IMPLEMENTATION CHALLENGES OF NATURAL SCIENCES CURRICULUM IN THE TEACHER EDUCATION PROGRAMME: A TANDEM BETWEEN CURRICULUM CONCEPTUALISATION AND IMPLEMENTATION

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Abstract

Literature internationally and nationally has unveiled that the process of curriculum development is a process that should be seriously considered. At the core of the conceptualization process of a curriculum, there are often variables that do not come into manifestation during the development stage but seem to crop up during the implementation phase. This has been a case in the institution where this study was conducted. The aim of this study was to trace how the designed curriculum model had been conceptualized and how this penned out when the natural sciences curriculum was implemented. The dominant philosophies, theories and models for curriculum development for the principle of integration of knowledge were carefully evaluated based on the 'ideal curriculum conceptualized'. The realities of the implementation of the curriculum faced by teacher educators during the first year at the sampled university where this case study was conducted showed a different picture from the principle of knowledge integration envisaged in the designed curriculum. The view of integration of knowledge for integrated learning by the teacher educators has been the fulcrum of the argument this study pursued. Results unveiled that the picture of what was painted about the conceptions and perspectives on the principle of knowledge production in the life sciences teacher education have not worked according to design principles envisaged in the curriculum designed. Further, the were challenges that were encountered in the middle of implementation phase emanating from pressure of relaxing criteria used for admitting students resulted in the admission of students who have either done Life Sciences or physical science in grade 12. This has resulted in the students who have done either of the two learning areas studied at grade 12 in schools. There were struggles and difficulties of coping mechanisms by these students as a result of this fact. The anxiety resulted in some students cancelling their registration and some who remained in the program seem to be battling and consequently creating anxiety on the teacher educators who teach this integrated discipline. Revision of admission criteria are recommended to get students that have done both subjects. In the meantime, intervention programmes have also been suggested to ameliorate the problem faced by such students.

Keywords: Knowledge integration; Curriculum development; Curriculum implementation; Multidisciplinary model, Science Education.

1 INTRODUCTION

The principle of integration in curriculum research in teacher education and training was introduced as an integral component of outcomes based education which had implications for organization and structuring of subject content knowledge from heterogeneous to multidisciplinary knowledge design (Gravette & Geyser, 2004; Jansen and Christie, 1999). The Norms and Standards curriculum policy ushered in a new paradigm for teacher educators which Jansen & Christie (1999) considered to be a radical change that resulted to various misconceptions. Fullan (2006) concluded that change is a process which is overloaded with new concepts, beliefs, attitudes, interpretations and misconceptions to those who are engaged in it. Literature highlighted that there are protagonist and antagonist to change, hence resistance to change is viewed by researchers in social sciences as a phenomenon that imposes challenges to new innovations and reforms in education (Goodson, 1994; Fullan; 2006 and Apple, 2004). At the core of this study, beliefs, attitudes, interpretations and conceptions of the Sciences teacher educators were viewed to be critical in the transformation of teacher education and training in the Higher Education Institutions (HEIs). The principle of integrated knowledge and integrated learning underpins the South African curriculum policy for teacher education and training; Minimum Requirement for Teacher Qualification (MRTEQ), (DHET; 2015). Translation of the policy outline served to ensure that curriculum for teacher training and development was subject to how

curriculum developers and designers' interpretations, how they perceived their role in curriculum design and development. Proponents of integrated knowledge for integrated learning needed paradigm shift in curriculum theorizing which should guide and outline the curriculum model that is carefully selected to inform the context where this curriculum is developed and consequently implemented. The theory that informs the principle of integration of knowledge declares that there should be a shift in the conceptualisation of knowledge from a homogenous disciplinary structure to a multi-disciplinary knowledge structure and integrated learning.

Research conducted in South African Institutions of Higher Education indicated that, since 1998 up to 2010, teacher education and training has struggled with the conceptualisation of the Sciences curriculum model for implementing multi-disciplinary or integrated approach to knowledge acquisition (Bantwini, 2014; Bransilal and Mkhwanazi, 2014 and Jansen, 2002; Jansen and Christie, 1999) when developing teachers to be competed in teaching a variety of disciplines which in this case are Life Sciences, Chemistry and Physics. The review of the Curriculum Policy for teacher education and training has been portrayed as another indication that teacher educators in Higher Education and Training face challenges in developing an adequate curriculum to implement multi-disciplinary and integrated learning. It is in this context, that this study explored the conceptual development of natural sciences which has contributed to the implementation process which has been done since the beginning of 2016. The argument could also unveil perceptions and perspectives of Sciences teacher educators on knowledge integration for integrated learning as well as contestations emanating from individual academics different perspectives on how sub-disciplines could use for an example teaching related themes at any given time so that students can be able to relate knowledge obtained from one sub-discipline to that of others.

Furthermore, it is on the basis of these perspectives that this study formulated an argument that there is a possibility of antagonism and conflicts in the perspectives of the Sciences teacher educators regarding the suggested guidelines presented by MRTEQ (DHET, 2015) on adoption of the principle of integrated knowledge and learning in the Minimum Requirements for Teacher Qualifications (MRTEQ) policy. Researchers in higher education in South Africa pointed out that qualifications such as the Bachelor of Science degree offered in the faculties of science had restricted curriculum. As a result, academics qualified in specialised knowledge in the field of science, for example the streamlined combination of disciplines such as Botany, Geology Mathematics, Statistics, Chemistry, Biochemistry, Microbiology, Human physiology, Physics and Zoology. This has been a case for some time that most of the academics in the field of science education have specialised in one or two of the above disciplines.

This is the scenario that this study assumes to be the reality facing the academics in faculties of Education including the university where this case study was conducted. The drive of the espoused curriculum policy for teacher education and training has been to highlight a necessary shift of doing business as usually since students graduating from most South African University have been identified to have a challenge to teach an integrated discipline at schools, due to the lack of content depth in a sub-disciplines of natural science identified a dire need to shift from heterogeneous disciplines to the integrated knowledge model for integrated learning across the sciences disciplines.

Further, this study based its argument on the possible fact that academics could be biased in the selection of themes driven by the passion of their specialisation. The verification of the above claim through the empirical study meant that sciences (Physical Science or Life Sciences) teachers prepared by such academics will be challenged to teach either physical sciences or life sciences as it is supposed to be taught according to Gibson's multi-disciplinary model.

At the institution in which this case study was conducted, Natural Sciences course guides were critically studied and analysed; documents obtained from admitting students in the natural Sciences course in 2016 will also provide us with criteria used in 2015 to advertise the Senior Phase – Further Education and Training (SP-FET) programme for 2016 implementation.

2 RESEARCH QUESTIONS

- How did Natural Sciences Teacher Educators perceive the shift from heterogeneous subject content knowledge to integrated knowledge structure?
- What approaches did they deem suitable for implementing the principle of integrated knowledge in the natural sciences curriculum?

- What were the main challenges that were prominent in implementation process at this university?
- If there were challenges; what are the possible ways of addressing such challenges so that other universities could learn from them and how they were dealt with?

3 LITERATURE REVIEW

Literature points out that integration or amalgamation of knowledge has introduced a remarkable discourse in curriculum research that is profoundly influencing the emerging trend in knowledge production globally and internationally (Gibson *et al* 1994, Department of Education and training 1997). Gibson *et.al*, 1994 asserted that there are various approaches to knowledge integration and integrated learning. In his view they are; trans-disciplinary knowledge production which means teaching across disciplines for the purpose of enabling learners to acquire skills, knowledge and competences and be able to transfer such skills and knowledge in their learning; multidisciplinary knowledge production which means the clustering of themes from various related disciplines which allow students to explore knowledge and develop multiple skills; and interdisciplinary knowledge production which deals with the issue of learning of concepts that relate to other disciplines that are clustered in one theme.

The proponents of the knowledge integration theory advocated for the shift from fragmentation of subject or disciplinary knowledge to a broad field of knowledge (Slattery, 2010, Apple, 2004; Gravette & Geyser, 2004 and Fullan, 2006). This theory contested for the generation of knowledge independent of proper context which is pursued by academics and researchers in universities. The theorists that pioneered this theory argued that world problems and real life challenges cannot be addressed by the compartmentalised knowledge (Nowotny et al, 2003, Berkes, 2008 and Gibson et al, 1994). Furthermore, Minkler and Wellerstein, (2008) and Wemsen, (2008) pointed out that the shift from mode 1 (which is heterogeneous disciplines or taxonomy of disciplines) to mode 2, (which is the amalgamation of disciplines). This has been viewed to require HEIs to adopt participatory research approaches for knowledge production. Babbie (2002) and Shirley (2005) highlighted that the amalgamation of the sciences disciplines which are; biological sciences (animal and plant anatomy and physiology), geology, geography, and ecology, biochemistry, chemistry and physics etc. resulted in the broad-field of study called natural Sciences which is then mode 2 type of knowledge production (interdisciplinary and intradisciplinary approach to curriculum design and development). According to Gibson *et al*, (1994) the shift form fragmented knowledge to one broad field of study enable students to transfer knowledge and skills in the process of learning because of the wider scope of exploration without limitations of boundaries caused by the separation of related disciplines.

4 THEORETICAL FRAMEWORK

The model of 'Knowledge Reproduction and cultural transformation' and 'pedagogic discourse' described in Bernstein's theory asserts the importance of codes as regulative principles for knowledge production in respective fields or subjects. Furthermore this theory claims that the legitimacy of the knowledge production in each discipline is classified according to specific codes modalities, which provides the recognition rules and syntax of knowledge generation. This theory declares that knowledge production is driven by three forces; labour market in the society, socio-economic development and political environment. In keeping with this theory's assertion, Levy and Murnane (2005); Stewart, 2010 and Wilmarth, 2010 argued that a rapid change in the world and pressures of competitiveness are redefining skills and expertise for the 21st century. Davis (2001) pointed out that although Bernstein's theory focuses on the research in sociology, it has had an influence in educational research in the 21st century. The Knowledge Reproduction Model in this theory provides the description of modes of knowledge production that generate the language or syntax and semantics for the knowledge produced. Therefore this theory could be used to analyse the findings of this study in identifying the new syntax and semantics that are used to describe integrated knowledge in Natural Sciences and how university academics dealt with the issue of codes modalities; something which Bernstein (2000) describes as the determinants or principles regulating knowledge production.

5 METHODOLOGY

The case study research design was selected as appropriate methodology to conduct this study and was used for framing the study and collecting data to answer the research questions (Cohen, Manion, Morrison, 2010; Schumaker and McMillan 2006). For the data collection and analysis, three participants were selected from a South African University of technology which participated in the designing and developing its Natural Sciences curriculum for science teacher education This study was based on the belief that the chosen university has its own contextual attributes that have influenced the conceptualization of integrated knowledge in the teaching and learning of Sciences curriculum. In-depth interview was a selected methodology of the data acquisition (Welman et. al, 2006). The purpose of this method of data collection was supported by Kumar (2005) as providing the face-to-face engagement between the researcher and the participants directed at understanding informants' perspectives on the experiences or situations as they are expressed in their own words.

The questions asked during interviews were prepared or structured before the arrangement of the interviews. The participants were asked the same set of questions seeking data to answer the questions on their views and perceptions of the knowledge integration as well as their views on compartmentalizing of different subjects that have been integrated to form a multidisciplinary subject such as Life Sciences or Physical Sciences components of the Natural Sciences curriculum.

Permission was sought from the Faculty of Education Ethics committee to perform the research and permission was sought from the interviewees to collect data through in-depth interviews as well as requesting documents that were used for the design and development of the curriculum according to MRTEQ policy's specifications The informants were asked for permission to use an audio-recorder during interview. The transcripts were then developed after the interviews for analysis purposes.

6 PRESENTATION OF FINDINGS

From the in-depth interview conducted with natural sciences educators, four of which were involved with the curriculum development for natural sciences; three are Life Science teacher educators and one Physical Science teacher educator. Of the four respondents, two Life Sciences teacher educators are currently involved in the implementation of the curriculum while the only respondent who trains Physical science novice teachers has also been part of the implementation of the curriculum.

Several themes emerge from the data obtained from interviews as well as document analysis:

- **Teacher educators' view to curriculum change to integrated curriculum for integrated learning**

One responded stated that at the earlier ages when the teacher training curriculum specifically focused in teaching the disciplines in silos that he was moved by the plight of recently qualified teachers from the program which focused on training Biology teachers to teach only biology as a distinct subject from the other science disciplines. This plight led to the respondent restructuring the programme to include other aspects within the other disciplines of science.

> "Let me give a bit of a background in terms of how we have perceived the program when I came here and – and – and the link between what is happening here and at the schools. Because as you said Life Sciences in the FET program at school draws from all kinds of disciplines that you've mentioned; Biology, uh Chemistry, Physics, Zoology, etc., etc. And because of that, it's very difficult to construct a program so that at least there can be some kind of knowledge depth in each of those disciplines. And – and – and we still have that kind of challenge. You'll probably notice that of all the disciplines we probably concentrate on a few and we just sort of scheme around the others. It's not very- I don't think it's very uh appropriate and so my thinking is that to train a – or to prepare a Life Sciences uh teacher, it's extremely difficult because of all the disciplines. They might be- we might choose say for instance six disciplines that we concentrate on, whereas the other disciplines, they just have to pick up on their own. And obviously if you're not – if you're not strong in certain parts, you tend to concentrate on the areas where you're strong and then the learners are going to suffer, if you've got a broad background. Then also I think-I – I've been grappling with – with- with this for- for –for some time, uhm 'cause when I came here some x years ago uh I noticed that – look it was called Biology for a very long time and then it switched to Life Sciences with the understanding of the integrated program, but I have picked up at schools, most of my students – I think this is where I would like to start- most of my students after they leave here – track a few of them informally – and about 99,99 percent

> of them find themselves in the school in their first teaching post teaching, or being asked to teach Natural Science. Ok? And because of that we - we are taken as the Biology stream. And so Biology steam sort of linked with traditional uhm Botanies or the general chemistry that. So they came back to me over time and said, "Sir, we struggle with certain parts of the Natural Science because I'm now being asked to take grade 8 and 9 ok. Maybe I'm a new teacher or maybe this is the hierarchy of the school – this is where you start." And so they battled with the Natural Science – or the science part of Natural Science, the Biology part was still ok they could manage that. So I – and especially those who didn't do Physical Science as well so Physical Science guys could survive in that part of the Natural Science, maybe not the Biology, I don't know, but I'm talking about Biology. So the students came back to me and they said, "Sir, we're battling with that" ok I helped a few of them and then I told myself, "Listen, I need to infuse some of those topics – that was now before this new program came in- I need to infuse some Chemistry and some little Physics, little bit of that, little bit of that" so when they leave here after the four years at least they would have Biology, Life Sciences then, and at least they've been exposed to the theoretical part – understanding of for instance – take for instance the Periodic Table or the uh atomic theory, reactions, a bit of optics and a bit of that. So – so I infused that into our program already because I could see there was a need nowhere else is that need being satisfied, I would argue, because look, when the collages closed that section was void."

Other respondents reiterated the same sentiments that the stature of graduates that came out of the programme was wanting. It came out strongly that the quality of content acquired by these students could not make them to be able to touch on related disciplines that are integrated in the secondary school curriculum. They were either trained to teach Physical Science or Biology and that made them to be rendered incompetent when they were given an integrated subject like Natural Sciences which needed them to have depth both in Physical Sciences and Biology.

The view of producing "Jacks of all trades" was strongly articulated by all respondents and in the same vein they put an emphasis on the depth of knowledge and balance in content depth in all these disciplines. This view reiterated the same sentiments that had led the department of Higher Education and Training (2015) to charge South African Institutions of Higher Education for producing incompetent sciences teachers.

> "You are taking a teacher to mean – to be a general person. Now look at grade 8 and 9 if you look at the reflections by the – our student teachers, I ask them, "How was the teaching practice?" they tell me that discipline was a problem with the grade 8 and 9's, they are not focused, they are not mature. Now why is - their level of development is different from a grade 12 learner? The way you treat your work you get is completely different from a grade 7 or 8 learner. So we need teachers who are specialised to handle those learners. When you are giving them integrated knowledge, which is probably the basis of whatever. You see that's why I said we are taking our teachers to be jack of all trades because it's the physical science here that you are talking about. If you look at the knowledge structure, in theory you should have been able to cope with Natural Science because it is sort of – you build on knowledge, but the difference is that at the lower level knowledge is very contextualised."

Research then advocated for further revisions in curriculum for teacher education and training driven by the research also conducted by curriculum specialists in South Africa (Jansen and Christie, 1999; Gravette and Geyser, 2004; Bantwini, 2014; Bransilal and Mkhanazi, 2014).

Change was therefore inevitable in South African Institution of Higher Education and training who were then given a task to develop and design curricula that would ensure that novice teachers would be trained an integrated Natural Sciences for integrated knowledge impartation which the proponents of this view named it curriculum for the 21st century (Davies, 2001).

Even though the curriculum for natural science has been designed and developed in this university, all respondents echoed the same sentiments of fragmented curriculum disguised as integrated curriculum. They stated that the curriculum was meant to teach the similar concepts or themes across the three sub-disciplines of Natural Sciences (Life Sciences, chemistry and Physics) which they stated that it was not the case. The view raised here was that these three disciplines are taught by four lecturers who are teaching in silos..

> "Eh this is what's happening because there are four lecturers who are teaching – who are supposed to be integrated. That means each lecturer now is likely to focus mainly on his area of speciality – his own discipline, but now – if I could put it this way – the problem is explaining that experience of that teacher to me eh could come the focus also of your study. Is it such that –

the way I see it is that we seem to take - the field of science is an integrated knowledge but at the same time we look at the learners as a homogeneous group and we look at the – those who are going to use our products as required just one type of scientist. You see scientist differ in so many ways and the question is, what does – can I call it the industry – require from the – those who are coming from the education system, that's for primary, secondary and tertiary education. Now there are areas where you definitely need a person who is focused on one discipline – a specialist in a particular area. Eh if you look at the way eh things are developing, people are becoming more and more specialists but the question is how many of these specialists do you require and how can you get them? The next level is where you get those with integrated knowledge but to integrate what and what. From what I understand science comes from every-day experiences then you got principles in Biology or whatever but you go there to apply them, built to this society. Are we integrating – simply integrating physics, chemistry and so on – which we can do but without considering where it's coming from and where it's going to end. Are we supposed to integrate that which comes from the environment with the principles so that our product can cope with the outside world? Because I can have physics integrated with chemistry with Life Science but how am I going to use that in real life? How am I going to apply it? Is different from the other one who is a produce of knowledge is a specialist and then we also need those people who are literate in science".

From the above, it has become clear that integration of knowledge for integrated learning means totally different things to different people. Interdisciplinary which is one form of integrating knowledge seemed to feature quite a little from the course guides of the three sub-disciplines of a Natural Sciences course in this institution. The passion of specialization of teacher educators' field of expertise seem to be a dominant feature in the implementation process whereas curriculum documents show opportunities of cross pollination of knowledge across disciplines. From the interviews it became evident that lecturers are quite territorial in the choice of topic and synergy and team work seemed to be a deterrent of infusing elements of knowledge that speak to one another across sub disciplines of Natural Sciences. The proponents of the view of integration of knowledge across disciplines cautioned the designers and developers of curriculum against the technist tendencies which are viewed as a major stumbling block to knowledge integration.

- **Models influenced the development and design of the curriculum in this Institution**

All respondents were not aware of which model influenced their development and design of curriculum. In their description of how implementation is to happen as the curriculum progresses in this integrated discipline, it became clear that the approach selected was to start from the basic concepts and build knowledge depth on top of the foundation laid from first year to second year. According to the design, when students get to their third and fourth year of the teacher training programme, they will then be able to choose between the three sub-disciplines which two they would specialize in. According to Carl, (2010); this approach to curriculum development and design is referred to as Brunner's spiral model which insinuates that knowledge grows in a spiral manner as concepts and insights to concepts develop levels of deep knowledge and critical understanding as a person develops depth in content knowledge and is able to move to higher dimensions of processing information and develop depth in inquiry structures of knowledge application.

If integration of knowledge which is mode 2 learning were to be embraced, there should be a serious discipline-to-discipline synergy so that as students get to the level of choosing the disciplines of specialty that they would have mastered to relay knowledge from one discipline to the other and to be given access to codes and modalities within the integrated broad-fields subject. This would enable them to develop strong semantic gravity and semantic density according to Maton Legitimation Theory which will provide them with depth of knowledge in the integrated disciples before they move into specializing with the disciplines of their choice.

- **Challenges impacting on the proper implementation of natural science in level 1**

From the interviewees, it became evident that the model of curriculum designed did not articulate what they envisaged when the design process was done. Probably, as in other South African Institutions of Higher Education and Training they needed more time to examine various models and identify a model that would best articulate their envisaged competent Natural Sciences teacher they want to produce. Timing of curriculum implementation seemed to be the challenge because for every curriculum to be successfully implemented, there needs to be prior preparation of resources that would cater for the needs of the new curriculum.

The respondents also felt that the relaxation of requirements for enrolment to the programme landed them with a bunch of students who were either qualified in one of the two matric subjects that were prerequisite for the integrated nature of Natural Sciences discipline. This compromised the standard and depth of content needed for level 1 university sciences. They attributed this challenge to the race to fill classes with students irrespective of meeting the minimum requirements set by subject specialists in the field.

> Interviewee: uhm we, I think the –the – the strategy we use is – is not – yes, because we write semester uh um semester tests, just for the two semesters of the year, so maybe we should regard it as semester courses, uhm but being planned for a term. So and with the – if you talk about the- if it is about the first years, we can't very much follow a – a thematic approach because of the fact that they are – there are some of those students have never done Life Sciences, for instance at school, or on the other hand Physical Science, which means Chemistry and Physics. So a thematic approach would not be to their advantage and if one really, really thinks about think kind of student, the heterogeneous groups of students you have in your class, you need to pay attention to that aspect.
>
> Interviewer: So in other words, are you saying that during the design, that was not factored in?
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> Interviewee: Definitely, it was not factored in, uhm there was – some of us have uh actually uh we talked about it and warned against the fact that if Physical Science is not an entry requirement, it would negatively affect those who did not do one of the required subjects at matric level.

It then became very clear that from this cohort of students that if adjustments are not effected or there are no lessons learnt from the mistakes and oversights that the curriculum will not achieve its ends as stated by the interviewees.

- **Conclusions and Recommendations**

It has been clear from this study that before any curriculum is designed and developed, there needs to be a thorough research conducted to identify the purpose of changes, context where these changes will be effected and the type of curriculum that will meet the desired needs. Again, from this study, it became evident that the principle of knowledge should be unpacked and every stakeholder be given an opportunity to understand and to deliberate on the conceptualization of the curriculum.

For the successful implementation of curriculum, it has also been made clear that the voice of the people who will be able to disseminate the curriculum should be heed to because they are specialists in the field and they will know better about the right resources needed for successfully implementing the curriculum and be made to be part of people who will describe the exact requirements to be able to ensure that standards are not dropped to accommodate students who are falling short because they fell in the cracks created when there was a rush to admit as many students as possible into the programme.

As the situation is in this institution, teacher educators have devised an array of intervention strategies such as mentorship and tutoring programs as well as appointing teaching assistants who will assist them with some academic burden while they are busy with scaffolding interventions for the unfortunate students. Also, to avoid the embarrassment of having many dropouts in the middle of the year, it is better to set up stringent requirements.

It was also recommended in this study that there be Life Sciences course for Natural Sciences for those students who are not strong in Life Sciences and vice versa.

REFERENCES

[1] Apple, W. (2004).*Ideology and Curriculum*. 3rd ed. New York: Routledge Falmer.

[2] Babbie, E. (2002). *The practice of social research*. 9th ed. Belmont, California: Wadsworth.

[3] Bantwini B. D. (2011). District officials' assumptions about teacher learning and change: Hindering factors to curriculum reform implementation in South Africa*. International Journal of Education*.Vol. (3) 1.

[4] Bansilal, S., Brijlall, D., &Mkhwanazi, T.W. (2014). An exploration of the common content knowledge of high school mathematics teachers. *Perspectives in Education, 32*(1), 34-50.

[5] Berkes, F. (2008).*Sacred ecology*. 2nd ed. New York: Routledge.

[6] Bernstein, B. (2000). Pedagogy, symbolic control and identity: Theory, research and critique. Revised edition. Oxford: Rowman & Littlefield.

[7] Carl, A. E. (2012). *Teacher empowerment through curriculum development*. Theory into practice.4th edition. Cape Town: Juta& Company Ltd.

[8] Cohen, L., Manion, L. & Morrison, K. (2010).*Research Methods in Education*. New York: Routledge.

[9] Davies B. (2001). Introduction. Towards a Sociology of pedagogy: The contribution of Basil Bernstein to research. New York. Peter Lang Press.

[10] Department of Higher Education & Training, (1998). Norms and Standards for Educators: Educators Employment Act. Pretoria: Government Printers.

[11] Department of Higher Education & Training, (2015). Minimum Requirements for Teacher Education Qualification. Pretoria: Government Printers.

[12] Fullan, M. (2006). Change theory: a force for school improvement. Centre for strategic education seminar series. Paper no. 157, November 2006.

[13] Goodson, I.F. (1994). *Studying curriculum*. Buckingham: Open University Press.

[14] Gravett S. and Geyser H. (2004). Teaching and learning in higher education. Pretoria: Van Schaik.

[15] Jansen J. D. (2002). The state of higher education in South Africa: from massification to mergers. Pretoria: Unisa.

[16] Jansen J. D. and Christie, P (1999).Changing Curriculum: Studies on Outcomes-based Education in South Africa. Juta: South Africa.

[17] Kumar, R. 2005. *Research methodology*.2nd edition. London: Sage Publications

[18] Levy, F., & Murnane, R. (2005). *The new division of labor: How computers are creating the next job market.* Princeton, NJ: Princeton University Press.

[19] Maton, K. (2014). *Building powerful knowledge: the significance of semantic waves. In Rata, E. and Barrett, B. (eds.). The future of knowledge and the curriculum.* London: Palgrave Macmillan.

[20] Minkler, M., and Wallerstein, N. (2008). Introduction to community-based participatory research: new issues and emphases. In M. Minkler, M. and Wallerstein, N. (eds.). *Community-based participatory research for health: from process to outcomes*. (pp. 5-6). San Francisco: Jossey-Bass.

[21] Morais, A. M., & Neves, I. P. (2001). Pedagogic social contexts: Studies for a sociology of learning. In Morais, A., Neves, I., Davies, B. & Daniels, H. (eds.). *Towards a sociology of pedagogy: The contribution of Basil Bernstein to research.* (pp. 185-221). New York: Peter Lang.

[22] Morais, A. M., & Neves, I. P. (2006). Teachers as creators of social contexts for scientific learning: Discussing new approaches for teachers' development. In Moore, R., Arnot, M., Beck, J. & Daniels, H. (eds.), *Knowledge, power and educational reform: Applying the sociology of Basil Bernstein (chap. 9)*. London: Routledge & Falmer.

[23] National Education Crisis Committee (1992).Curriculum for post-apartheid education. Pretoria.

[24] Nowotny, H., Scott, P and Gibbons, M. (2003). Mode 2 Revisited: The New Production of Knowledge. *Minerva* 41, 179-194.

[25] Schumacher, S. and McMillan, J.H. (2006).*Research in Education: Evidence-Based Inquiry*. 6 th ed. Boston: Pearson Education.

[26] Shirley, J. (2005). C-CIARN North-Nunavut community research needs survey. Summary report. Canadian Climate Impacts and Adaptation Research Network North. Iqaluit, Nunavut: Nunavut Research Institute.

[27] Slattery P. (2013). *Curriculum development in the postmodern era*. New York. Routledge

[28] Welman, C. Kruger, B. and Mitchell, F. (2005).*Research methodology*. Cape Town: Oxford University Press.

[29] Wilmarth, S. (2010).Five socio-technology trends that change everything in learning and teaching. In Heidi Hayes Jacobs (ed.), Curriculum 21: Essential education for a changing world, (pp.80–96). Alexandria, VA: Association for Supervision and Curriculum Development.

[30] Wilmsen, C. (2008). Negotiating community, participation, knowledge and power in participatory research. In Wilmsen, C., Elmendorf, W., Fisher, L., Ross, J. Sarathy, B. and Wells, G. (eds.). *Partnerships for empowerment: participatory research for community-based natural resource management*. (pp. 1-22). London: Earthscan.

[31] Wolhuter, C.C. (2010). Weaknesses of South African education in the mirror image of international educational development. *South African Journal of Education*, 34(2).