TEACHERS SKILLS IN IDENTIFYING CHILDREN'S UNDERSTANDING OF THE NATURAL WORLD

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ABSTRACT - This paper explores what primary school teachers know about the intuitive/naive theories that children have and the skills they use to identify these theories when preparing and teaching science lessons in the primary school. The sample included 12 teachers from a primary school in Soweto, Johannesburg, with at least 1 to 15 years' experience in grade R to grade 5 teaching. Semi structured interviews were used. The findings indicate that teachers depend on the Curriculum and Assessment Policy when preparing Life skills/science lessons although being confronted by a number of challenges recommended in the policy. Furthermore teachers do not conceptualize learners' prior knowledge when preparing and teaching science lessons which they view is a formal process. The following themes emerged from the data analysis: Science lesson preparations which explored the influence of the curriculum as a preparation guideline for science lessons; Time management and its influence on how teachers teach science, Language implications on teaching science in the learners preferred home language and the language of instruction; The connections teachers create in order to comprehend learners' prior knowledge about specific science topics during lessons; The notion of science being a formal subject/ learning area and its implication on adequate teaching in the classroom; and lastly the influence of learning theories in science lesson preparations and teaching. The results suggest that although teachers' may be aware of children's naïve theories about the natural world they do not fully appreciate them as a connection to new scientific knowledge in any science lesson.

Keywords: Intuitive theories, Primary school teachers, pre-knowledge and conceptual change.

1. INTRODUCTION: CHILDREN'S INTUITIVE THEORIES

The South African curriculum includes science concepts in foundation phase although the amount of content is restricted and only enforced with significance once children progress into the intermediate phase (South Africa Department of Basic Education, 2011). South Africa has been ranked by the World Economic Forum (WEF) at the bottom with regards to science performance (Wikinson, 2013). This is also echoed in the international benchmarking initiatives like TIMMSS (2011) and PIRLS (2011). It is quite evident that the quantity of content and time invested in teaching science at an early age could be the cause of such a ranking. The quality of education in this country could be calling for a fix in the amount of time spent in science teaching at primary level. Teachers need to spend more time discovering what children already know or think about the natural world before teaching science lessons. Research indicates that children from as early as age six to nine have developed intuitive/naive theories about certain science concepts depending on their own experience. From this age most children begin to intuitively formulate ideas about the natural world as a way of creating their own meaning of all that is presented to them in their environment. Children articulate such through involuntarily taking on basic casual realistic activities that they create to make sense of the natural phenomena (Gopnik & Wellman, 2012) and whatever they experience during this time impacts severely on their acquisition of science knowledge and skills.

The intuitive theories that children create ground the deepest ontological commitments and the most general explanatory principals in terms of which we understand our natural world (Carey, 2009). These theories are created by children and are a sincere ontological assurance and the most overall clarifying principles in relations to how we comprehend the world naturally (Naude, 2015). Carey elaborates on

these perceptions as being "entities of intellectual illustration, approximately the ounce of single lexical items, which include objects, material and mass" (Carey, 1992). We argue that teachers need to comprehend the processes involved in the acquisition of these intuitive theories in order to inform their teaching practice. Anecdotal evidence however shows the contrary in that teachers report little to no training during their tertiary studies on how to identify these intuitive theories and the pedagogies involved to address the conceptual change required to transform these naïve concepts into conceptually competent conceptions of the natural world.

2. BACKGROUND AND MOTIVATION TO THE STUDY: TEACHERS KNOWLEDGE ON THE CHILD'S IDEAS ON THE NATURAL WORLD

This study addresses the urgent need for knowledge about how children in their first years of learning conceptualize the natural world (Gopnik & Wellman, 2012) and what teachers know about children's reasoning and factors that influence this type of reasoning. The field of cognitive development studies in psychology in South Africa has insufficient confirmation of what children express either linguistically, through tasks when engaging with objects, through their reactions to science experiments that they witness, or their interpretation of content in books or electronic media content (Naude, 2015) hence there are few studies of South African children's ideas on science regarding their natural environment. This paper claims that due to limited teacher knowledge about how children develop science concepts which are influenced by these theories, problems arise and as a result this causes a haphazard foundation phase curriculum for science teaching. Evidently those involved in the teaching and learning process give insignificant thought about what children perceive and the ways in which some acquire scientific knowledge or skills. The argument of this paper is that teachers should know more about how children develop intuitive theories (Carey, 2009) and use that knowledge to prepare for their science lessons in the primary school. Following from this discussion thus this far the following research question is posed?

How do Foundation and Intermediate phase science teachers' identify the intuitive theories of children?

The aim of this paper is to describe and clarify how a sample of 12 teachers in a primary school identify the existing naïve/intuitive theories children have about science phenomena and how they use this knowledge to prepare their science lessons.

3. THE SALUTATION OF INTUITIVE THEORIES IN PRIMARY SCHOOL SCIENCE

Some teachers in the primary level contribute limited attention to their learners' prior-knowledge and naïve theories about the natural world when introducing scientific concepts. They do not establish pedagogies that accommodate such ideas in the instruction process. These teachers usually have limited knowledge about children's ideas on how the natural world functions and also devote most of their teaching time to literacy and mathematics (Naude, 2015). Though young children have limited understanding of scientific enterprise they have important perceptions that could be a guide for the teacher to plan learning events that allow children to learn more about science (Carey, 2009). Sackes (2014) also says that:

> (r)ecent writings have proposed that early childhood educators feel to be obligated to dedicate most of their teaching time to other learning area's such as mathematics and languages (Greenfield et al. 2009). Educators in the intermediate who might have greater influence on their curriculum might teach science with more dedication compared to those who don't.

Viewed from the constructivists philosophy as set out by Piaget (1952), the role of the teachers' is to institute which foundation (no matter how naïve or impractical it might be) may have been placed by the child's regular interaction with the environment. The learners' prior knowledge is at the heart of socio-constructivists and cognitive psychology perspective on learning and it is also fundamental in shaping the learning of new concepts in the classroom. This approach assumes that humans construct

their own knowledge using the knowledge that which already exists to them (Piaget, 1952). Though some teachers claim to teach according to the idea of constructivism, most of them do not establish a learner-centered classroom which allows the learners to reflect and make relations of their existing knowledge to develop new understandings of scientific concepts. Novice teachers do not tap into the learner's prior-knowledge hence it is found that their discourse is confined to developing vocabulary and descriptive understanding of phenomena and situations (Newton & Newton, 2000). Furthermore the activities that they provide formally and informally also concentrate on developing vocabulary and explanations of phenomena, however this practice does not provide the learner with an opportunity to develop and create an understanding of the intuitive theories that already exists and to evaluate its quality (Carey, 2009). We would argue that foundation phase and intermediate phase science teachers need to understand the variety of ideas that children have about the natural world before attempting to teach science as this will affect the ways in which they connect the new science content to what the learners already know. If not they will most likely have difficulties in teaching the appropriate content and using techniques that will 'associate' with the present concepts that learners have learnt. It is the teacher's duty to acknowledge the existing ideas that children have and apply the idea of conceptual change teaching when preparing or teaching science lessons (Thomas, Koballa, Shawn, Gylnn, & Dava, 2005). The lack of concern that teachers have for these theories could be influenced by their own lack of content knowledge. This insufficient subject knowledge could result in low confidence, narrow lesson objectives, restricted teaching strategies and high levels of transferring information and facts when teaching and engaging with primary science in the classroom (Harlen &Holroyd, 1997).

Obviously, not all teachers contribute inadequate attention to the intuitive theories that children have and always attempt to establish teaching pedagogies that connect with the learner's prior-knowledge as viewed by the constructivists. Occasionally these teachers create lessons that will enhance extreme modification on these theories. This practice has been advanced into a "model of conceptual change" (Posner, Strike, Hewson, and Getzog, 1982), from this assumption learning takes place when there is a constant relation between fresh and prevailing conceptions. These teachers often establish a learner centered classroom which allows the reflection and relation of learners existing knowledge as key to the development of new scientific concepts. Conceptual change entered education as an analogy drawn from the ancient times and viewpoints of science that identified difficulties which people have when changing from one explanatory framework to another (Hawson, 1981). The teachers who practice this model constantly create a change in the child's present understanding of science through lessons that are built on transformation, are student–centered, aim at clarifying student's misconceptions and where learners are encouraged to respond to many open ended questions (Newton & Newton, 2000).

Conceptual change is used to think about the process of learning and its purpose in teaching science should not be about compelling learners to surrender their intuitive theories to the teachers or scientists conceptions but rather it should assist learners to actively formulate a habit that will encourage them to question one conception in relation to another (Harlen &Holroyd, 1997). Children have different conceptions that often need to be changed or enriched by the teacher through applying appropriate teaching practices that facilitate conceptual extension (during this process children learn what they did not know and connect it with what they know) or conceptual exchange (children may have to eliminate existing ideas that contradict the goal idea presented to them) (Hawson, 1981). In effect, most teachers who teach science with a purpose of creating a conceptual change understand that learners either assimilate or accommodate the given knowledge based on the theory that they have created and use their existing knowledge which is also known as their "conceptual ecology" to decide if whether a new concept or idea is intelligible, plausible and fruitful or useful (Ozdemir & Clark, 2007).

Most technical concepts will alter based on new practical confirmation, similarly to how children reform their intuitive theories based on different empirical knowledge regarding phenomena which

creates better understanding, accuracy in the predictions and including better ways to explain the phenomena. We believe it is influenced by the dissatisfaction that a learner may have about certain phenomenon and as a result decide to restrain it and agree to take a scientific conception for effective conceptual change to occur (Ozdemir & Clark, 2007). Carey (2009) argues that this is a very difficult process as the semantics that are associated with the 'new' concept are incommensurable with those of the 'old' concept.

We thus argue in this paper that teachers need to identify the intuitive theories that children have for effective teaching and learning to take place, they need to focus on using this knowledge to prepare constructive science lessons. This practice is achieved through the use of diagnostic techniques which will provoke children's intuitive theories and reasons why these theories exist. Spelke (1991) argues that innate ideas are not substituted or restrained, but rather innovative thinking is created and grounded on them. Through education children adapt their own ideas of the natural world and begin to create concrete meanings that are logical and authentic. When they are released to fresh practice as well as instructions they suddenly substitute their theory - like intangible structures with theories which are logically correct (Carey, 1999). Children and scientists formulate the truth about the natural world similarly through observations and identifying possible causes of certain phenomena constructing explanatory theories (Gopnik, 1996). Both the child and scientist pursue the truth about the world through similar strategies. Children are 'little scientists' who constantly use their own techniques of observation, hypothesizing and testing.

4. METHODOLOGY

Data was collected by conducting focus group interviews with teachers in a primary school. This study is a descriptive case study (Stake, 2013; Yin 2013). Sampling was purposeful and the interviews were conducted with 12 teachers representing one school in Soweto. The teachers in the cohort were woman from middle class socio-economic background who ranged from the age 30 to 42. The teachers had experience in teaching Life Skills in the foundation phase for grade R to grade 3 and Natural Science and Technology in the intermediate phase. The level of experience among the teachers raged from 2-15 years of teaching.

The study investigates the bounded systems of how teachers identify intuitive theories children hold regarding the natural world and which types of knowledge (Shulman, 1986) are evident in their response during the interview. The 12 teachers were questioned about their understanding of children's intuitive theories and how they prepare for science lessons at the primary level. A semi structured interview process was used to address issues such as, what teachers thought of the science curriculum in the foundation or intermediate phase, what they enjoyed most about teaching science in the foundation or intermediate Phase and how do they prepare for teaching science lessons. Three sets of interviews were conducted and teachers were interviewed in small groups of three. Session 1 included grade R and one teachers where session 2 included teachers from grade two and three. The third interview session included natural science and technology teachers from the intermediate phase. The interviews were recorded and the teachers' responses were transcribed. Most of the interviews lasted approximately 30 minutes.

5. DATA ANALYSIS

The analysis of the transcriptions started off with initial descriptive codes that were allocated to the teacher's responses. The codes were then divided into broader categories that were visible in the transcripts. The categories that were distinctive would be grouped into themes (Cresswell, 2007; Henning et al., 2004). One additional reviewer was used to confirm the reliability of the interview transcript codes. The additional reviewer identified and verified the possible codes and trends in the interview transcript codes. The reviewer and interviewer individually identified similar trends in the coding categories. If differences prevailed they discussed evidence from the data and reached agreement on the final results.

6. RESULTS

The interviews were coded in order to find suitable themes that developed from the teachers' responses. The table provides an outline of themes and sub-themes. The themes and sub-themes are conversed in the following section.

Table 1: Summary of emerged themes and sub-themes

Themes	**Science lesson preparations**	**Time management and its effect on teaching science**	**Language implications on science teaching**	**Children's prior knowledge in science teaching**	**Science as a formal subject /learning area**	**Learning theories in science preparation and teaching.**
Sub-Themes	The curriculum as a preparation guideline for teachers	The Systemic challenges such as the availability of time to teach the subject	Scientific terminology difficulties in LOLT(Sotho/Zulu)	Teachers connections with learner prior knowledge	1.Teachers integration of science with other subjects 2. Resources applicable to science teaching in FP and IP.	Teachers' notion of learning theories in science preparation and teaching.

The analysis indicated in the table shows evidence that all 12 teachers interviewed show no interests in what children already know about the natural world or science phenomena. Thus three of the six themes advanced from the data indicate that these teachers depend on the curriculum as a guideline on how they prepare and teach their science lessons. None of them declared the importance of what the children know about science before attempting to teach them new concepts, however when prompted to discuss educational learning theories they use to teach science they mentioned the idea of teaching from the known to the unknown which indirectly eluded to constructivism but the disadvantage of this feedback was they knew of no strategies to identify what children already know. One of the themes also shows that these teachers have a formal view of science and see it as a subject that involves being more serious and structured, meaning it could never be accurately taught without a laboratory. None of them see it as something that can be informally taught. The data also revealed that primary school science teachers conclude that some of the inadequate teaching of science is influenced by challenges such as time which is stipulated in the curriculum and language difficulties between the teacher, child and content taught.

7. DISCUSSION OF THE FINDINGS

Theme 1: Science lesson preparation

The curriculum as a preparation guideline for science lessons

During the interview the teachers mentioned that they are content with the requirements set in the curriculum including the quality of concepts that is presented to the learners. However, they stated that the quantity stipulated in the policy was not enough and not scientific especially in the foundation phase. These teachers feel obliged to follow this curriculum as a guideline in how they need to prepare and teach their science lessons. They mentioned that they refer to other sources like the internet and books to broaden their understanding of a particular topic but they often need to constantly refer to the curriculum to make sure that the given information from these external sources align with what has been stipulated in this policy. They also specified that the curriculum helps them in becoming science teachers that are well grounded.

Theme 2: Time management and its effect on teaching science
The systemic challenges of teaching science
The teachers viewed time as being vital to teaching science lessons that are beneficial to the learner. However teachers in the foundation phase mentioned that the amount of time invested in teaching Life Skills which incorporates science in the foundation phase as stipulated in the policy is limited in the sense that not much can be done during that time to teach adequate science to the learners. The majority of the learners in the school appear to be critical thinkers who are constantly asking questions about why certain phenomena occur and what science implies about those phenomena but due to time limitations teachers are not able to engage with those learners' questions. This means that teachers do not have enough time to tap into what children already know or how they make meaning of certain scientific issues. The foundation phase teachers mentioned that their teaching time is invested in teaching mathematics and languages which at the end influences them to spend restricted time on science teaching. They seldom allow the learners to do further research on certain concepts nor do they allow them to have a followed up discussions on those topics. Ideally these teachers believe that due to time constrains whatever the child didn't acquire will be taught to them in the next grade. No importance was placed on learners receiving the best science content with the best practical and theoretical examples but rather the focus is on covering the content of the curriculum at the expected time.

Theme 3: The implications of language on science teaching
Scientific terminology difficulties in LOLT (SeSotho/isiZulu)
What was evident from the interviews was that these particular teachers struggle especially in the foundation phase to teach science in the home language mainly due to the fact that they themselves are not fully competent with that language in terms of all the scientific vocabulary that they need to use to explain the concepts further to the learners. This indicates that the teachers' lack of proficiency in the language contributes to how science should and can be taught. The foundation phase teachers also mentioned that although they are expected to teach Life Skills in the home language, either isiZulu or SeSotho, in Foundation Phase they decide to code switch into English as it is the best possible language of explaining certain topics. They assume that their learners will now have a much better understanding of the topic if they employ code-switching.

The intermediate phase teachers mentioned that terminology is the most common struggle especially in grade 4 in the sense that "50%"of the learners do not understand the English terms that are being used in science lessons mainly due to the fact that the learners have been taught in their home language from grade R to grade 3. However in grade 4 they are now taught strictly in English. From this response we could determine that the teacher could not translate the content to the learner's home language as a strategy to ensure that the content is well understood by the learners'; however this could be due to the fact that the teacher's language of proficiency could only be English and no other language. From the overall response of the teachers we could determine that language was causing severe limitations in the ways in which they taught science.

Theme 4: Children's prior knowledge in science teaching
Teacher's connections with learner prior knowledge
The interviews indicated that teachers do not determine the children's prior knowledge when preparing or teaching science lessons. When asked in the interview how they prepared for a science lesson none of them mentioned how they connect with what the children already know then link that to what they want to teach them but rather emphasized the importance of the curriculum in their planning. Observed from this responses neither of them inquired on what the learners know either from the previous work done in the class or shared experiences, the same teachers taught science lessons that did not encourage discussions and sharing of ideas. The learners' prior knowledge was never used to scaffold learning. The reason for such practice could be because they are too focused on

the curriculum and fulfilling its requirements that they pay limited attention to the child present in the classroom.

Theme 5: Science as a formal subject /learning area
Teachers' integration of science with other subjects
The majority of teachers view science as a subject or learning area that is very formal and this perception is influenced by their responses in the interview. The teachers view this subject as one that can be well taught if the learning environment is well structured and has a laboratory with all the important apparatus such as cylinders or beakers. Very few interviewed teachers viewed science as informal but in grade R the teachers' responses indicate that they still see science as a subject that can be taught informally where learners actively engage through play as a way of understanding the science phenomena. The teachers mentioned that science could be taught well if integrated with other learning areas such as mathematics and the languages, they also suggested the implementation of themes that would be integrated again in the various learning areas. Based on the responses with regards to what was the biggest challenge in teaching science, teachers mentioned resources as key to inadequate science lessons mainly referring to the apparatus which are much more formal. Evidently they mentioned that they teach science theoretically where they give information and notes on certain topics without any practical examples or experiments for the learners' due to such a challenge.

Theme 6: Learning theories in science preparation and teaching.
The implications of educational theorist in teachers lesson preparation
The teachers' responses exhibited limited knowledge on what educational theories are and the ways in which these theories can be incorporated in to planning to teach science lessons. The response that projected itself about these theories from two teachers was Moslow's hierarchy of needs which is not a learning theory, from this idea of Moslow one teacher eluded to constructivism when referring to "teaching from the known to the unknown". When further asked to explain this particular idea no teacher mentioned how they identify what children already know and how they connect that knowledge to the unknown which they will provide to the learner.

8. RECOMMENDATIONS
From the above the following recommendations are made

- Further investigation is required on how teachers can identify children's intuitive theories.
- In service training should be presented to teachers on what intuitive theories are and how children formulate them.
- The amount of time allocated to teaching Life skills in the Foundation Phase curriculum should be reviewed.
- Primary school science teachers should be trained further on how to create science lessons that are innovative and not only dependent on formal apparatus.

9. CONCLUSION
In exploring how primary school teachers identify children's intuitive theories and how they use that knowledge to prepare science lessons, this study brought attention to the limited opportunities that teachers create in understanding what children already know about the natural world. It has been noted that South Africa has been ranked the lowest in science education and many factors have influenced such a ranking. The interviews conducted in this study confirm the idea that not much motivation is taken by the teacher in understanding the learner and what they have come to conclude about certain science phenomena. The findings have revealed that teachers spend most of their time trying to project the expectations of the curriculum during their lessons and not much effort is invested in understand the child and their educational needs when learning science. Teachers experience challenges with teaching science lessons that are interesting and at the level of the learner, mainly because they view science as a subject that needs to be formally taught, hence most of them blame the insufficient apparatus for teaching lessons that are more theoretical with limited or no science

experiments at all. They also indicate language being a challenge hence both the teacher and child experience difficulties with understanding the terminology that is used in science creating a restriction in how this subject can be explored and taught in the classroom.

The main argument of this study was that the intuitive theories that children create about the natural world ground the deepest ontological commitments and the most general explanatory principals in terms of which we understand our natural world (Carey, 2009) and it is the role of the teacher to help the child connect or reform these theories to the new science content taught by the teacher. There is a great need for addressing these findings hence they will assist develop teachers' skills in science education with a focus of equipping them with expertise that will permit them to teach science with more enthusiasm and creativity. The study has discovered that teachers do not have the skills to acknowledge children's naïve theories about the natural world; they do not fully appreciate them as a connection to new scientific knowledge in any science lesson.

REFERENCES

Carey, S. (2009). *The Origins of concepts*. Oxford University Press: Oxford.

Carey, S. (1999). Sources of conceptual change. In E. K. Scholnick, K. Nelson & P.Miller(Eds.), *Conceptual development*, (pp. 293-326). Mahaw NJ: Lawrence Erlbaum Associates.

Cresswell, J.W. (2007). Qualitative inquiry and research design: Choosing among five approaches. Thousand Oaks California: Sage.

Department of Basic Education. (2011) .Curriculum and Assessment policy. Pretoria: Department of Education.

Gopnik, A. (1996). The Scientist as a Child: Philosophy of Science, 63 (4): 485-514.

Gopnik, A. & Wellman,H.M. (2012). Reconstructing constructivism: Casual models, Bayesian learning mechanisms and the theory. Psychological Bulletin, 138 (6): No. 1805.

Henning, E., Van Rensburg, W. & Smith,B. (2004). Finding your way in qualitative research. Van Schaik: Pretoria.

Gomez-Zwiep, S. (2008). Elementary teachers understanding of students science misconceptions: Implications for Practice and Teacher Education. *Journal of Science Teacher Education,* 19 (5):437-454.

Howson, P.W. (1981). Conceptual change in science and teacher education. University of Wisconsin-Madison: United States of America.

Harlen, W. & Holroyd,C. (1997). Primary teachers' understanding of concepts of science:

Impact on confidence and teaching. *International Journal of Science Education*, 19: 93–105.

Naude, F. (2015). Foundation phase children's causal reasoning in astronomy, biology, chemistry and physics. *South African Journal of Childhood Education,* 5 (3): 263-275.

Newton, D.P. & Netwon,L.D. (2000). Do teachers support casual understanding through their discourse when teaching primary science. *British Educational Journal,* 26 (5):599-613.

Piaget, J. (1952). The origins of intelligence in children, 8 (5):18. International Universities Press: New York.

Posner, G.J., Strike, K. A., Hewson, P. W. & Gertzog,W.A. (1982). Accommodation of scientific conception: Towards a theory of conceptual change. *Journal of Science Education,* 66: 211-227.

Shulman, L.S. (1987).Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review,* 57 (1): 1-23.

Roberta, J. & Bradshaw,B. (2001). How do children know what they know? : Science and children. 39 (2): 28-33.

Sackes, M. (2014) .How often do early childhood teachers teach science concepts? Determinants of frequency of science teaching in kindergarten, *European Early childhood Education Research Journal,* 22 (2): 169-184.

Spelke, E.S. (1991). Physical knowledge in infancy: Reflections on Piaget's theory. The Epigensis of Mind: Essays on Biology and Cognition, 133-169.

Stake,R.E. (2013). *Multiple case study analysis*. Guilford Press

Thomas, R., Koballa, S. M., Gylnn, L. & Dava,C. (2005). Conceptions of teaching science held by novice teachers in an alternative certification program. *Journal of Science Teacher Education*, 4 (16): 287-308.

Ozdemir, G. & Clark,D. B. (2007). An overview of conceptual change theories. *Eurasia Journal of Mathematics, Science & Technology Education*, 3(4): 351-361.

Yin, R. K. (2013) Case study Research: Design and methods, Thousand Oaks, California: Sage.