Teacher Educators’ Contending Perspectives on Designing a Curriculum Underpinned by Knowledge Integration of Science Education Disciplines in South African Universities

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Abstract- The move from teaching disciplines in silos has been questioned as producing educators who are unable to teach integrated curriculum for integrated knowledge. South African Teacher Education Institutions have had to design teacher education and training curricula mandated by Department Higher Education and Training through the policy on Minimum Requirements for Teacher Education Qualification. This study adopted a qualitative method through case study which explored the conceptions and perspectives of science teacher educators of the principle of knowledge integration as suggested in the policy. Interviews were conducted with sciences teacher educators from a purposively sampled institution. For triangulation, documents of the new curriculum were also analyzed as tools to solicit data from the participants. Interview transcripts were coded and themes were extracted for data analysis. Findings demonstrated existence of contestations on the participants’ views of how integrated knowledge in curriculum is. Further, findings unveiled that some design models used for curriculum design in the selected institution demonstrated attributes that work against knowledge integration with a reason of ensuring that discipline content codes and modalities are not to be tempered with.

Keywords: curriculum development; knowledge integration; science teacher education; teacher educators; south africa.

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Abstract- The move from teaching disciplines in silos has been questioned as producing educators who are unable to teach integrated curriculum for integrated knowledge. South African Teacher Education Institutions have had to design teacher education and training curricula mandated by Department Higher Education and Training through the policy on Minimum Requirements for Teacher Education Qualification. This study adopted a qualitative method through case study which explored the conceptions and perspectives of science teacher educators of the principle of knowledge integration as suggested in the policy. Interviews were conducted with sciences teacher educators from a purposively sampled institution. For triangulation, documents of the new curriculum were also analyzed as tools to solicit data from the participants. Interview transcripts were coded and themes were extracted for data analysis. Findings demonstrated existence of contestations on the participants’ views of how integrated knowledge in curriculum is. Further, findings unveiled that some design models used for curriculum design in the selected institution demonstrated attributes that work against knowledge integration with a reason of ensuring that discipline content codes and modalities are not to be tempered with. This stance arose out of discipline specialists’ fear that knowledge integration could lead to the lack of depth of content knowledge with possibility of production of inadequately prepared science educators. In conclusion, this study suggests that curriculum designers and developers could explore varieties of models of integrated knowledge production. This knowledge, if explored could have a snowballing effect which can be substantiated further as the current curriculum continues to be designed and implemented.

Keywords: curriculum development; knowledge integration; science teacher education; teacher educators; south africa.

I. 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 in various misconceptions. Fullan (1995 and 2006) concluded that change is a process which is overloaded with new concepts, beliefs, attitude, 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). This study considers the beliefs, attitudes, interpretations and conceptions of the natural Science teacher educators 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 curriculum policy for teacher education and training; Minimum Requirement for Teacher Qualification (MRTEQ), (DHET, 2015), has implications for teacher educators in the field of Life Sciences in universities. The theory that informs this principle declares that there should be a shift in the conceptualization of knowledge from a homogenous disciplinary structure to a multi-disciplinary knowledge structure and integrated learning (pedagogy).

Research indicates that, since 1998 up to 2010, teacher education and training has struggled with the conceptualization of the natural Sciences curriculum model for implementing multi-disciplinary or integrated approach to knowledge acquisition (Bantwini, 2014; Bansilal, Brijlall, and Mkhwanazi, 2014; Jansen and Christie, 1999; Nkomo, 1997). The review of the Curriculum Policy for teacher education and training is 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 explores the perceptions of the Life Sciences teacher educator on knowledge integration for integrated learning.

Furthermore, it is on the basis of these perspectives that this study formulated a thesis that
there is a possibility of antagonism and conflicts in the perspectives of the natural science teacher educators regarding the imposed principle of integrated knowledge and learning in the Minimum Requirements for Teacher Qualifications (MRTEQ). 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 specialized knowledge in the field of science, for example the streamlined combination of disciplines such as Botany, Mathematics Statistics, Chemistry, Biochemistry, Microbiology, Human physiology and Zoology. Most of the academics specialized in one or two of these disciplines (Sharma, 2017; Carl, 2012; Ahmad, 2014).

This is the scenario that this study assumes to be the reality facing the academics in faculties of Education: the need to shift from heterogeneous disciplines to the integrated knowledge model for integrated learning across discipline. It is assumed in this study that academics could be biased in the selection of themes driven by the passion of their specialization. If that is verified through the empirical study it will mean that natural Sciences teachers prepared by such academics will be ill-prepared to teach natural Sciences as it is supposed to be taught according to a multi-disciplinary model (Ahmad, 2014; Sharma, 2017; Conbleth, 1990; Carl, 2012).

These ideas and views provided a background to the problem investigated in this study which is stated as follows: How do Life Science educators perceive the shift from heterogeneous subject content knowledge to broad field knowledge structure? What approaches do they think are suitable for implementing the principle of integrated knowledge?

a) Research Question
- What are Science teacher educators’ conceptions and perspectives of knowledge integration in universities developing and training science educators?

b) Literature Review

The Higher Education and Quality Committee (HEQC) of the Council of Higher Education (2010: 73) emphasises that reviews of teacher qualifications take into account the needs of basic education for all:

“In choosing the area of education, and in particular, professional qualifications in education as the focus of this review, the HEQC took into account the fundamental role that basic education and the national schooling system have in the development of a democratic society. It also took into account the responsibility that higher education institutions have in this regard given their role in the training of teachers both in pre-service and in-service situations. The selection of the specific type of qualifications to be accredited took into account the size of the enrolments as well as the strategic importance attached to mathematics and science in the broader developmental goals of the country”.

Literature indicated that review committees were mainly concerned to design and develop curricula in the field of Science, Mathematics and Technology and to integrate applied competences (CHE, 2010: 86): ‘A preferred area selected for review was the field of Science, Mathematics and Technology Education. In choosing specializations in relation to the B.Ed. and the PGCE, it was decided to review Senior Phase and the Further Education and Training band respectively. In this way the Review could provide insights into the quality of training received by teachers responsible for the entry and exit phases of the schooling process. Literature emphasises that streamlining the National Curriculum Statement, in terms of changes proposed by the ministerial committee in 2011, forced the Department of Higher Education to formulate policy guidelines that were in keeping with the proposal of the Ministerial Committee of the Department of Basic Education. The Department of Higher Education (DHET, 2011) gazetted the modified curriculum policy to guide the design and development of curricula for teacher qualification. The process of evaluating teacher qualification programmes resulted in departments undertaking the action presented (CHE, 2010: 87):”

“The currency of the report’s findings and their relevance, despite its delayed publication, is a sign of the persistency of the difficulties faced by the country in the area of basic education. It also highlights the complex relationship between higher education institutions’ conceptualisation of teacher education and the understanding and experiences of the teaching profession operating among policymakers, government, unions, the broad public and the teachers themselves. In finalising the decision-making process, the HEQC Board took due cognisance of the strategic importance of the provision of teacher education nationally and took, in consultation with the Department of Education, a developmental view in those cases in which the closing down of programmes”.

Research pointed out that the same cohort of academics who reported to have difficulty [or reluctance/resistance] in interpreting NSE regulators, were expected to align programmes with the guidelines provided in the Minimum requirements for Teacher Qualification (MRTEQ). The programme could have accommodated the provisions of the NSE, and at the same time been in a position to re-align existing programme design and curriculum structures with the principles of the new regulations. The panel reports indicate, however, that, on the whole, the staff of B.Ed. programmes were balanced in terms of the range of
disciplinary fields, the phase or learning programme specializations offered and the practical and theoretical components of the B.Ed. Reports point out that institutions of Higher learning are faced with the challenge and the problem of finding replacement staff with the appropriate professional and academic qualifications and experience, particularly in terms of equity. The report noted that institutions that provide teacher education qualifications often have staff members who are not engaged in scholarly activities such as research and other forms of structured inquiry. The DHET (2010) reported:

“This suggests that the level of staff qualification across the sector as a whole is generally low (the reason for this being again related to the history of teacher education and the process of its incorporation into universities) and in need of urgent attention at a number of institutions”.

HEQC (2010) in the National Review of B.Ed. degrees offered in South African Higher Education Institution reported that: ‘the B.Ed. is deemed to be the training of efficient classroom practitioners’.

Analysis of the guidelines provided by the CHE for aligning curricula and programmes for teacher qualification identified similarities between regulations in the NSE (2000) and those in the MRTEQ (2015). The chief difference was the explicit differentiation indicated in the knowledge matrix and the exit outcomes enshrined in the roles. The main emphasis remains on integration of learning which needs to be manifested in the knowledge mix in the programme.

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 (Gao et al 1994, Department of Education and training 1997). Gao et al, 1994 asserted that there are various approaches to knowledge integration and integrated learning and 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 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; Gravetteeee & 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.

Literature shows that integration of knowledge into a curriculum manifests some of the following images. The first group of models depicts integration of knowledge within a single discipline. Integration could take any of the following forms: fragmented models, connected models and nested models (Sharma, 2017; Zarry, 2012).

II. Methodology

The case study research design was used for collecting data through in-depth interviews and curriculum design and development analysis documents (Kumar, 2005; Cohen, Manion and Morrison, 2010). The purpose of the choice of this methodology was to gain insight into how science teacher educators in sampled institution interpreted the principle of multidisciplinary, interdisciplinary and trans disciplinary concepts required in unpacking the principle of knowledge integration in their process of curriculum design (Babbie, 2002; Henning et al, 2004). Three natural sciences teacher educators who were involved in the process of re-curriculation of natural sciences curriculum were purposively selected as participants in the empirical study (Henning et al, 2004). The results obtained from the undertaken study were used a springboard to launch the study nationally.

Permission was sought from the university’ gate keepers as well as interviewees to collect data through in-depth interviews as well as requesting documents that were used for the re-curriculation of natural Sciences teacher education. Participants were informed of their right to confidentiality and pseudonyms were used instead of using their names (Cohen, Manion and Morrison, 2010; Kumar, 2005). Transcripts developed from interviews were used for open coding and themes were generated from codes and categories for data analysis purposes.

The analysis of the following documents was also carried out: (i) Templates outlining proposed scope of content for natural Sciences curriculum, (ii) proposed natural Science course outlines for all year levels in the Bachelor of Education qualification informed by MRTEQ policy were requested. Data collected by means of document analysis was therefore used to triangulate information collected by in-depth interviews (Cohen, Manion and Morrison, 2010).

III. Discussion of Results

Institution Q: brief historical background about the institution. This institution received the status of a university after the former white technikon which offered teacher education and training merged with two historical colleges of teacher education and training in
the province. It was thereafter called, a university of technology. The implication of amalgamation of these institutions was the sharing of physical and academic resources by individuals who could have diverse perspectives of philosophical foundations of educations and theories underpinning curriculum. This information was important in this study, for providing the historical context to the data collected from this institution.

a) Participants’ views and perceptions of integration of science disciplines

Participant: D

Life Sciences discipline is a basket science because we draw from different disciplines and sub-disciplines. It is a philosophy-driven subject. Taking a bit from different disciplines makes the subject unique and currently, social sciences play a pivotal role in science teaching (social sciences, social justice, language and philosophy) feeding in the teaching of science hoping to get credible, viable, products that will enrich somebody as well as me, as a teacher educator. Science is not factual and as such there are so many disciplines acknowledged in the sciences. Life Sciences is not exactly like other sciences … Social aspects are taken into consideration and acknowledging these aspects within the discipline adds value to the uniqueness in Life Sciences. There is quite a lot that is feeding into Life Sciences to make it an integrated discipline.

b) Participant C responses on knowledge integration follows

This implies that knowledge will be diluted to accommodate disciplines that are clustered to form a multi-disciplinary subject or a broad-field subject which has been formed through knowledge integration. The teaching of Life Sciences content knowledge in themes would help student to understand that knowledge of Life Sciences can be integrated. For instance, themes from Chemistry and Botany can be clustered to enable students to understand connections or integration. It is in that sense that I view the implementation of integration. Inquiry methods such as experiments or research are also suitable for integrating knowledge across sub-disciplines in Life Science Education. This is my view.

c) Participant H response to the key question was

I will first point to the issue of contestation being the main thing that overwhelmed discussions about what content? And how delivery will be made? The issue of ideological beliefs and theoretical principles took a long time to resolve, particularly because of the divergence in the views informed by our backgrounds. Really, I would say, in this regards that the unanimous conceptualisation of curriculum held during discussions appears to have been ignored in what is in the document. The curriculum officer who was an overseer of the process had dominant influence on the product.

The curriculum model, I would say is more of a fragmented modularised content knowledge which disregards the original draft wherein the thematic-approach was preferred.

Probing question

d) Participants H response to the key question

My response to this question will be more of the repetition of some of the things I have already said, however, I can say content supersedes the pedagogy. Students do require intensive knowledge of the disciplinary knowledge.

Time constraints is also an issue, big classes for laboratory work make it difficult to assist students who are challenged. In my view, such challenges have an effect on training a successful science teacher. Another challenge is that students who want to teach Life Sciences do not understand the academic content offered at the university. Some of them have not done some of the [central] themes of disciplinary knowledge. For example, not all students enrolled for Life Sciences teaching have done Physics and Chemistry.

The data from documentation for case studies [D], the merged institution, did not indicate the strategies of curriculum delivery. The course guide provided a list of assessment methods which were: group discussion, oral presentation and assignment, examinations and test. Documentation from case study [D] mentioned, self-discovery, problem solving and group discussion as methods.

This category embraces the thematic approach as a means of showing interconnections and interrelatedness in selection and organisation of academic content knowledge for Life Sciences teaching in schools. A thematic approach focuses on the vertical articulation of knowledge from basic, simple conceptual and theoretical knowledge to complex and advanced knowledge.

Perceptions of knowledge integration were identified with views linked to teaching across disciplinary knowledge integration in curriculum design and development. The data, in curriculum blue prints reflect the maintenance of heterogeneity in specialized knowledge domains for acquisition of in-depth knowledge in Life Sciences. This implies that academics in the department of Science Education construed integration of knowledge to imply mixing topics (themes) form different specialized disciplines in Science Education. The scenario presented in the curriculum document for science education indicates the mixture of themes and topics taught to students in the school to enable them to teach Life Science competently in Further Education and Training phase.

Data classified under this category indicate that academics who shared this pattern of thought understood at least the importance of aligning the curriculum for preparing Life Sciences teachers with the
needs of students, the expectations of the work place and the national Life Sciences curriculum for schools called (CAPS) although their distrust of integration was a concern.

Finding: Learning outcomes identified from the curriculum documents presented learning outcomes as assessment criteria: for example, ‘after completion of this module, students will be able ‘to’, ‘or ‘describe the characteristics/discuss the structure and functions of’... etc.

Implication: The finding manifested that non-alignment of learning outcomes and content as well as assessment criteria has negative implications for implementing the curriculum. The discrepancy noticed in other curriculum documents was the omission of assessment criteria or the fact that only assessment methods were highlighted.

Finding: The first item that was highlighted by the data was the fragmentation of subject content into discrete realities. There is a possibility that students are not able to link the concepts with conceptual knowledge acquired from subject content which is taught on a quarterly basis.

Implication: The organisation of knowledge in this case could create the impression, to students, that these disciplines are distinct or taught in silos.

Finding: Data highlighted that academics represented in this view in the sample were resisting the international trend in knowledge production which proposed a shift from heterogeneous subject content knowledge to hybridisation of knowledge from various related disciplines (Gao, 1994 and Fogarty, 1991).

The implications: This pattern of thought appeared to be negative towards adoption of such international trends in knowledge production was not held by the overwhelming majority of participants in the sample. In this study such a reactionary, retrogressive trend is concerning: all academics should provide Life Sciences teacher trainees with knowledge that enables them to implement changes and meet the objectives of the espoused curriculum. Contestations about knowledge organisation and selection of subject content knowledge in the curriculum for Life Science education and training are viewed in this study as detrimental to the production of competent Life Sciences teachers in South Africa.

Finding: Semester courses, modularisation and thematic approaches identified from data and indicated a positive inclination towards knowledge integration which emphasised modularisation of themes across disciplines in the broad field of Life Sciences: Geography, Physical Science, Chemistry and Life Sciences such as observed in the plant kingdom and animal kingdom. Participants who shared this view highlighted in their responses that themes should be organised on a semester basis to enable students to navigate through related themes from a subject’s knowledge.

The data associated with this pattern of thought points out challenges encountered by students teaching broad knowledge of Science at schools. Such challenges informed the design and development of the Life Sciences curriculum in the reviewed program. Consideration of the need for infusion of topics into the reviewed curriculum came into being because there were gaps in student knowledge.

Finding: According to this view, the product that resulted from the process of the Review of Life Sciences did not introduce any substantial changes.

Implication: This implies that the Curriculum Review for preparing Life Sciences teachers was just ‘pouring an old wine into a new glass’. This shows that recommended attributes of a competent Life Sciences teacher, as promulgated in the policy for minimum requirements for teacher education qualification (MRTEQ), were ignored.

Data point to contrasts that surfaced from utterances that appeared to be in support of this perception.

The way I see it, we are taking the field of Science as integrated knowledge but at the same time we look at the learners as a homogenous group. There are areas where you need a person to focus on one discipline; particularly a specialist in a certain area of Life Sciences.

Finding: Lack of interrelations between the description of the core subject content and learning outcomes was considered as a matter of great concern. However, the topics, as presented, manifested vertical articulation as recommended by Bruner’s spiral model.

Implication: Learning of linear topics, according to Killen (2003:90), does not add value in the acquisition of integrated knowledge. Killen (ibid.) states that: “packing the curriculum with many topics results in superficial understanding for many students”.

From the curriculum templates approved by CHE for the university curriculum that is being stated as institution Q, documents document revealed the same views and mind-sets unearthed from the interviewees. The organisation of topics or themes in this case indicates adherence to the notion of content-driven curriculum. The sequential list of the scope in the form of topics points to the vertical articulation of learning progression in the faculty of Education (Science Education). The scope of work displayed in the curriculum document shows that topics are aligned with specialized disciplinary knowledge in Life Science for example, Chemistry, Biochemistry, Zoology and Botany.
IV. Conclusions

This study arguably suggest that the interim solution to problems pointed out that the institution could come up with an interim programme which covers different levels such as; life sciences for natural science; physics for natural sciences and have physics for physics major (FET).

In curriculum studies there is not much provided for integration of knowledge in this situation and such curriculum is viewed as being erratic (now and then one stumbles on a concept that originate from a sub-discipline) and yet there is no room to cater for it. A subject specialist within a sub-discipline just alerts students as and when a cross cutting concept is used, though a huge need for team work was viewed as necessary.

In this institution the faculty of education offers a variety of disciplines, to some extent, but with the new curriculum the choices are a bit streamlined. There is no room for diversity of disciplines especially in the conceptualisation of sub-disciplines. Integration of knowledge if properly addressed could benefit the program because the demand out there is looking for specialists and yet attracting more teachers who can be competent in other sub-disciplines forming sub-disciplines of multidisciplinary subjects is seen as being important. Content caters for everything but in terms of curriculum developed from MRTEQ, there are limitations of for FET phases (still to be researched in depth). Therefore, work places are looking for people who are well rounded. Hence, this study suggested the importance of multiple stakeholders’ involvement in unpacking the policy for curriculum design and development in order to share their convergent and divergent perspectives of who the envisaged teachers should be that would measure to required 21st century educators endowed with skills to adequately teach school sciences curriculum as a conglomerate of integrated disciplines and as such be equipped to teach sciences across disciplinary boundaries.

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