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Exploring the Alignment of the Intended and Implemented Curriculum Through Teachers' Interpretation: A Case Study of A-Level Biology Practical Work

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ABSTRACT
The research reported on here is part of a larger study exploring the alignment of the intended, implemented and attained curriculum with regard to practical work in the Zimbabwean A-level Biology curriculum. In this paper we focus on the alignment between the intended and implemented A-Level Biology curriculum through the lens of teachers' interpretation of the curriculum. This interpretive study sought to understand how teachers interpret a particular curriculum design. Participants were five teachers drawn from four High schools in Zimbabwe. The findings show a misalignment between the intended and implemented curriculum caused by teachers' misinterpretation of the intended curriculum. Teachers lacked knowledge of Science Process Skills and could not interpret them from the curriculum documents. They interpreted the curriculum through the examinations and were reluctant to engage with the curriculum in order to understand the objectives for practical work. The poor design of the curriculum contributed to this reluctance. This misalignment has implications for curriculum design and implementation.
Keywords: curriculum alignment, intended curriculum, practical work, science process skills

INTRODUCTION

An aspect of education that has received attention from numerous authors internationally is that of the relationship between different levels of a curriculum. Kuiper, Folmer and Ottevanger (2013) and van den Akker (2003; 2010) recognise that curriculum is influenced at different organisational levels of society. At government level (macro-level), political and administrative decisions about the curriculum are made; at school and classroom level (meso-level), the implementation of the curriculum is executed and at learner level (micro-level), the impact of the curriculum is viewed through the output (NRC, 2004; Thijs & van den Akker, 2009; van den Akker, 2003). Decisions about educational goals are made at each level and

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State of the literature

- The establishment of curriculum levels assists in and contributes towards an understanding of the necessity to coordinate the different curriculum domains, leading to an alignment of the intended, implemented and attained curriculum.
- The intended curriculum consists of the ideal and the formal curriculum where the ideal curriculum constitutes the original ideas of the curriculum developers. When these ideas are encapsulated in a formal document it constitutes the formal curriculum.
- The implemented curriculum consists of two domains; the perceived curriculum which refers to the interpretation of the users of the curriculum who are the main actors- the teachers. The actual instructional process is regarded as the operational curriculum. Misalignment between the intended and implemented curriculum may exist as gaps occur between the expectations of the curriculum designers and what happens in the classroom.

Contribution of this paper to the literature

- In this study a misalignment exists between the ideal and certain aspects of the formal curriculum.
- Teachers choose to consult only limited parts of the intended curriculum which results in a perceived curriculum which does not reflect the intention of the curriculum designers.
- Within the context of biology practical work this means an inability by teachers to identify the Science Process Skills learners are expected to develop in A-Level Biology.

different actors are involved (van den Akker, 2003). Different stakeholders at different levels tend to influence the way the curriculum should be viewed at that particular level and this difference between different levels of the curriculum has an important bearing on teaching. As with all other subjects, the quality of Science Education depends on a strong relationship between the vision of the curriculum developers and the consumers of the education system (NRC, 2004). However, findings of research in Science and Mathematics Education show that there is significant difference between the intended, perceived, and implemented curriculum at both primary and secondary level (Levitt, 2001; Smith & Southerland, 2007).

A number of researchers concur that conceptualising the curriculum as consisting of different levels, helps in the analysis and understanding of the coordination between the different curricular domains (Goodlad, Klein & Tye, 1979; Thijs & van den Akker, 2009; Treagust, 2004; van den Akker, 2003; 2010), which in turn can shape the teaching and learning of the curriculum. These domains are named differently by different researchers, depending on the way each domain is perceived (Goodlad, Klein & Tye, 1979; Kuiper, Folmer & Ottevanger, 2013). Thijs and van den Akker (2009) and van den Akker (2003) regard the levels of curriculum as intended (curriculum plans at the macro-level), implemented (meso-level, consisting of the content, time allocations, instructional strategies for teaching and learning to take place) and attained curriculum (micro-level, consisting of competencies and attitudes learners demonstrate as the result of teaching and learning process). Aikenhead (2006) views curriculum as that plan of activities that prescribes what will happen in schools (intended curriculum) and regards the actual instructional practice as the implemented curriculum. Mills and Treagust (2003) recognise the intended, implemented and the achieved curriculum and regard the perceived curriculum as a level between the implemented and the achieved curriculum. Decisions about the educational goals are made at each level and different actors are involved (van den Akker, 2003).

The intended curriculum is determined by the educational organisational system (macro level) of many countries in the world (van den Akker, 2003; 2010). It usually includes goals and expectations set by the curriculum policy makers and curriculum developers along with textbooks, official syllabi or curriculum standards set by a particular nation or organisation (Kuiper, Folmer, & Ottevanger, 2013; NRC, 2004; van den Akker, 2003). The intended curriculum comes in two important forms, namely the ideal and the formal curricula. The ideal curriculum, also known as the ideological domain constitutes the original ideas of the curriculum developers (Goodlad et al, 1979; Thijs & van den Akker, 2009; van den Akker, 2003). It considers the convictions and values of content experts outside the school system (van den Akker, 2003). When the ideas of the developers are written down to produce a document or converted into curriculum materials, that constitutes the formal curriculum. The domain of the formal curriculum is represented by documents that have been developed inside the school system, for example syllabi, practical guides which are officially approved by the curriculum coordinator or any government agent (van den Akker, 2003; 2010). In the process of converting the ideals of the developers into the formal curriculum, there is a chance of distorting the curriculum as language can change the original ideas of the developers. The danger is that the assessment of learners may occur against a curriculum which was never implemented due to the distortion originating from the curriculum developers themselves (van den Akker & Voogt, 1994).

The implemented curriculum which is enacted at the school level (meso-level) comprises of content, instructional strategies and time allocations which are meant to guide teachers with regard to the way the intended curriculum should be put into practice. For Goodlad, Klein and Tye (1979), Thijs and van den Akker (2009) and van den Akker (2003), the implemented curriculum is viewed in two forms, namely the perceived curriculum which refers to the interpretation of the users of the curriculum who are the main actors- the teachers. The perceived curriculum takes into account the philosophy of the teacher, the lesson plans, schemes of work, the interpretation of what should be taught in the classroom (Goodlad, Klein & Tye, 1979; van den Akker, 2003). The actual instructional process is regarded as the operational curriculum (Kuiper, Folmer & Ottevanger, 2013; van den Akker, 2003). It considers the expertise of the teachers in interpreting the ideas of the developers and putting them into practice, as well as being able to change the thinking of the learner.

The attained curriculum which is also regarded as the experiential curriculum refers to the reactions and outcomes of the learners after receiving instruction (Thijs & van den Akker, 2009; van den Akker, 2003; 2010). The interactive process between the learner and the learning materials, compounded by the teacher interactions contribute to the output of instruction and translates into how learning is achieved (Ennis, 1990).

Curriculum implementation may be fraught with problems as it may not occur as intended and it reflects loopholes which create a gap between the expectations of the designers of the curriculum and what really takes place within the classroom (Thijs & van den Akker, 2009; van den Akker, 2003). Curriculum developers assume that their 'good' curriculum will be interpreted and implemented in line with their expectations. This notion ignores the role of other players in the curriculum implementation process. Stenhouse (1979) underlines the need for an agent for the curriculum implementation process and identifies the teacher as the key agent for curriculum implementation. It is therefore imperative that teachers understand the curriculum requirements as clearly as possible in order for them to correctly implement the curriculum as intended.

The challenges faced by curriculum planners and those faced with the implementation process are different. This creates the possibility of a gap developing between the intended and implemented curriculum (Sethole, 2004). Rogan (2004) has referred to this incongruence as a "mismatch between expectation and reality" (p176) and Jansen (2001) quoted an example as a deviation from the original policy. These researchers agree that what is articulated by the policy documents on curriculum and what happens during the implementation process may be quite dissimilar. Distortions of the intended curriculum at different organisational levels have a resultant effect on the learner. The coherence between the intended, implemented and the attained curriculum is important as it determines the kind of product the teaching and learning process yields.

In this study our aim was to explore the alignment between the intended and implemented curriculum with regard to the teaching of Science Process Skills (SPS). The learning of Science involves the acquisition of SPS. Literature has demonstrated that SPS cut across disciplines (Chiappetta & Adams, 2004). The teaching of SPS along with other disciplines has produced significant effects on concept development within various disciplines (Chiappetta & Adams, 2004; Rambuda & Fraser, 2004). Lumbantobing (2004) has found that teaching SPS enhances problem solving skills. Donmez and Azizoglu (2010) have shown that teaching SPS is strongly linked to the transition from one level of cognitive development to the next. That the development of scientific processes simultaneously promotes reading processes is a notion advocated by Harlen and Gardner (2010) who further posit that science processes have an important role in the development of skills of communicating, critical thinking, problem solving as well as the ability to use and evaluate evidence. Therefore, learners' competencies in SPS enable them to learn with understanding and Harlen and Gardner (2010) view this as achievable if a linkage is established between the new experiences and the previous ones and extending these ideas to other related areas. Harlen (1999) further alludes to the fact that poor SPS development may impede the understanding of the world around us.

Research has also established that by learning SPS learners develop critical and creative thinking as they will be able to make decisions and apply the process skills in other disciplines (Meador, 2003; Halim & Meerah, 2012). For Sevilay (2011) learners develop a sense of responsibility as they take control of their own learning. Opateye (2012) posits that process skills will foster the development of positive scientific attitudes. Our views also concur with those of Ogunniyi and Mikalsen (2004) who indeed suggest that the understanding of scientific concepts heavily rely on the application of SPS in order to bring about the essence of the phenomenon. The understanding of the natural world requires a strong craftsmanship in the process skills as these will guarantee that conclusions drawn about a given phenomenon are authentic as they are verifiable, giving results that are either contrary to the established knowledge or in line with what is already known. A similar view is shared by Harlen and Gardner (2010) who also emphasises the role of SPS in practical work as measures of verifying scientific facts which helps to understand the world in a better way.

The idea of using SPS in the teaching and learning of Science is to establish a strong linkage between the two domains of knowledge, namely the domain of objects and observables and domain of ideas. This, as Millar (2004) notes, helps learners to understand and explain the world around them. Bilgin (2006) supports the idea that the learning of SPS helps learners in deriving the meaning of phenomena through their capacity to interpret the data generated through the realisation of the scientific processes. Sevilay (2011) posits that SPS equip learners with tools for understanding content knowledge.

Purpose of the study

The purpose of this study was to investigate the alignment of the intended and implemented curriculum by exploring the way teachers interact with the intended curriculum in A-Level Biology in Zimbabwe with regard to practical work. As mentioned above, the aspects of practical work that were focused on are Science Process Skills (SPS). The questions that drove the research are:

- What does the intended curriculum stipulate with regard to the acquisition of Science Process Skills in A-Level Biology practical work?

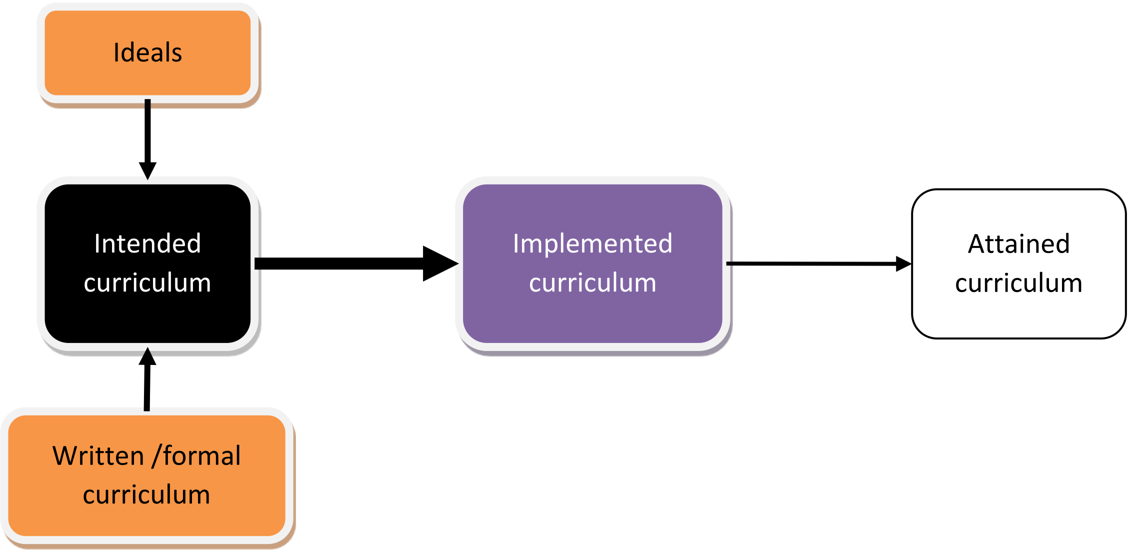

Figure 1. Model of curriculum alignment (Taken from van den Akker, Fasoglio and Mulder (2010)

- How do teachers interpret the intended curriculum with regard to Science Process Skills in A-Level Biology practical work?

Framework

Elements of curriculum alignment as perceived by van den Akker and Voogt (1994) were adopted as a conceptual framework for this study. These are the intended, implemented and the attained curriculum. Van den Akker, Fasoglio and Mulder (2010) recognise the different levels of the curriculum and view the alignment of these curriculum levels as the basis for the successful achievement of the goals for the curriculum. **Figure 1** shows the ideal arrangement of the different levels of curriculum.

The intended curriculum is influenced by both the ideals designers may have and the written curriculum. The intended curriculum should align with the implemented curriculum in order to achieve the goals of the curriculum through the attained curriculum. As mentioned before, in this study we focus on the alignment between the intended and implemented curriculum. For a better understanding of how the curriculum is interpreted with regard to practical work it was necessary to consider the SPS as defined by Padilla (1990). Padilla categorises SPS as basic and integrated SPS. A similar view of the categories of the SPS is shared by Coil et al (2010).

Figure 2 shows the categories of SPS. Padilla (1990) viewed basic SPS as those simple SPS which form the foundation for studying more complex SPS (integrated). The basic SPS are implied in the integrated (complex) SPS. This is supported by Rezba et al. (2007). A good

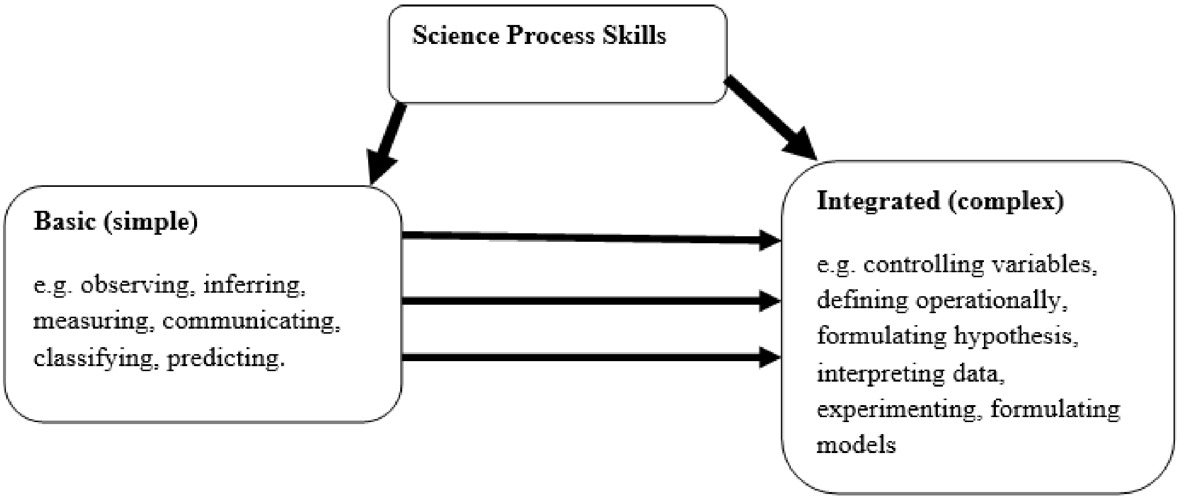

Figure 2. Categories of SPS (Padilla, 1990; Coil et al (2010)

foundation in the basic SPS therefore makes the acquisition of integrated SPS easier for learners.

METHODOLOGY

This study is located within an interpretive paradigm as the purpose was to understand the alignment of the intended and implemented curriculum. In this research, we used a qualitative research approach to understand the intentions of the curriculum developers with respect to A-level Biology practical work. This understanding of the demands of the curriculum developers enabled us to establish connections with the way in which the curriculum is interpreted by the teachers. However, there were cases where the results were summarised and presented quantitatively.

Five teachers from four purposefully selected high schools in Zimbabwe participated in this case study of the Zimbabwean A-Level Biology Curriculum with particular focus on SPS. The choice of five teachers is appropriate for a case study and is regarded as a suitable number by experts in case study design, such as Yin (2003). The intention of the study was to understand how teachers interpreted the A-Level Biology Curriculum with respect to practical work. Teachers were therefore selected on the basis that they were teaching A-Level Biology in the selected schools. This purposeful selection of teachers was done to ensure that appropriate data were gathered which would facilitate our understanding of how teachers understood the curriculum with respect to practical work from the intended curriculum.

An analysis of the curriculum documents was conducted to understand the demands of the A-level curriculum for biology practical work. These included the curriculum statement in the form of the national syllabus for A-Level Biology and the national examination papers for A-Level practical work in Biology for the years 2010-2013, as well as analysis of the curriculum policy. The content analysis of the A-Level Biology curriculum and the national examination papers helped in the understanding of the kind of SPS curriculum developers envisioned as essential for A-level Biology. Padilla's (1990) categories of Science Process Skills were used to identify the types of SPS mentioned in the curriculum documents. This served as a benchmark against which the teachers' interpretations were measured. These documents provided an insight into what the intended curriculum expected for practical work in Biology. The data gathered enabled us to answer the first research question.

An analysis of the teachers' workbooks was conducted in order to understand more about how teachers interpret the intended curriculum with respect to practical work. Teachers were subsequently asked to complete a questionnaire and were interviewed afterwards.

The questionnaire solicited teachers' interpretation of the practical work objectives as enshrined in the curriculum document. In the questionnaire teachers were presented with an extract from the curriculum document for A-Level Biology. This extract included the objectives for practical work for each of the themes in A-Level Biology as well as the associated SPS for each theme. Each teacher was requested to indicate which activities they would plan for their learners to achieve the stated objectives. A pilot study was conducted with participants from a school that did not participate in the research. The purpose was to be able to identify shortcomings of the questionnaire before it could be applied to the actual participants of the research. The questionnaire was approved by the University Ethics Committee which approved by providing an ethical clearance certificate with a protocol reference number HSS/1284/013D.

The interview focused on the way teachers interpreted the curriculum objectives on practical work. We had a thorough discussion of the items included in the interview schedule so as to ascertain the data we wanted to generate with the use of the interview. Again, the coding scheme was derived from Padilla's (1990) categories of Science Process Skills. The data obtained through these three sources enabled us to obtain insight into how teachers interpreted the curriculum with respect to practical work and helped in answering the second research question.

FINDINGS

The Advanced Level Biology (9190) Curriculum assumes that candidates taking this course have some background in Biology obtained from O-Level Biology studies. The curriculum emphasises a practical and contextual approach with regard to the teaching and learning of biological concepts and processes. Besides the basic SPS the curriculum includes the learning of integrated SPS in pursuing the fulfillment of the requirements of the course (ZIMSEC, 2008-2012; 2013-2015). However, these SPS are not stated explicitly, but are implied within the curriculum and teachers are expected to identify them as they study the curriculum documents.

The A-Level curriculum is a continuation of the work that was covered at O-level. The learnt SPS at O-level are further developed and more complex SPS become prevalent in the A-Level Biology curriculum. The curriculum is comprised of six aims. The aims provide a broad description of the intentions of the curriculum developers with regard to what learners of A-Level Biology should achieve. Implicit in the aims are the objectives with regard to practical work. While all the six general aims have practical work implicit in them, there are no specific objectives that address the specific aims for practical work. It is therefore left to the teacher to interpret and think about how best he/she can address the practical work component implicit in the general aims of the curriculum. **Table 1** shows a summary of the advanced level Biology Curriculum (9190).

The objectives for practical work in A-Level Biology are a continuation of the objectives for practical work in the O-level curriculum. A-level practical work emphasises both the integrated and basic SPS. More integrated SPS such as experimenting, controlling variables, formulating hypothesis, formulating models and defining operationally are quite prominent in this curriculum whereas in the O-level curriculum emphasis is placed on the basic SPS such as observing, measuring, predicting and communicating. The objectives demand both the hands-on and minds-on activities. The underlying intentions of the A-Level Biology Curriculum is that the learning of Biology should be viewed as taking place through transitional stages based on the cognitive development of the learner. Recognition of the transitional stages of the biology curriculum has an important bearing on the nurturing of the learners' practical skills development in A-Level Biology.

The first three columns in **Table 1** are extracts from the A-level Curriculum, while the fourth shaded column is our summary of SPS embedded in the text of columns one to three.

Although the curriculum emphasises the teaching of Biology using a practical work approach, it does not clearly indicate the extent to which practical work should feature in the curriculum. The A-Level Biology curriculum has no suggested practical activities or equipment and materials for practical work. The curriculum just gives an outline of the expectations of the curriculum designers in the form of an objective or aim. It is the responsibility of the teacher to make the necessary interpretation of the curriculum and find ways by which they can meet the objectives of the curriculum.

The practical examinations are regarded as part of the intended curriculum as the examiner follows the curriculum requirements closely when setting practical examinations. Practical work is examined as a component of the final examination with duration of two and half hours. Candidates are expected to answer three compulsory questions which involve knowledge of Biochemistry, Physiology and biological processes. The total mark for this paper

Table 1. Summary of the Advanced Level Biology Curriculum (9190)

General Aims for A-Level Biology	General objectives for handling information and solving problems	General objectives for experimental skills (practical work)	Science process skills(SPS) implied
1. Provide a basis for further studies in Biological Sciences and other related professional and vocational courses. 2. Develop abilities and skills that enable students to solve day to day problems and become confident in a technological world. 3. Develop an awareness of the diversity of life, global environment and understand the need for conservation and its relevance to society. 4. Stimulate the desire for research in Biological Sciences and related areas to solve societal problems. 5. Appreciate the beneficial and detrimental aspects of the applications of Biology to society. 6. Promote an awareness of the use of information technology (IT) for communication as an aid to Biological research.	1. Locate, select, organise and present information from a variety of sources; 2. Translate information from one form to another; 3. Manipulate numerical and other data; 4. Use information to identify patterns, report trends and draw inferences; 5. Present reasoned explanation for phenomena, patterns and relationships; 6. Make predictions and propose hypotheses; 7. Apply knowledge, including principles, to novel situations; 8. Solve problems.	1. Follow a sequence of instruction; 2. Use techniques, apparatus and materials; 3. Make and record observations, measurements and estimates; 4. Interpret and evaluate observations and experimental data; 5. Devise and plan investigations, select techniques, apparatus and materials; 6. Evaluate methods and techniques, and suggest possible improvements.	Observing Predicting Measuring Classifying Inferring (basic) Controlling variables Defining operationally Formulating hypothesis Interpreting data Experimenting Formulating models (integrated)

Table 2. SPS in Practical Examination Questions for four consecutive years

SPS in 2013 examination	%	SPS in 2012 examination	%	SPS in 2011 examination	%	SPS in 2010 examination	%
Observing	24	Observing	22	Observing	24	Observing	23
Communicating	24	Communicating	24	Communicating	24	Communicating	26
Measurement	20	measuring	22	Measuring	23	Measuring	22
Predicting	10	Predicting	5	Predicting	6	Predicting	7
Inferring	10	Inferring	13	Inferring	11	Inferring	10
Experimenting	6	Experimenting	5	Experimenting	4	Experimenting	4
Controlling variables	2	Controlling variables	3	Controlling variables	3	Controlling variables	4
Defining operationally	2	Defining operationally	2	Defining operationally	3	Defining operationally	3
Formulating hypothesis	2	Formulating hypothesis	2	Formulating hypothesis	1	Formulating hypothesis	1
Total	100	**Total**	100	**Total**	100	**Total**	100

is 60 and the weighted average for this examination is 20%. The distribution of marks throughout the paper varies from year to year. The allocation of time per question also varies from year to year following the expected demands of the questions. The examination is offered both in June and November of each academic year.

The questions are designed in the form of instructional procedures which candidates need to read, understand and follow so as to achieve the expected results. Therefore, various SPS are required to undertake the tasks given in the examination. Process skills range from basic SPS to integrated SPS. The questions have blank spaces in which the candidate is expected to fill in answers based on the results of the experimental procedure. The mark next to the question informs the candidate of the value given to the question (ZIMSEC report, 2013; 2012; 2011; 2010).

The examinations which should depict the intentions of the curriculum designers with regards to SPS tend to emphasise basic SPS more. Less emphasis is placed on integrated SPS. In many of the A-Level Biology content topics the curriculum has practical skills implied in the general content outlines (ZIMSEC, 2013-2015). The ideal scenario is that the implied skills, if identified by the teacher may be achieved through a variety of activities ranging from those that target the development of manipulative skills, improving understanding of a scientific phenomenon, development of scientific inquiry and those that target the development of transferable skills (Godding, Smith, Patterson & Perry, 2013). Implicit in these practical activities are a whole range of SPS (basic and integrated) which learners are expected to use when carrying out practical work in the light of Padilla's (1990) categories of SPS. The intention is that the teacher should interpret the practical activities embedded in the curriculum in order to guarantee that learners acquire the expected practical skills initially intended by the curriculum designers.

Table 2 shows the distribution of SPS in practical work examinations over four years. From the table, it can be deduced that the examinations place much emphasis on basic SPS and draw very little attention to the integrated SPS. However, in the A-Level curriculum as given in the syllabus there is emphasis on integrated SPS. The examination papers therefore tend to suggest to teachers that basic science process skills are more important than the integrated.

The objectives for practical work in the A-Level Curriculum are implied in the various content topics but are not explicit. The curriculum assumes that teachers are competent enough to interpret the intentions of the curriculum designers; hence teachers are expected to extract the objectives and activities for practical work from the outlined curriculum content. Generally, the intended curriculum for A-Level Biology pays sufficient attention to SPS as embedded in the objectives. However, while the objectives are clear, the embedded SPS are

Table 3. Interpretation of objectives for A-Level Biology practical work on cell structure and function with regard to practical work

Theme: Cell structure and function		
Objectives	**Assumed associated SPS to be learnt**	**Activities teachers would use in practical lessons**
1. Use a graticule and stage micrometer to measure cells. 2. Draw plan diagrams of tissues (including a transverse section of a dicotyledonous leaf) and calculate the linear magnification of drawings 3. Investigate the effects on plant cells of immersion in solutions of different water potentials.	1. Observing 2. Measuring 3. Inferring 4. Communicating 5. Manipulation of different instruments such as microscopes, hand lens, 6. Experimenting 7. Predicting. 8. Controlling variables 9. Defining operationally.	*1. Activities from past examinations papers in order to carry out demonstrations on cells.* *2. Learners work in groups in carrying out measurements using a microscope, making and recording observations of the biological specimens.* *3. Teacher directed scientific investigations to drive practical lessons(osmosis).*

Table 4. Interpretation of objectives for A-Level Biology practical work on biological molecules and water with regard to practical work

Theme: Biological molecules and water		
Objectives	**Assumed associated SPS to be learnt**	**Activities teachers would use in practical lessons**
1. Carry out tests for reducing and non-reducing sugars (including quantitative use of the Benedict's test,), the iodine in potassium iodide solution test for starch, the emulsion test for lipids, and the biuret test for proteins.	1. Observing 2. Measuring 3. Inferring 4. Communicating 5. Manipulation of different instruments and equipment. 6. Experimenting. 7. Predicting. 8. Controlling variables. 9. Defining operationally. 10. Formulating hypothesis.	*1. Activities from both the past examination papers and the textbook for doing practical activities.* *2. Teacher directed investigations (biochemical reactions)* *3. Teacher directed scientific investigations to drive practical lessons on food tests.* *4. Worksheets extracted from the past examination papers for experimental activities.*

less so. The examiners appear to have interpreted the formal curriculum in such a way that basic SPS are given preference over integrated SPS.

Interpretation of the practical work objectives by teachers

Findings on how teachers interpreted the curriculum with respect to practical work were derived from the questionnaire and teachers' work books as well as interviews. As teachers responded to the questionnaire they demonstrated their interpretation of the curriculum with respect to practical work. This was consolidated through the analysis of the teachers' workbook which indicated how the teachers understood the curriculum through their planning of practical work activities. **Tables 3 to 6** present a summary of the teacher's interpretations of where practical work could be conducted with regard to the four curriculum themes. **Table 3** presents the findings for the topic *Cell structure and function,* **Table 4** presents findings on *Biological molecules and water*, **Table 5** presents findings on *Enzymes* whilst **Table 6** presents findings on *Energetics.* Teachers' interpretations are indicated in the shaded columns.

Teachers' indication of their choice of activities gave us an indication of the way they interpreted the curriculum.

Table 5. Interpretation of objectives for A-Level Biology practical work on enzymes with regard to practical work

Theme: Enzymes		
Objectives	**Assumed associated SPS to be learnt**	**Activities teachers would use in practical lessons**
1. Follow the time course of an enzyme-catalysed reaction, by measuring rates of formation of products (for example using catalase) or rate of disappearance of substrate (for example using amylase); 2. Investigate and explain the effects of temperature, pH, enzyme concentration and substrate concentration on the rate of enzyme catalysed reactions, and explain these effects.	1. Observing 2. Measuring 3. Inferring 4. Communicating 5. Manipulation of different instruments, equipment and apparatus. 6. Experimenting 7. Predicting. 8. Controlling variables 9. Defining operationally.	*1. Demonstrations as per past examinations papers on time course of enzyme catalysed reaction.* *2. Theory work* *3. Experiments on enzyme catalysed reactions.* *4. Activities from both the past examination papers and the textbook for enzymes catalysed reactions.* *5. Teacher directed investigations(enzymes).*

Table 6. Interpretation of objectives for A-Level Biology practical work on energetics with regard to practical work

Theme: Energetics		
Objectives	**Assumed associated SPS to be learnt**	**Activities**
1. Carry out investigations on the effects of limiting factors, such as light intensity, CO2 concentration and temperature on the rate of photosynthesis; 2. Carry out investigations on the effect of temperature on respiration rate, using simple respirometers to measure RQ.	1. Observing 2. Measuring 3. Inferring 4. Communicating 5. Manipulation of different instruments, equipment and apparatus. 6. Experimenting 7. Predicting. 8. Controlling variables 9. Defining operationally 10. formulating hypothesis.	*1. Demonstrations based on past examinations papers for practical work.* *2. Experiments and group reports on photosynthesis* *3. Practical activities derived from both the past examination papers and the textbooks experiments in photosynthesis.* *4. Teacher directed investigations(enzymes)* *5. Use demonstrations when doing practical work with the use of past examination papers.* *6. Teacher directed scientific investigations on energetic experiments.*

Despite the fact that the extract from the curriculum had 12 core topics for A-Level Biology, all five teachers indicated that only the four topics mentioned above provided the possibility for practical work. For the teachers, practical work was confined to the four mentioned topics of the syllabus. In their schemes of work, they only derived activities for the four topics of the syllabus. For the teachers, the rest of the syllabus topics did not involve any practical work, hence no SPS could be achieved in those topics.

Teachers chose limited activities. The activities selected by teachers include observing, measuring, inferring, communicating (which are the basic SPS) while there was no recognition of the integrated SPS as the experiments referred to were the 'recipe book' type of experiments rather than experimental design. The objectives for practical work in A-Level Biology are enshrined in the content topics of the syllabus and it is the role of the teacher to identify them from the syllabus. Teachers chose standard activities which showed no indication of including integrated SPS. Teachers did not appear to see the link between the objective and the associated SPS and this resulted in their challenges with regard to identifying relevant activities that would result in the achievement of the SPS. For example, they could not interpret the objectives related to the production of biological plan drawings for a given specimen (as they were not clearly specified in the curriculum document for A-Level Biology), or the identification of the objective related to the measurement of cells using a microscope and understanding the different skills learners were to acquire from the curriculum documents among many other challenges. They failed to recognise that practical work objectives were embedded in the various topics of the curriculum as one explained during the interview:

> *The syllabus does not specify the objectives for measuring using a microscope or any other practical skill. It shows content to be covered by learners …………..*

It was also significant that they stated that they drew on past examination papers for examples of activities. One teacher had this to say;

> *The syllabus does not tell how the questions will be set……………..They just show the content and not the practical work activities. It's difficult to see them. What is needed is to know what ZIMSEC is going to set. ………Some topics require theory and practical work because they have theory………*

DISCUSSION AND CONCLUSION

The intended curriculum for advanced level Biology is an extensive document with clear aims and objectives, but no clear indication of what kinds of activities relate to the different topics, especially practical work. There is no clarity with regard to the designers' views of basic and integrated SPS regarding practical work. The curriculum is therefore difficult for teachers to interpret. In addition, the fact that examiners seem to interpret the ideal curriculum in such a way that emphasis is placed on basic skills is problematic. The ideal curriculum and one part of the formal curriculum are not aligned. The misalignment between the curriculum designers and the examiners has brought confusion in the way the curriculum is interpreted by teachers. While the curriculum advocates for more SPS development, the examinations assess mostly basic SPS. In many instances the examiners for the practical component of the curriculum displayed some misunderstanding of the intended curriculum through ignoring the stated demands of the curriculum and confining testing to a few of the stated SPS. The examination system that is supposed to be an expression of the intended curriculum, did not express the intentions of the curriculum with respect to practical work. For a curriculum to be interpreted correctly all components need to be aligned. The A-level Biology curriculum is therefore a poorly designed curriculum.

The findings show that teachers had difficulty in understanding the requirements of the curriculum with respect to practical work in A-Level Biology. All five teachers believed that practical work was confined to only four topics of the syllabus, yet the syllabus advocated a practical approach to the teaching of all sections. However, one teacher had a better understanding of some of the objectives of practical work. The findings also showed that there were several distortions in the interpretation of the different curriculum documents on practical work in A-Level Biology. Some teachers could not distinguish which curriculum document preceded the other. There was an overreliance on the past examination paper by teachers for the design of practical work in A-Level Biology. Teachers preferred to use past examination papers as they argued that it was a measure of the expectations of the national examiner. This has an impact on how curriculum implementation is realised by teachers and attained by learners. Van den Akker (2003, 2010) is of the view that teachers, through their beliefs about the curriculum can filter information from the curriculum documents, hence diluting it or even distorting the intentions of the developer. The view is supported by Thijs and van den Akker (2009) who advocate for the need for the curriculum to be viewed as a web of interrelated and aligned activities which are focused at achieving the end. The role of the teacher in interpreting the curriculum is essential. Van Etten and Smit (2005) and Sethole (2001) mention the uncertainty teachers have in interpreting the expectations of the curriculum designers during the implementation. Green and Naidoo (2006) and Ramsuran (2005) attach these uncertainties to the nature of the curriculum. Teacher's beliefs about the curriculum will influence how he/she interprets it. The attitude of teachers in this study reveals a reluctance to engage with the curriculum with regard to SPS as they have a poor understanding of what SPS entail and the curriculum is designed in such a way that encourages non-engagement.

All the five teachers could not interpret the curriculum effectively with respect to practical work in A-Level Biology. Failure by these teachers to identify the practical activities which they could use to fulfill the requirements of the curriculum with respect to practical work implied a serious misunderstanding of the curriculum by the teachers.

A-Level Biology teachers regard practical examinations as their curriculum for practical work. Whatever practical work was planned was based on previous examination papers (as reflected in their scheme books). This also points to their lack of engagement with the curriculum. Teachers in this study only worked with examination papers (except for one teacher who sometimes designed her own practical activities) and were not able to identify the SPS embedded in the questions. While the curriculum is heavily embedded with SPS which learners are expected to acquire, there is no evidence of teachers' constructive engagement with the curriculum. A serious misalignment between the intended and implemented curriculum for A-level Biology practical work exists which is caused by teachers' misinterpretation of a poorly designed curriculum.

This study points to the importance of effective curriculum design. No matter how noble the ideals of curriculum developers, if the formal curriculum is not clearly articulated, misinterpretation will occur, leading to the kind of misalignment demonstrated here.

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