alkalis from grade nine; and (3) physical and chemical changes from grade eight.
Basic Constituents of Matter

This topic is considered an important topic for beginning students in chemistry and is chosen from grade eight of the Kerala state board curriculum. This topic explains the basic components of a matter and the reason to learn chemistry. The topic can be subdivided into the following topics: elements, atoms, molecules, and methods of representing molecules and compounds. The topic was chosen because the concepts should be understood thoroughly by students. Various learning materials can be incorporated in teaching these topics.

Acids and Alkalis

This topic is taken from grade nine and is an important topic because it is an introduction to inorganic and organic chemistry. Acids and alkalis are two broad classes of compounds that have a great deal of importance in both chemistry and biochemistry. The topics can be subdivided into the following topics: acids, alkalis, neutralization, and salts. Different learning materials inspired from the Montessori approach can be integrated into this topic.

Physical and Chemical Changes

This topic would be easy for students because they can observe much about the topic from their surroundings. Students will be interested to know the changes occur in and around themselves. The topic was chosen from grade eight. The physical and chemical changes chapter can be subdivided into the following topics: physical changes, chemical changes, different types of chemical changes/reactions, thermochemical reactions, photochemical reactions, and electrochemical reactions. Observation would be an excellent resource for this topic. Other learning materials, which will be discussed in the following section, can also be used to teach this topic.
The above-mentioned topics are chosen because of their importance and necessity for a beginner in chemistry. Many other topics exist in which Montessorian aspects can be implemented. The selected topics offer only a small-scale sample for the project.

**The Implementation of Montessorian Aspects**

This section discusses the possibility of incorporating various aspects of the Montessorian system outlined in the first section of the chapter into the high school topics selected in the second section. The chapter also explores and demonstrates a small number of learning materials and activities that could be used as learning tools in the classroom. According to Harlen (1992), the active engagement of students in itself is oriented towards a method of knowing and thinking. The purpose of implementing these aspects is to break the conventional method of instruction, thereby actively engage students in the classroom. Therefore, the teaching task demands allowing students to engage in activities that help them organize their own experiences successfully and in ways that make sense for them.

The teacher plays an important role in any classroom. From the traditional to the Montessori approach, the teacher turns from authority to guide and mentor. When implementing Montessori aspects in a conventional classroom, a teacher can arrange the nurturing environment for learning so that it is safe, orderly, and well equipped. The teacher can group students according to their learning capacity. The teacher can provide resources for the topic and guide students to discover in their group provided with the instructions and guidelines of discipline.

When considering freedom within limits from a Montessori perspective, freedom can be given to students in their groups to choose the order of activities they need to complete within the class. However, students can be instructed to complete the whole set of activities in that class.
Discipline should be maintained by students under the guidance of the teacher. Students are free to raise their observations and discovery during the activities.

The concept of multi-age classrooms integrating in a conventional classroom is not possible. However, it could be possible to group students according to their learning capacity—not necessarily having all the brighter or less able students working together, but to engage students of different levels working in collaboration. Students could be grouped specifically above average, average, and below average so that each student can benefit from others in the group. Students might also be thoughtfully mixed in their groupings.

Montessori teaching and pedagogy teaches us that each teacher could and should expertly and carefully consider the grouping of students so that students might benefit from these considered groupings. In mixed groupings, for example, above-average students could be expected to guide below-average students in their daily work and the interactions between students could be wisely used to build an edifying social culture. As noted by Rinke et al. (2013), students might interact with each other as both scientific mentors and co-investigators.

Mindful practices could be integrated into a conventional classroom by providing first-hand learning materials and activities. Students could be given individual and group activities so that they could work with attention. Advanced research studies for each topic could be given after students gained a clearer understanding of the topic by asking them to present in the class through projects, seminars, or exhibits. These activities help create focus and mindfulness in children.

The physical and learning environment is an important factor that can be implemented in a conventional classroom. The learning environment inspired from a Montessori system could be introduced in a conventional classroom by providing opportunities to develop strong interests in
science, especially chemistry. Creating strong interest could be done by using a variety of learning materials and activities. The learning materials could be handmade or electronic. Using charts and pictures for topics that cannot be shown directly to students is one example. PowerPoint presentations or videos are other possible learning materials. A number of other learning activities could also be made and conducted in a regular classroom so that the students could build interest in the subject and learn with first-hand experience.

The learning activities are adopted from *Towards Active Learning* developed by the Royal Society of Chemistry. The Royal Society of Chemistry is the world’s leading chemistry community and works to shape the future of chemical sciences for the benefit of science and humanity. Around the world, The Royal Society invests in educating future generations of scientists. They provide support and resources for teachers to enhance chemistry education that is engaging, inspiring, and relevant. *Towards Active Learning* is one of the workshops conducted by the Royal Society of Chemistry, which I have attended during my teaching career. The workshop helped me to explore different active learning strategies and techniques that can be implemented into our everyday teaching.

**Show-Me Board**

This activity could be done in the beginning of a class to check the students’ prerequisites for the topic. It could also be used at the end of a class to check whether the students have got a clear picture of the topic they learned in the class. The materials needed for the activity are a paper and a pen. The teacher would ask a few questions to the whole class. Then, students have to write one-word answers on the paper and, when asked, they will show the paper by lifting it up. For example, to check the prerequisites for the Acid and Alkali chapter, the questions that could be asked include:
1) What is the taste of lemon juice?
2) What is the chemical name for cooking salt?
3) Name the chemical found in alkaline batteries.
4) Name the chemical found in our stomach.
5) What happens to a nail polish remover bottle when kept open?

Show-me board activities help build a rapport between the teacher and students. They also help the teacher identify students and their learning capacities. Therefore, they could be used as a starter in the class.

**Concept Mapping**

Concept mapping is another tool that could be used in a classroom to assess the relationships between the concepts or important ideas within a concept. The materials needed for the activity are a paper and a pen. Concept mapping could be done in a group, where students are given a brief idea about the concept. They could discover relationships between concepts and then chart each concept. They could also be used to summarize a topic on a sheet of paper. Teachers could use concept mapping in their lesson plans so they could structure lessons beforehand. Examples for a few topics are discussed below.
A) Acidity

B) Physical and chemical changes

A concept map about the physical and chemical change concept is demonstrated below. Students could develop more relations using different examples of physical and chemical changes.
Concept mapping provides teachers with insights about students’ understanding. If students make an incorrect link with the ideas, a teacher could revisit the concept and explain it in a different way to the group. Concept mapping could be used for revising topics. If students create their own maps, they are more likely to remember the connections they have made and thereby remember the concepts.
Card Sorting

Card sorting, a tool for understanding the key ideas, terms, and concepts, could be used as a learning material/activity in a classroom. This activity provides students in a group an opportunity to talk in meaningful ways with one another about the content. The materials needed for the activity are cards with the key ideas written on them. Students would be asked to arrange the cards in different ways under different themes. Rearranging helps students gain a better understanding about the concepts. A few card-sorting examples are demonstrated below.

A) Acids and alkalis

Different cards for the concepts could be as follows.

<table>
<thead>
<tr>
<th>acid</th>
<th>Calcium hydroxide</th>
<th>vinegar</th>
<th>Lime</th>
<th>Milk of magnesia</th>
<th>KOH</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH&gt;7</td>
<td>CH₃COOH</td>
<td>Sodium hydroxide</td>
<td>Sulphuric acid</td>
<td>NaOH</td>
<td>Mg(OH)₂</td>
</tr>
<tr>
<td>HCl</td>
<td>Potassium hydroxide</td>
<td>H₂SO₄</td>
<td>HNO₃</td>
<td>Litmus red to blue</td>
<td>Ca(OH)₂</td>
</tr>
<tr>
<td>alkali</td>
<td>pH&lt;7</td>
<td>Litmus blue to red</td>
<td>Caustic potash</td>
<td>Magnesium hydroxide</td>
<td>Caustic soda</td>
</tr>
<tr>
<td>Nitric acid</td>
<td>Acetic acid</td>
<td>Calcium hydroxide</td>
<td>King of chemicals</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Card sorting could be done under the following themes:

a) Acids and alkalis - characteristics

<table>
<thead>
<tr>
<th>Acid</th>
<th>pH&lt;7</th>
<th>Litmus blue to red</th>
</tr>
</thead>
</table>
Alkali | pH>7 | Litmus red to blue
---|---|---
b) acids and alkalis – common name and chemical name

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Chemical Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrochloric acid</td>
<td>HCl</td>
</tr>
<tr>
<td>Sulphuric acid</td>
<td>H₂SO₄</td>
</tr>
<tr>
<td>Nitric acid</td>
<td>HNO₃</td>
</tr>
<tr>
<td>Acetic acid</td>
<td>CH₃COOH</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Chemical Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium hydroxide</td>
<td>Ca(OH)₂</td>
</tr>
<tr>
<td>Sodium hydroxide</td>
<td>NaOH</td>
</tr>
<tr>
<td>Potassium hydroxide</td>
<td>KOH</td>
</tr>
<tr>
<td>Magnesium hydroxide</td>
<td>Mg(OH)₂</td>
</tr>
</tbody>
</table>

B) Physical and chemical changes

<table>
<thead>
<tr>
<th>Physical change</th>
<th>Permanent change</th>
<th>Burning camphor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burning of paper</td>
<td>Water to ice</td>
<td>Chemical change</td>
</tr>
<tr>
<td>Melting of wax</td>
<td>Temporary change</td>
<td>Stretching of rubber band</td>
</tr>
</tbody>
</table>

Cards could be sorted under their theme elements or/and their Latin names
<table>
<thead>
<tr>
<th>Physical change</th>
<th>Temporary change</th>
<th>Stretching of rubber band</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melting of wax</td>
<td>Water to ice</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chemical change</th>
<th>Permanent change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burning of paper</td>
<td>Burning of camphor</td>
</tr>
</tbody>
</table>

C) Constituents of matter

<table>
<thead>
<tr>
<th>Iron</th>
<th>Silver</th>
<th>Argentum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ag</td>
<td>Ferrum</td>
<td>Na</td>
</tr>
<tr>
<td>Aurum</td>
<td>Kalium</td>
<td>Gold</td>
</tr>
<tr>
<td>K</td>
<td>Natrium</td>
<td>Au</td>
</tr>
<tr>
<td>Sodium</td>
<td>Potassium</td>
<td>Fe</td>
</tr>
</tbody>
</table>

Cards could be sorted under their theme elements or/and their Latin names

<table>
<thead>
<tr>
<th>Iron</th>
<th>Fe</th>
<th>Ferrum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silver</td>
<td>Ag</td>
<td>Argentum</td>
</tr>
<tr>
<td>Sodium</td>
<td>Na</td>
<td>Natrium</td>
</tr>
</tbody>
</table>
Potassium | K | Kalium
---|---|---
Gold | Au | Aurum

**Tarzia Grid**

As a chemistry teacher, it is challenging to link chemistry ideas or concepts without using our visual senses. However, first-hand learning materials could help students draw a picture of concepts in their minds. The Tarzia grid is one of these ideas. A Tarzia grid is made up of a series of paired statements, questions and answers, or key words and definitions arranged randomly on polygon-based grids. Students are asked to solve the grid by matching or pairing these concepts. Students could also be asked to make bigger patterns by finding key words from concepts. This activity engages students rather than simply working on questions. It also helps develop their thinking skills as they work through problems.

Tarzia grids could be made in any polygonal shapes. A few examples are demonstrated below. The first example is based on the acids and alkali lesson.

<table>
<thead>
<tr>
<th>Statement 1</th>
<th>Statement 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical formula for Sodium chloride</td>
<td>NaCl</td>
</tr>
<tr>
<td>Chemical formula for Hydrochloric acid</td>
<td>HCl</td>
</tr>
<tr>
<td>Chemical formula for Sodium hydroxide</td>
<td>NaOH</td>
</tr>
<tr>
<td>How does alkali feel in hand?</td>
<td>Soapy</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>Taste of acid</td>
<td>Sour</td>
</tr>
<tr>
<td>Litmus reaction in acid</td>
<td>Red</td>
</tr>
<tr>
<td>Litmus reaction in alkali</td>
<td>Blue</td>
</tr>
<tr>
<td>Reaction of phenolphthalein in acid</td>
<td>Pink</td>
</tr>
<tr>
<td>Reaction of alkali in methyl orange</td>
<td>Golden yellow</td>
</tr>
</tbody>
</table>

A Tarzia grid could also be made for acid and alkali statements, as follows:
The second example is from the constituents of matter lesson. The grid is made for learning elements and their chemical symbols. The chemical symbols of elements are fundamental in chemistry, and therefore it is important to ensure that students learn it thoroughly.
Several learning activities could be used in the conventional classroom to implement a Montessori learning culture. The activities illustrated above are a few samples. It is the task and learned competency of a teacher to bring out more activities in accordance with themes that emerged from the Montessori approach that could be used within the four walls of a traditional classroom. I believe that the habits of learning to use such materials/activities in a traditional classroom would benefit students both in physical and mental development academically as well as non-academically.
Chapter Summary

In summary, the first part of Chapter Four analyzed data from interviews and brought forth answers for the research question, “What aspects of a Montessori approach could be implemented in a conventional classroom?” In this chapter, data were discussed under important aspects, which could be implemented in traditional classrooms in India. A small number of emergent themes were compared to the literature review section in Chapter Two.

The second part of Chapter Four explored a small number of high school chemistry topics in which Montessori aspects could be integrated. Three topics were considered in this section as examples of how a chemistry teacher in India might work to construct and demonstrate learning materials and activities for lesson plans in more detail.

The third part of Chapter Four is crucial because it helps to answer my second research question, “How can I implement Montessori aspects in a conventional chemistry classroom?” This section illustrates the connection between the first and second parts of the chapter. The aspects of the Montessori system that came from my focus group interview with Montessori teachers in British Columbia were not directly copied to the traditional system of classroom, but instead were merged with aspects of a more traditional classroom routine. For example, multi-age in a classroom is impossible; however, classroom changes can be envisioned and inspired from that concept; for example, grouping students according to their learning capacity is possible. A small number of learning materials and activities were also demonstrated in this section. These activities will lead to the preparation of a sample lesson plan, which will be discussed in the next chapter.
Chapter Five: Results and Conclusion

Results

Chapter Five discusses the results from the data collected and analyzed from Chapters Three and Four. This chapter shares the outcome of my research question asked in Chapter One, “How is it possible to implement Montessori aspects in a regular traditional classroom?”

As discussed in Chapter Four, the aspects listed by Montessori teachers during primary data collection (interview) were (a) using first-hand learning materials to create a natural learning environment, (b) using the concept of multiage/multi levels of learning capacity in groupings of students, (c) giving freedom within limits to discover themselves during classroom activities, (d) using meaningful context in the classroom while lecturing, (e) using inquiry science and imaginative play wherever necessary as a tool of instruction along with the traditional practices of instruction (lecture method) for theory parts in chemistry could be used in a classroom. The third part in Chapter Four explained how to implement these aspects in a chemistry classroom in India. In this chapter, a nutshell of the third part in Chapter Four will be demonstrated in the form of a sample lesson plan.

Careful planning of classroom lessons is a key to successful teaching (Thurber & Collette, 1964). As defined by Good (1945), a lesson plan is a teaching outline of the important points of a lesson arranged in the order in which they are to be presented, which may include objectives, points to be made, questions to ask, references, and assignments. A sample lesson plan will be demonstrated based on topics explained in the second part of Chapter Four.

The lesson plan is based upon the acids and alkalis topic from grade nine. All the learning materials discussed in the previous chapter are included in the sample lesson plan. The duration
of the lesson is 45 minutes and the strength of the class is 30. Therefore, students can be grouped into five with six members in each group.

**Lesson Plan**

<table>
<thead>
<tr>
<th>Name of the teacher:</th>
<th>Standard: IX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of the school:</td>
<td>Strength: 30</td>
</tr>
<tr>
<td>Subject: Chemistry</td>
<td>Age: 14</td>
</tr>
<tr>
<td>Unit: Acids and Alkalis</td>
<td>Date:</td>
</tr>
<tr>
<td>Lesson: Properties of acids and alkalis</td>
<td>Duration: 45 min</td>
</tr>
</tbody>
</table>

**Curricular Statement**

Develops different dimensions of knowledge, process, skills, and attitudes on acids and alkalis through lecture method, group discussion, activities, and evaluation by questioning.

**Content Analysis**

New terms: Acids, bases, neutralization.

Facts:

1) Acids change blue litmus red.
2) Bases change red litmus blue.
3) Acids are sour to taste.
4) Bases are soapy to touch.
5) Acids react with metal to form hydrogen.
6) Bases dissolving in water are called alkalis.
7) Common factor in acid is H⁺ and in alkali is OH⁻
8) Neutralization is the process in which acid and alkali react with each other to give a neutral solution.
Minor concepts: Definitions of acids and bases, physical properties of acids and alkalis.

Major concept: Chemical properties of acids and alkalis.

Learning objectives: The pupil:

1) Distinguishes acids and alkalis
2) Identifies the chemical formula for acids and alkalis
3) Lists the physical and chemical properties of acids and alkalis
4) Lists acid base indicators and their colour changes
5) Writes the products for neutralization reactions

Pre-requisite: To know the chemical symbols and formulae of elements and compounds.

Teaching learning resources: Textbook, activity chart, beakers, acids, alkalis, papers, and pens.

<table>
<thead>
<tr>
<th>Classroom Interaction Procedure</th>
<th>Expected Pupil Response</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction</strong>&lt;br&gt;Teacher introduces the class with show-me board to check the pre-requisite.</td>
<td>Students show the correct answers in show-me board card.</td>
</tr>
<tr>
<td><strong>Presentation</strong>&lt;br&gt;Grouping the students. Teacher explains the definition and properties of acids and bases with an experiment. Based on the concept explained by the teacher, students perform activities. Activities are based on physical and chemical properties of acids and alkalis. Activities are briefly explained to students. Students are free to choose the activity.</td>
<td></td>
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<tr>
<td><strong>Activity 1</strong>&lt;br&gt;Card sorting: Cards are given to students. A sheet of paper with the instructions will be given.</td>
<td>Students arrange cards under different themes.</td>
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<tr>
<td><strong>Activity 2</strong>&lt;br&gt;Tarzia grid: Two-dimensional shapes of paper with data will be given. Instruction will be given in a separate sheet of paper.</td>
<td>Students arrange the cards to complete grid and build concepts.</td>
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</tbody>
</table>
### Activity 3
**Concept map:** Sheets will be provided to the group to generate concept maps.

Students construct concept maps from which they had learned.

### Activity 4
**Experiment on neutralization reaction:** Teacher demonstrates the reaction in the class. Also demonstrates the colour change with different acid base indicators. Teacher raises questions in between.

**Chalkboard summary**
1. Chemical formulae of acids and alkalis.
2. Physical and chemical properties of acids and alkalis.
3. Neutralization reaction.

Students observe the experiment and predict the answers.

**Follow-up activity**
1. Find out natural acid base indicators from your surroundings.
2. Make a chart for common names and chemical names of salts.

Students develop the concept and operational definitions.

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The lesson plan demonstrated above is a sample lesson plan on the acids and alkali topic. Similar lesson plans with more learning activities can be designed so that the aspects of the Montessori approach can be incorporated.

**Conclusion**

The chapters in this thesis reveal the possibility of incorporating Montessori educational aspects into a traditional high school chemistry classroom in Kerala, India. My vision of combining the traditional educational system used in India with an alternate educational approach has been inspired from my daughter’s educational experience. The literature review in this study displays the philosophy of the Montessori educational approach and the aspects that
could be implemented in a traditional classroom. The data collected by interviewing Montessori teachers directed me to find the appropriate facets of the system that could be implemented in a conventional classroom. Analysis of the interview and the explication of a small number of high school chemistry topics paved the way to construct learning materials that could be used in a traditional classroom to create a natural learning environment. A sample lesson plan was also constructed considering all the aspects of both the traditional and Montessori systems.

Although the traditional educational system has drawbacks, many qualities could be sustained in a classroom for instruction, especially teaching high school chemistry concepts. The lecture method is useful for delivering theory portions of a concept. Rote memorization can be helpful for a student to learn the formulae or chemical symbols of elements and compounds. Discipline and careful observation are important, particularly while demonstrating experiments to a class. It is important to maintain these aspects of the traditional approaches while implementing Montessori aspects.

Considering the aspects of the Montessori system, a natural physical and learning environment is necessary for a child to nurture knowledge, which can be created by a teacher who plays the role of guide and mentor. Consequently, the physical and natural learning environment could be the most important aspect that could be considered in incorporating the Montessori system in a conventional classroom. Learning materials that give first-hand learning experience has to be created by the teacher according to the necessity of the students. These experiences can help to create a natural learning environment.

In the second place, the role of a teacher, as always, is an important aspect, especially in a Montessori-inspired classroom. This role is important because the teacher is a guide, mentor, and motivator, a practice that is entirely different from the practices of the traditional classroom.
Although the concept of the multi-age classroom cannot be directly possible in a traditional classroom, the thought of grouping students according to their learning capacities could be adopted. Freedom within the limits to choose activities and discover themselves could be another important aspect to be imported. Using different teaching and learning techniques, namely imaginative play, inquiry science, and meaningful context in lessons are other aspects that could be implemented in a conventional classroom.

However, there are limitations in implementing the aspects of the Montessori system in a conventional classroom. The Montessori teachers mentioned the challenges I might face while implementing the Montessori aspects. First, considering the big factor, the management should be flexible and open to teachers to plan their classes. Second, considering the classroom within the teacher’s area, freedom given to students should be under the teacher’s control. Specific and clear guidelines should be outlined prior to the activities so that the teacher could maintain class management. Third, time management is an important challenge that a teacher might face while implementing the Montessori aspects. It is necessary for a teacher to be patient and focused to help students to complete the activities within the stipulated time. The constraints for completing the portions will be another challenge while giving freedom to students. The learning resources could be another important challenge a teacher may face in implementing Montessori inspired classroom.

In conclusion, good teaching rests in the hands of a passionate teacher when safely working to create a balance between the Montessori and traditional aspects in a conventional classroom while teaching high school chemistry concepts in India. I believe that the study will be a small step towards a big difference.
Limitations of the Study

Although the study on implementing Montessorian aspects in a regular traditional classroom has been a successful one, I will briefly explain a small number of limitations in this section. The study was done in a small scale limited to one school in Nanaimo. I chose this method because there were fewer Montessori elementary schools in Nanaimo. This method, although it made my research more manageable, could be considered a limitation for the study. Another limitation could be the small number of teachers selected for participants as part of my data collection. Again, I chose these teachers because they had undergone Montessori training and I believed they could share their insights, answer my questions, and because I believed I might gain a profound knowledge about the Montessorian philosophy.

Recommendations

As a result of my research study, I came to believe that the Montessori system of education is an alternative approach that could be implemented in a traditional classroom in my home country of India. The aspects inspired from its philosophy as studied in this research could be used in every class, especially in science classes. The future scope for the study will be considering greater numbers of Montessori high schools and teachers who have been trained under the Montessori system for data collection.

A wide variety of Montessorian aspects can be considered according to the subject, and lessons could be another scope of study. A passionate teacher who believes in individual differences could make use of the pedagogy of incorporating Montessorian aspects into a conventional classroom, which would be a small step toward a big difference in educational change. As I work towards my own future teaching and sharing what I have found with teaching
colleagues in India, I believe that I might work to design a workshop for other science teachers as a future step in my continuing research.
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