

**Designing Open Education Resources to facilitate cognitive and
intellectual diversity for grade 5 Science learners**

by

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Supervisor: Prof R Callaghan

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Declaration

I declare that the dissertation/thesis, which I hereby submit for the degree **MEd Curriculum and Instructional Design and Development** at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at this or any other tertiary institution.”

.....
Hanno Tromp



15 April 2019

Ethical Clearance Certificate



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A handwritten signature in black ink, appearing to read 'Bronwynne Swarts'.

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“The author, whose name appears on the title page of this dissertation, has obtained, for the research described in this work, the applicable research ethics approval. The author declares that he has observed the ethical standards required in terms of the University of Pretoria’s Code of ethics for researchers and the Policy guidelines for responsible research.”



Signature: Hanno Tromp

15 April 2019

Dedication

I dedicate this research to all the people who supported me on my journey, especially my wife and children. They have shown me unwavering support and encouraged me to continue and finish the race, especially when times were hard and I was discouraged.

Never before have I persevered for such a long period of time and dedicated my efforts to obtain a degree. Their sacrifice gave me the time and will to see the project through and for that I will be forever grateful to them.

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- Last, but not the least – My parents and family who believed in me and encouraged me throughout the process.

Abstract

Open educational resources (OERs) have been around since 1994, however, after a series of events, UNESCO officially coined the term ‘Open educational Resources’ in July of 2002. The movement was aimed at providing students with freely accessible learning material and narrowing the educational divide in developing countries. Although, the movement was a noble one, certain challenges also arose. One of the key problems that this dissertation sought to address was that of designing for differentiation. OERs by definition is freely available to anyone, however, no two individuals have the exact same cognitive ability.

The research followed an intervention strategy to investigate how OER interventions could be designed (at the hands of the Bloom-Gardner Matrix) to facilitate for cognitive and intellectual diversity in grade 5 Science learners. An intervention strategy allowed for OER activity design which supported curriculum differentiation, the investigation of how the learners utilized the OER, and determining which design aspects within the intervention impacted on the learners’ experiences.

Therefore, by designing an OER that had differentiation at its core, the researcher was able to establish which elements an OER could incorporate to differentiate the resource and cater for cognitive and intellectual diversity.

Key Terms:

Bloom-Gardner Matrix, cognitive differentiation, cognitive and intellectual diversity, intervention design, learning path, Open Educational Resources

Language editor

Letter from language editor to indicate that language editing has been done.



To whom it may concern

The dissertation entitled "**Designing Open Education Resources to facilitate cognitive and intellectual diversity for grade 5 Science learners**" has been edited and proofread as of 6 April 2019.

As an English language teacher and HOD of the English department, I have been proofreading and editing academic documents for 14 years.

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Kind Regards

A handwritten signature in black ink, appearing to read 'PP', is written above a horizontal line.

Penny Paul

List of abbreviations

AL	Adaptive Learning
BMG	Bloom-Gardner Matrix
CAPS	Curriculum and Assessment Policy Statement
FOMO	Fear Of Missing Out
HTML	Hyper Text Mark-up Language
IR	Intervention Research
KE	Knowledge Elements
LMS	Learning Management System
MI	Multiple Intelligences
OER	Open Educational Resource
OERs	Open Educational Resources
PDF	Portable Document Format
ROER	Repositories of OERs
TIP	Technology Integration Planning
UCD	User-Centred Design
UNESCO	United Nations Educational, Scientific and Cultural Organization

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1. Chapter 1: General orientation

Educational technology is developing at a rapid rate and the different ways in which technology can be used in education is also expanding greatly. With this influx of educational technology, it is of the utmost importance to establish the effectiveness of its use. Although there are literally hundreds of new and innovative ways in which to use technology, the use of technology still needs to be guided to be effective. Open Educational Resources (OER) is one such technological advance that has seen tremendous growth and support during the last 10 years (Jhangiani & Biswas-Diener, 2017).

The purpose of OERs is to provide access to free web-based digital resources for teaching, learning and research. The information that is made available ranges from full academic courses to single modules within a unit of study (Knox, 2013). This has tremendous possibilities for the developing world. OER has the potential to bridge the gap and provide poor countries with quality resources to develop education.

1.1 Problem statement

Although the purpose of OERs is noble, merely providing the resources is not enough. Richter and McPherson (2012) argue that simply providing the resources can be counter-productive because the resources are not developed with inclusion in mind.

There is still little evidence on how OERs are utilized. This makes it difficult to gauge if the resources are in fact useful, regardless of whether they were designed for inclusion or not (Hodgkinson-Williams & Cartmill, 2015). A recent study that was conducted in Kenya, however, revealed that there was a significant positive relationship between the students' perceptions of OERs and their utilization thereof. The better their perceptions of OERs were, the better they utilized the OERs (Nyamwembe E. O. et al., 2018).

OERs are accessed by a variety of different people who all study in various ways and have varying levels of cognitive abilities and therein lies the problem. The users are just too diverse and a single OER has very little chance of catering for this

diversity (Felder & Brent, 2005). Together with the findings of the above-mentioned study, it is therefore important to determine how OERs can be designed with differentiation in mind.

1.2 Aims of the research

The research aimed to establish guidelines for OER intervention developers to be able to design interventions that could be differentiated. It aimed to establish which elements could be incorporated in an OER intervention to cast a wider net and add value to the diverse group of people who would access an OER. The guidelines that the research sought to establish, ranged from the physical design of the OER, to the educational content and the various assessment activities that could be incorporated to differentiate an OER intervention.

1.3 Purpose of the research

The purpose of this study was to determine how an OER intervention could be designed to facilitate for the cognitive-intellectual diversity in grade 5 Science.

Therefore, by designing an intervention that had inclusion at its heart, the research aimed to shed some light on how OERs could be designed to facilitate for cognitive-intellectual diversity and inclusion.

1.4 Research questions under investigation

Main Research Question:

How can OER interventions be designed (at the hands of the Bloom-Gardner Matrix) to facilitate for the cognitive-intellectual diversity in grade 5 Science learners?

Supporting Questions:

Sub-question 1 - Which activities can be designed in an OER intervention to support curriculum differentiation for science learning for grade 5 learners?

Sub-question 2 - How do learners utilize the OER?

Sub-question 3 - What design aspects have an influence on learning in this OER intervention?

1.5 Concept clarification

1.5.1 Bloom-Gardner Matrix (BGM)

The BGM is an integration of Bloom's Revised Taxonomy and Gardner's theory of multiple intelligences (Noble, 2004). When the two theories are combined, a learning matrix can be constructed which enables a teacher to design an intervention that supports differentiation. The BGM formed the backbone or the structure for the OER for the purposes of this study. It enabled the researcher to determine which activities learners gravitated towards with regard to their science development.

1.5.2 E-Learning

E-learning refers to digitally delivered instruction and is usually associated with ubiquitous learning (learning anywhere and anytime) (Clark & Mayer, 2016; Cope & Kalantzis, 2010). The purpose of e-learning is to support students in their education by utilizing digital media. It may be either instructor-led or self-paced.

1.5.3 Learning intervention

Learning interventions, or instructional interventions are educational programmes that are designed to assist a learner in improving a particular area of educational need. These interventions are characterized by being specific and intentional and enable a teacher to monitor a learner's progress (Lee, n.d).

1.5.4 Intellectual Diversity

Learners do not only differ in terms of culture, language or ethnicity. They also differ in terms of intelligence. This implies that learners learn in different ways. They have different intellectual strengths and will naturally perform better according to their intellectual strength (Cole & Association for Supervision and Curriculum Development, 2008). William Gardner termed intellectual diversity as multiple intelligences (Pritchard, 2013). This further implies that one form of assessment will not necessarily be a true reflection of a learner's abilities.

1.5.5 Cognitive Diversity

For the purposes of the research cognitive diversity refers to the diversity in cognitive processes that students encounter when they work with knowledge. The cognitive diversity is based on Bloom's Revised Taxonomy which uses various types of knowledge for the different cognitive processes (Anderson L. W. et al., 2001).

1.6 Research methodology & value of the research

The research sought to determine how OERs could be designed to facilitate for cognitive and intellectual diversity. To answer the question, the experiences of OER users had to be investigated. Therefore, a qualitative methodology was chosen which is outlined below. A more detailed discussion on the methodology is found in Chapter 4.

1.6.1 Research approach and strategy

The research approach was qualitative in nature and intervention research was employed as a strategy to gather the needed data. The intervention research model was used in conjunction with the Technology Integration Planning (TIP) model in the development of the OER intervention. However, some of the principles of design research was used to design the intervention. A more detailed discussion on intervention research is found in Chapter 4.

1.7 Target population and sampling

The study focussed on primary school learners and how they utilized the OER. grade 5 learners were asked to participate and express their experiences as they interacted with the OER intervention. A sample from the population was selected using a purposive sampling method. More details on the population and sampling can be found in Chapter 4.

1.8 Data collection

The data collection methods and processes are discussed in detail in Chapter 4. To support triangulation, data was collected using focus group discussions and observations. The triangulation was critical for facilitating the interpretive validity and to establish data trustworthiness (Maree, 2016). The focus group discussions were semi-structured which gave the study a certain flexibility with regard to the

information that was gathered. Maree (2016) advised to have guiding or base, open questions at the ready to steer the interview. These questions were then followed up by further probing and clarification (See Appendix B for Focus Group Protocol).

The software on which the course was provided, enabled me to observe the learners' use of the OER. The observations were done without interfering or influencing the participants. The risk of being biased towards a certain individual or focusing on a single event was also greatly reduced due to the fact that the observations were done remotely (Maree, 2016). The observations were not necessarily on the individuals themselves, but rather on the data that they produced as they engaged with the OER. The OER environment allowed me to monitor and observe the participants' choice in activity, the time spent on the activity, and also the assessment of the various activities. Combined, these findings proved useful in determining whether the OER had to be adjusted and whether it was successful in catering for cognitive-intellectual diversity or not.

1.9 Data analysis

An in-depth discussion on the data analysis process is found in Chapter 4. The data analysis of the study was based on the TIP model and the BGM. The final phase of the TIP model required evaluation and revision. The collected data provided the means by which the intervention was to be evaluated. The data was able to indicate where the pitfalls of the intervention were and gave insights as to how these pitfalls were to be rectified.

1.10 Reliability insurance methods

In general, it is difficult to determine the reliability of qualitative research. The interpretive nature of the research and the premise that knowledge is constructed through experience, renders qualitative research difficult to reproduce in other contexts.

Nevertheless, the credibility of the research still needed to be evident. Whereas quantitative research's reliability focusses on the instrument, qualitative research focusses on the credibility and methods of the researcher seeing that the researcher is deeply involved in the research process (Golafshani, 2003).

1.10.1 Sampling

The sample of the population was not randomly selected due to their involvement in the OER. The research problem could only be investigated by observing and studying participants who interacted with the OER intervention. Selecting a sample of the population who did not interact with the OER would not yield credible information, seeing that they would not be able to recount their experiences with the OER. Therefore, the sample was considered reliable due to the participants who were able to express their experiences and inform the research.

1.10.2 Data collection

The data that was obtained from the focus group discussions can also be considered to be reliable. During the data collection process, notes were constantly taken. The participants were constantly asked whether the summaries that the researcher made correlated with their experiences. His observations were also recorded and both data sets were digitally stored and processed using *Nvivo 12*, which is qualitative research analysis programme.

1.10.3 Analysing of data

Coding was used to analyse the data from the focus group discussions as well as the researcher's observations. The questions that guided the focus group discussions were designed to answer the main and supporting research questions. See Figure 4.3 for a visual outline of the process that was followed to analyse the data.

1.11 Ethical considerations

Inherent to any educational research are the ethical considerations that need to be taken into account to ensure that the research will be conducted in such a way that the participants will not be put in harm's way, or be negatively affected by participating in the research. At the heart of ethics is the intention to do good and to avoid harm (Orb et al., 2000). McMillan and Schumacher (2001) emphasise the importance of ethical considerations or principles, since the research is centred around humans. These considerations need to be embedded into the research to minimize or reduce the risk of harm to the participants.

The ethical considerations that were taken into account are outlined below, but a detailed discussion can be found in Chapter 4.

- Risk/Harm mitigation
 - *Informed consent and assent*
 - *Anonymity and confidentiality*
- Conflict of interest
- Beneficiation, reciprocity and remuneration

1.12 Research structure

To assure a well-structured research report in which the content flows in a logical order and in which the research aims and questions are addressed, the remaining chapters are outlined as follows:

Chapter 2: Literature Review

This chapter focuses on the relevant literature of OERs and OER development. It also looks at the use of technology in education in South Africa and attempts to highlight some of the issues associated with ICTs.

Chapter 3: Theoretical framework & intervention design

In this chapter the theoretical framework that the study was based on is discussed and outlined. Furthermore, the intervention design is also discussed and how it was constructed to fit in with the theoretical framework. The design of the OER intervention and the software that was used is also mentioned.

Chapter 4: Methodology

This chapter informs the reader of how the research was conducted. It explains in detail how the data was collected and analysed to arrive at the conclusions. The ethical considerations that were taken into account are also discussed in detail.

Chapter 5: Research result

This chapter summarizes the results that were obtained from the data that was collected. It explains how the data was used and graphs and figures were added to give a visual representation of the results.

Chapter 6: Research findings and conclusion

This chapter summarizes the findings that were deduced from the results and eventually provides a conclusion to the study.

1.13 Conclusion

This chapter served as an introduction to the research and aimed to provide the reader with a general outline of how the research was conducted and how the researcher arrived at the conclusions. In the next chapter, the literature review is discussed. It aims to give the reader some background information on OERs and sheds some light on the research problem and the gap in the literature that this research study attempted to fill.

2. Chapter 2: literature review

Open Educational Resources (OERs) have enjoyed a remarkable amount of attention since 2002 when UNESCO decided to invest in world education development. This chapter will attempt to provide an overview of OERs, the nature of OERs and the quality issues that are associated with OERs. Furthermore, it will also highlight the South African context and the need for quality resources to be developed and distributed.

2.1 A brief history of OERs

The history and development of Open Educational Resources (OERs) can be traced back to the mid-1990's. In 1994, Wayne Hodgins coined the term "learning objects" and educators soon realized that these learning objects could be digitally designed, reproduced and reused in a number of different educational and pedagogical settings (Camilleri et al., 2014).

Later on, in 1998, Wiley coined the term "open content" and this term was targeted at educators, but more specifically, learning object designers. Open content, however, soon found its way to internet users. With regard to OERs, it was instrumental in the popularization of open software that could be applied to learning content. Thus, the first open license for content (Open Publication License) was born (Bliss & Smith, 2015).

The license was further refined and developed and in 2001, Larry Lessig and others founded the Creative Commons License which was considerably stronger in legal terms. These licenses were to become the most widely used publication licenses due to their uncomplicated nature. MIT also announced their OpenCourseWare initiative during 2001 and became a flagship of sorts for OERs and institutional developers (Bliss & Smith, 2015).

Finally, in 2002, UNESCO held a forum in which world education was discussed and the term Open Educational Resources was born. The name was chosen to describe the efforts and aims they were looking to achieve and thus OERs was defined by UNESCO as:

“The open provision of educational resources, enabled by information and communication technologies, for consultation, use and adaptation by a community of users for non-commercial purposes.” (UNESCO, 2002, p. 24)

Today, OERs are not limited to a single type of resource, but rather encapsulates any resource that is freely available in both digital and print form. However, for the purpose of this study, the focus was on digital OER interventions and their development.

2.2 The nature of OERs

OERs are released under an open license which enables the user to access the resource cost-free, and use, adapt and redistribute it with limited or no restrictions (UNESCO, 2015). In other words, OERs can be anything from digital media, to individual worksheets to complete online courses that are freely available. Universities like MIT OpenCourseWare have made virtually all of their course material available to use for free. OER repositories hold large collections of OERs and according to Phalachandra et al. (2016), the most popular repositories are OER Commons, Wikimedia Commons and COL’s Directory of Open Educational Resources.

There is no shortage of OERs and one merely has to do a quick internet search to find OERs. Phalachandra et al. (2016) found in their study that 72% of their respondents used a search engine to find OERs and a further 22% used repositories. In 2016, there were over 3000 OER repositories world-wide (Leng et al., 2016). However, that number has grown, and according to OpenDOAR, there are currently 4064 repositories (26 March 2019) across the globe (OpenDOAR, 2019).

2.3 OER quality and design

Despite the investment in OERs, there have risen a number of concerns and arguments against the use of OERs. These concerns include the quality of the resources and their design, language, monitoring, assessment standards, sustainability, implementation and overall use of OER (Richter et al., 2014).

Quality and design go hand-in-hand with regard to OERs and this is one of the major concerns or arguments against OERs. Bates (2011) argued that even though one has a quality resource, it might not be very useful if used by someone in the wrong or different context. This is not an empty claim, but the nature of OERs enables the resources to be adapted.

Richter et al. (2014) stressed that the value of OERs is directly related to its adaptability and the opportunity to reuse in diverse settings. They suggested, however, that the onus to provide a contextual overview lies with the developer. They also mention that at a minimum, an OER should be designed in a format that allows for change.

2.3.1 OER contextualised design

Kalchik et al. (2010) explained that contextualized learning and teaching referred to how academic concepts are taught by applying the content to specific contexts that are interesting and authentic to the student. They also noted that research suggested that there are learners who learn more effectively when they are taught to apply academic concepts to authentic contexts. It is therefore the OER designer's responsibility to provide context to the assessment activities, but if that is not possible, the instructors who use OERs, need to design the resource so that it can be changed by other users.

However, whether you are an OER developer, or an OER user, the format in which the OER is or was created will determine to what extent it is adaptable. Phalachandra et al. (2016) found that MS Word documents were the easiest resources to adapt, whereas PDF documents and HTML formats were more difficult. Consequently, OER re-users would find it difficult to contextualize an OER that was already developed.

2.3.2 OER design and access

The design of an OER has a further dimension. The end-users do not just differ in terms of cognitive ability but also in terms of mode of access. Mobile learning and the research regarding mobile learning is becoming ever more important and is highly relevant when one considers the design of OERs (Ally & Prieto-Blázquez, 2014). One has to assume that the resources will be accessed by a range of devices

and the design, therefore, has to take this diversity into consideration. More people access the internet with mobile devices than with any other device (McGreal & Commonwealth of Learning, 2013).

2.4 OER assessment strategies

The assessment strategies that are used in OERs is another area of concern. Bates was very outspoken about the lack of quality assessment with regard to OERs as they rely mainly on peer assessment and multiple choice questions (Bates, 2011). Camilleri et al. (2014) also mention that in formal education, the quality of assessment is crucial to the recognition of the quality of teaching and learning. They also mention that the assessment strategies used in OERs are sometimes radical and research still has to be done with regard to the quality of the assessments. The assessment methods are thus still in constant flux.

Seeing that OERs are mostly of a digital nature, it would then be feasible to take a closer look at e-learning and how OERs and e-learning can be linked. If one can borrow the principles of e-learning and apply them to the design of OERs, it would be plausible to design resources that are reliable and adhere to sound pedagogical theory and approach. This would also shed some light on how the resource could be designed to facilitate for diversity. Beetham and Sharpe (2013) state that there are no new models for e-learning per se, just e-enhancements for existing models of learning. They go on to say that technology merely plays a role in achieving desired learning outcomes. The challenge, however, lies in describing how e-resources help with the development of learning.

2.5 Curriculum and OER differentiation

Carl Washburne gave a brief summary of the reality of learners with various levels of cognitive ability and further explained how differentiation was attempted. He came to the conclusion that the school curriculum needed to be adapted to cater for all the different levels of maturity (Richter et al., 2014; Washburne, 1958). However, when one looks at curriculum differentiation, it refers to more than just the content.

The Maker Model of Differentiation distinguishes not only between differentiation in content, but also in environment, process and product modifications (Ronksley-Pavia, 2010). For the purposes of this study, curriculum differentiation will refer to

the differentiation in process. The Maker model states that process differentiation involves how the teacher presents the content, the questions he asks of the learner and the activities he expects them to complete (Ronksley-Pavia, 2010). To facilitate for learner diversity and the design of the intervention, user-centred design (UCD) principles need to be implemented to ensure that all the learners are catered for.

UCD revolves around the end-user. The whole design of the interface is guided by the user's capabilities and needs. Rather than focusing on the technologies and the content, UCD focusses on displaying information in ways that align with the user's goals, tasks and needs (Endsley & Jones, 2012). Endsley and Jones (2012) further state that apart from increased productivity, improved acceptance and user satisfaction are further benefits of UCD.

2.6 Learning paths

Keeping in step with differentiation, new research has emerged that adapts learning paths for education (Muhammad et al., 2016). A learning path can be defined as a series of tasks or activities that are designed to assist a learner in improving his or her knowledge and skills in a specific subject. The premise of the sequence of activities is to provide the learner with a custom path that is most suitable to the individual. Therefore, the learner can choose a path that suits his or her individual characteristics and skill level and consequently achieve the learning outcomes with minimal effort (Muhammad et al., 2016).

Muhammad et al., (2016), however, mentions that there are certain challenges when one develops resources with embedded learning path strategies. The diversity of the learners, learning styles, cognitive styles and learning objectives are among the chief challenges. However, OERs and Learning Management Systems (LMS) can be used to develop resources that embody learning paths.

2.7 Differentiating OERs through learning paths

In 2010, Yang et al. (2010) proposed an open model for learning path construction that incorporates Bloom's taxonomy and also allows for knowledge elements (KE) to be delivered and assessed in various ways. Lastly they also proposed that learning activities be designed to be adjustable in such a way that teachers could change the existing activities into new ones with minimal effort.

To achieve this open model in learning path construction, the Bloom-Garner Matrix (BMG) could be used as a theoretical framework to design a differentiated OER intervention.

Cash (2017) provided an outline of the elements that separated the differentiated classroom from the rest. The ten characteristics that he pointed out were:

- Defined content goals.
- Acknowledgement of learning differences.
- Curriculum adjustment based on pre-assessments, formative assessments and summative assessments.
- Brain-compatible learning instruction.
- Active learning classroom environment.
- 21st Century skills development.
- Flexible grouping for optimal learning.
- Tiered and parallel assignments and activities.
- Flexible, interesting, enjoyable and challenging learning environment.
- Learning autonomy.

Although these elements referred to a physical classroom setting, it would also be possible to incorporate all of the above-mentioned elements in a digital learning environment when incorporated with UCD principles and utilizing a differentiation matrix like the BMG. Learning Management Systems (LMS) like Edmodo and Haiku PowerSchool Learning would be able to serve as platforms where OER interventions could be hosted. The only drawback to these platforms would be that the OER designer would have to know the users personally. Nevertheless, they do offer the designer full control over how the information of the intervention is displayed and would enable the OER designer to incorporate the differentiating elements that was outlined by Cash.

2.8 Global and South African access to OERs

Access to OERs and repositories of OERs (ROERs) is yet another concern. Bhavnani et al. (2008) found that although people in the developing world do not have access to computers, they do have mobile devices and tablets with wireless capabilities that enable them to access OERs. According to statistics of the

International Telecommunications Union, there are now more mobile network subscriptions than people on the planet. This is mainly due to some people having more than one mobile subscription. Consequently, this does not mean that everybody has a mobile subscription. The number of mobile users has grown from 400 million people in 2000 to the current number which equals to an estimated 76.4% of the world population (International Telecommunications Union, 2018).

Given the statistics above, the South African context is no different than what the global trends suggest. In fact, a study done by Beger and Sinha (2012) revealed that South African residents lead in the number of mobile technology users on the African continent, but still lack stationary computers. It also found that 72 percent of those users were between the ages of 15-24. This would then suggest that a large number of learners would have access to OERs and have the opportunity to improve their own education. According to the International Telecommunications Union (2018), in 2017 the number of mobile network subscriptions in South Africa grew to 88 497 610.

2.9 The awareness of OERs in South Africa

It is important to note that even though many South Africans have potential access to OERs, these resources would largely go unnoticed due to the lack of knowledge of their existence. In a recent study, Hodgkinson-Williams and Arinto (2017) examined the impact and adoption of OERs in the Global South. Among the countries who took part in the study was South Africa and compared to other countries in Africa, South Africa still has a long way to go in adopting OERs.

Their research found that more educators than students use OERs, or have used OERs in the past. However, of their randomly selected 295 educators, less than 40% reported that they had used OERs in the past. Of the 4784 randomly selected students, less than 28% of South African students indicated that they use OERs. Seeing that the study focussed on University students, who are already more academically inclined than school learners, one can then reasonably assume that the numbers would look similar for high school and primary school learners and teachers.

The sheer volume of OERs is another aspect that their research illuminated. They found that many educators found the search for appropriate OERs daunting and that many of them were not aware of the repositories that were available (Hodgkinson-Williams & Arinto, 2017). On the other hand, compared to the European and Western Countries, South Africa has a very limited selection of OER repositories. In total, there are a mere 41 repositories (OpenDOAR, 2019).

Taking the contextual factors and the ability to adapt the resources into account, the number of appropriate OERs comes into question. It would be fair to assume that, at the current stage, the average South African student would find it difficult to use OERs seeing that the majority of the resources are not written within a South African context.

2.10 The potential and need for OERs in South Africa

Taking the South African context into account together with the diverse group of learners in the country and current economic trends, it is clear that cost-effective resources need to be made available to support the learners in their education. When one compares the costs of education and the average gross South African income, it is clear to see that there is a great divide that can hinder many South Africans from obtaining a quality education.

2.10.1 South African household income vs the cost of education

According to statistics that was released by the *French Institute for Demographic Studies*, the average family in South Africa in 2017 had 2.4 children (Pison, 2017). Effectively, this would mean that the costs involved for putting a family's children through school would be more than double the average cost of education. This would essentially put tremendous financial strain on a family seeing that the average gross income for families in South Africa is generally very low.

The University of Cape Town released disturbing statistics on the state of family incomes in South Africa in 2018. The statistics showed that 46% of South Africans brought home less than R 1000 a month. It further accentuated the economical divide when the statistics showed that only 10% of working South Africans brought home a salary of R 7300. To put things further into perspective, the statistics showed that two thirds of South Africans managed to live off R 1800 a month (Head, 2018).

When one looks at the income of the majority of South Africans, there isn't much left to pay for education. The financial services group, Discovery, stated that the average tuition fees for public and private public schools were roughly R 20 000 and R 100 000 per year respectively ("Extending Shared Value to Education (White Paper)," 2017). However, basic education is one of the core human rights and free basic education in South Africa can bring some relief. Although some schools in South Africa are no-fee schools, they are also poor in resources, therefore OERs could supplement their need for quality resources.

2.10.2 Relationship between unemployment and education

Regardless of the average income that South African families bring home, there are still many working class individuals who are still unemployed. According to Statistics South Africa (2018), unemployment rose to 27.2% in the second quarter of 2018, of which 31.9% did not have a matric education. Furthermore, 28.3% of the unemployed workforce had a matric education, but only 6.9% of graduate students were unemployed. This would indicate that a tertiary education is of the utmost importance to curb the unemployment rate in the country and alleviate poverty. However, based on the costs of education, the average income per family and the unemployment rate, it is clear to see that quality, cost-effective educational tools are needed to bridge the gap.

By utilizing OERs, one can supply the South African learner with appropriate resources to further their education. However, given the arguments of quality, context and design, it is necessary to determine how OERs can be designed to provide suitable support for South African Learners.

2.11 Conclusion

In this chapter, the history of OERs was briefly summarized together with the nature thereof. The quality concerns of OERs were addressed with a focus on OER design. The design aspects that were investigated included not only the design of the content and assessments, but also the mode of access. Furthermore, the critiques of assessments in OERs were also addressed. The link between e-learning and assessment strategies was investigated and how learning paths could be used to

enhance OER intervention design. This link leads the investigation to differentiation and how UCD could be used to facilitate differentiation. Finally, the literature shed some light on the need for quality, cost-effective educational resources to alleviate unemployment in South Africa.

The purpose of the literature review was to paint a picture of the shortcomings in the design of OER interventions and also to shed light on possible strategies that could be investigated to further develop OER design. It aimed at providing the grounds for the research study and paved the way for the theoretical framework and intervention design of the study which is discussed in the next chapter.

3. Chapter 3: Theoretical framework and intervention design

The Hewlett Foundation 2013 Annual Report (2014) documented that there was not a comprehensive body of evidence that supported or documented the productivity gains and effectiveness of using OER, especially in primary schools. For this very reason, the research study was designed to shed some light on how OERs could be designed to support learning in primary schools.

Therefore, in this chapter, the researcher outlines the theoretical framework that the design of the OER intervention was based on. Thereafter, the intervention design is described due to the fact that it was the main tool by which data was collected. Moreover, it serves as background information for the reader to better understand the research methodology.

3.1 Theoretical Framework

The Bloom-Gardner Matrix can be regarded as the backbone for the study, as this was the basis on which the interactive elements and differentiation of the OER was structured and which the learners interacted with. The matrix is a framework that combines Bloom's revised Taxonomy with Gardner's Multiple Intelligences (MI) theory (Noble, 2004). Practically, this means that a single unit of study can be differentiated to accommodate not only learners with various levels of ability, but also multiple intelligences.

The MI theory expands on the traditional academic intelligences of linguistic and logical mathematical intelligences by including musical, bodily kinaesthetic, interpersonal, intrapersonal and naturalistic intelligences (Gardner, 1999). The key element that the MI theory hinges on is that each intelligence has its own developmental path and core processing operations. This means that learners will generally engage in higher order thinking activities in an area where they are more intellectually inclined and lower order thinking in areas of weakness. Thus, combining Bloom's taxonomy and Gardner's MI theory will result in a single unit of study being differentiated into 42 different activities. This casts a wide net to cater for the inclusive nature of South African Schools.

Table 3.1 is a visual representation of how the matrix is structured and shows how activities can be differentiated in both cognitive demand and intelligence as proposed by Gardner.

Table 3.1 – Bloom-Gardner Matrix
 ("Blooms-Gardner Matrix - Steedie," 2016)

Blooms Taxonomy	Remembering	Understanding	Applying	Analysing	Evaluating	Creating
Gardner's MI theory						
Verbal/Linguistic Highly developed auditory skills.	1	2	3	4	5	6
Visual/Spatial Thinks in terms of space	7	8	9	10	11	12
Logical/Mathematical Thinks conceptually, reasons and calculates	13	14	15	16	17	18
Musical Is sensitive to rhythm and sound.	19	20	21	22	23	24
Bodily/Kinaesthetic Uses Body effectively	25	26	27	28	29	30
Intrapersonal Shy, knows own strengths and weaknesses	31	32	33	34	35	36
Interpersonal Social and interactive	37	38	39	40	41	42
	Less Difficult Tasks  More					
	Difficult Tasks					

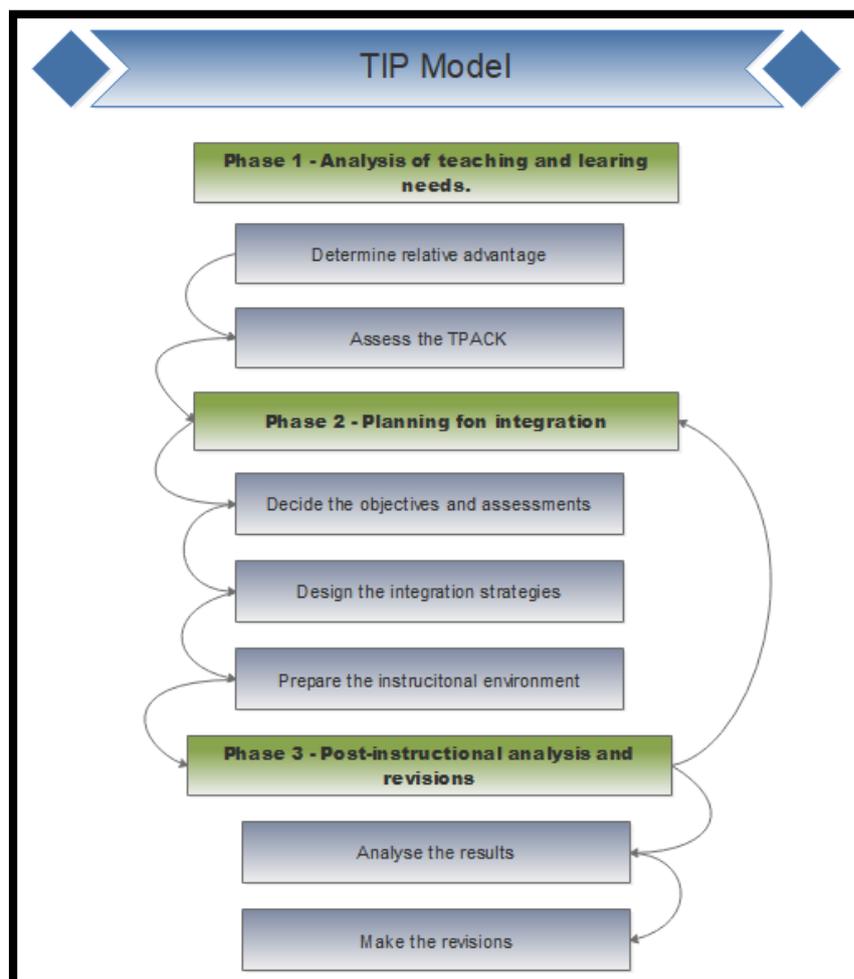
3.1.1 Critique on Multiple intelligences

The MI theory and learning styles have come under fire of late and it has been found that there is very little evidence to support the MI theory, as well as learning styles. Garner himself mentioned that the MI theory was no longer current and that many other theories on knowledge had advanced since the 1980s (Sternberg et al., 2017). Willingham et al. (2015) also stated that learning styles were not accurate and scientific support for learning theories were largely lacking.

However, the BMG was **not** used for the sake of catering for different learning styles, but rather to give the designer a large pool of varied activities that the participants could participate in. In utilizing the BMG, the researcher was able to design a number of different activities that incorporated various audio, visual and practical elements. Essentially, the purpose of the intervention was to determine what the participants enjoyed and found useful and the BMG provided the researcher with enough material to choose from to include in the intervention.

The design of the research was based on the Technology Integration Planning (TIP) model. Roblyer and Doering (2013) thoroughly explained the TIP model and how it could be used to implement technology in a school setting.

The TIP model consists of seven steps which is divided into three phases of integration. Figure 3.1 serves as a visual representation of the phases which make up the TIP model.



*Figure 3.1 – TIP Model
(Roblyer & Doering, 2013)*

Phase one of the model had already been completed, as the research problem wanted to address the development of OERs. To summarise, phase one of the TIP model required the researcher to determine his/her *technological pedagogical content knowledge* (Roblyer & Doering, 2013). In other words, the researcher needed to determine to what level a certain technology would be able to be used for technology integration. In the case of the study, the *PowerSchool K-12 Digital Learning Platform* was deemed suitable for the purposes of the research.

Phase two involved the design of the intervention. Once the intervention was completed, phase three was conducted. It was peer reviewed to ensure that the resource was reliable (See Appendix C for peer review questionnaire). The necessary amendments were made and the resource was released to the students.

Once the participants had engaged with the OER, phase three was initiated. Focus group discussions were conducted to establish if there were any alterations which needed to be made. The participants were also observed throughout the study to determine how they interacted with the OER. This enabled the researcher to intervene and make adjustments according to the behaviour of the participants.

The TIP model then requires the researcher or educator to repeat phase two and evaluate the resource once more. However, for the purpose of the research, the cycle was only completed once.

The theoretical framework was the basis from which the intervention was designed. The differentiation that the BMG enabled, was used to create an OER intervention that was differentiated. It allowed the researcher to incorporate various assessment strategies and include various forms of content. This was done to give the participants the opportunity to explore the intervention freely and use the elements that they were more comfortable with.

3.2 CAPS and constructive alignment

The South African Curriculum served as the content and assessment pool from which the intervention was to be populated. The Curriculum and Assessment Policy Statement (CAPS) is clear that various differentiation strategies should be used to overcome barriers to learning (Department of Education, 2011). This enabled the

researcher to design a differentiated intervention that was to be integrated into the school curriculum. The intervention was designed to supplement the participant's Science curriculum and the CAPS document was used as a guideline to ensure that the correct or applicable content was used.

The knowledge strand of Energy and Change formed the core of the intervention and all content and assessments were tailored to supplement this knowledge strand. Furthermore, a backwards design was used to create the assessments and activities.

According to Wiggins and MacTighe (2006), a good design is always preceded by a clear understanding of what the desired results are. This will enable the designer to choose the most appropriate materials and assessment tools to achieve the desired results or the aims as stated in the CAPS document

As a result, the combination of a backwards design and having the CAPS document as a guide, enabled the researcher to ensure that constructive alignment was achieved. In other words, the content was chosen in such a way as to prepare the participants to successfully complete the assessments and achieve the desired results. Figure 3.1 illustrates how the backwards design was utilized in the study.



Figure 3.2 Backwards Design

As an example, when one looks at the CAPS document, there are a number of aims that are posed, one of those aims is to investigate cell or battery and mains electricity. The learners are expected to know how what components are necessary for an electrical system to work and how these components are combined to construct an electrical system. When one looks at what the learners are expected to know and what skills they need to develop one can start to determine what assessment activities are needed.

Assessment activities that range from Bloom’s knowledge level, all the way to the creation level would be able to indicate whether the aims have been achieved or not. In using the Bloom part of the BMG, the researcher was able to develop activities that tested whether the participants could remember the components of an electrical system and also whether they understood what each component’s function was. Furthermore, the researcher designed activities that evaluated whether the participants knew how circuits worked and finally if they could create their own working circuits.

In order for the learners to be adequately prepared to be assessed, the researcher could now design the content that was needed to provide the learners with the knowledge that they needed.

Thus the learners were provided with open source videos that were obtained via YouTube, as well as illustrations and explanations of the various concepts. All of the content that was used was open source.

Table 3.2 provides a summary of the aim, cognitive level as well as the assessment technique and source that was used to test the learners.

Table3.2 – Backwards design example

Aim	Cognitive level	Assessment technique and source
Be familiar with the components that are needed for an electrical circuit.	<ul style="list-style-type: none"> • Knowledge • Understand 	<ul style="list-style-type: none"> • Multiple choice – Haiku built-in tool.
Learners should be able to evaluate whether an electrical circuit will work or not	<ul style="list-style-type: none"> • Evaluate 	<ul style="list-style-type: none"> • Multiple choice – Haiku built-in tool. • Open ended explanations – Apache OpenOffice.
Learners should be able to create various circuits	<ul style="list-style-type: none"> • Create 	<ul style="list-style-type: none"> • Create circuit – PheT circuit simulations.

3.3 The Openness of the designed resource

Before the researcher started with the OER design, he investigated a number of learning management systems. At the time, Haiku PowerSchool was determined to be the most appropriate for the design of the resource because it was completely open source.

The researcher was able to design an intervention and make it publicly available. However, he also had the option of making it available to the participants alone. Since then, however, Powerschool has grown and some of the features that were originally available are now only available on a paid account.

In terms of the content of the resource, all the content, as well as the external resources were either completely open source, or there were free versions available. Table 3.3 provides a summary of the resources that were used as well as links to the resources.

Table 3.3 Resources and links

Source Name	Source type	Location
World's most asked questions – What is energy?	Video	https://youtu.be/CW0_S5YpYVo
Energy Chain	Image	https://commons.wikimedia.org/wiki/File:Complete-circle-foodchain.jpg
Animaker – Cartoon Maker	Web app	https://www.animaker.com/cartoon-maker
What is energy?	Webpage	https://www.teachengineering.org/lessons/view/cub_energy2_lesson01
Energy quiz	Interactive	https://quizlet.com/16370228/science-ch-15-energy-vocabulary-words-grade-5-flash-cards/
Energy glossary	Webpage	https://www.alliantenergykids.com/AllAboutEnergy/EnergyGlossary
Terminology	Document	https://www.myhaikuclass.com/MrTromp/science/file/show/113474780.docx?t=1520257200
MindMup	Web app	https://www.mindmup.com/
Canva	Web app	https://www.canva.com/graphs/mind-maps/
Bubbl.us	Web app	https://bubbl.us/

Kinetic and potential energy	Video	https://youtu.be/ASZv3tlK56k
Stored energy	Video	https://youtu.be/8ScodXQy_qg
MindMeister	Web app	https://www.mindmeister.com/
Visme	Web app	https://www.visme.co/make-infographics/
Infogram	Web app	https://www.visme.co/make-infographics/
Nuclear fission and nuclear fusion	Video	https://youtu.be/xrk7Mt2fx6Y
What is sound?	Video	https://youtu.be/gdGyvGPZ1G0
What is electricity?	Video	https://youtu.be/ru032Mfsfig
Great science teacher risks his life	Video	https://youtu.be/PWNs7i4rEWA
How a battery works	Video	https://youtu.be/PyrWx4ExZE4
Explaining an Electrical circuit	Video	https://youtu.be/VnnpLaKsqGU
Coal fired power plant	Video	https://youtu.be/rEJKiUYjW1E
Circuits	Document	https://www.myhaikuclass.com/MrTromp/science/file/show/115453273.pdf?t=1523820192
Circuits 2	Document	https://www.myhaikuclass.com/MrTromp/science/file/show/116205563.pdf?t=1524951804
Circuit construction kit: DC	Interactive	https://phet.colorado.edu/en/simulation/circuit-construction-kit-dc

3.4 OER intervention Design

The design of the OER intervention was based on the BMG and conceptualized into a digital online intervention that embodied the principles of an open learning path. In other words, the OER was designed to give the participants the opportunity to follow their own learning path. Moreover, incorporating open learning path strategies into the intervention served the purpose of differentiating the intervention and providing the participants with a multitude of learning opportunities. As a result, a number of different assessment strategies and learning material was included into

the resource to determine if there were elements that the participants preferred above others.

The OER was designed on the **PowerSchool K-12 Digital Learning Platform**, which is a LMS that is free, but also had a paid option. This platform had built-in features that enabled the researcher to design an intervention that modelled the BMG. However, a complete BMG that incorporates all the intelligences was not designed. This is due to the fact that the BMG was used as a tool to provide an array of learning opportunities in a digital format and not necessarily to cater for learning styles.

As a result, only the Verbal/Linguistic, Mathematical/Logical and Visual/Spatial intelligences were included. The Verbal/Linguistic and Mathematical/Logical were chosen because they were the only two intelligences that had been valued and tested in modern schools and were seen as the “scholarly” intelligences (Davis et al., 2011). The Visual/Spatial intelligence was included to provide visual options of assessment opportunities for the participants.

The BMG was developed to give learners the opportunity to choose how they wanted to be assessed. Traditionally, they would be presented with a grid such as is illustrated in Table 3.1, however, the grid was replaced with a menu bar that was labelled with the major KEs. Figure 3.1 is a screenshot of the homepage of the intervention with the menu bar on the left.

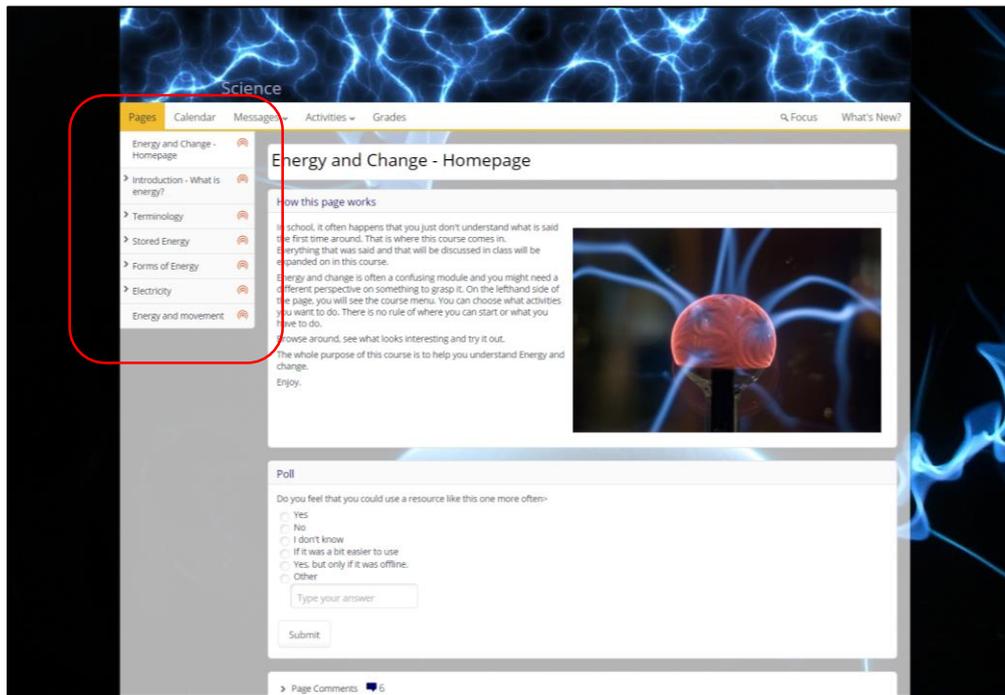


Figure 3.3 – Intervention homepage

Each of the KEs in the menu bar had sections that consisted of the learning material and sub-menus that contained the differentiated assessment opportunities. The assessment opportunities were designed according to Bloom's taxonomy, therefore, the assessments were not only differentiated in terms of intelligence, but also in terms of difficulty. It has to be noted at this time that the learning material and learning outcomes dictated the level of difficulty of the assessment activities.

In other words, if the content and learning outcomes required the participants to recall facts, only Knowledge level questions were asked in the intervention. On the other hand, if the content and learning outcomes required the participants to create something, the assessment activities demanded more cognitive rigour.

Figure 3.2 can be regarded as a sitemap of the intervention that details the hierarchical structure of the entire intervention with the labels that were used.

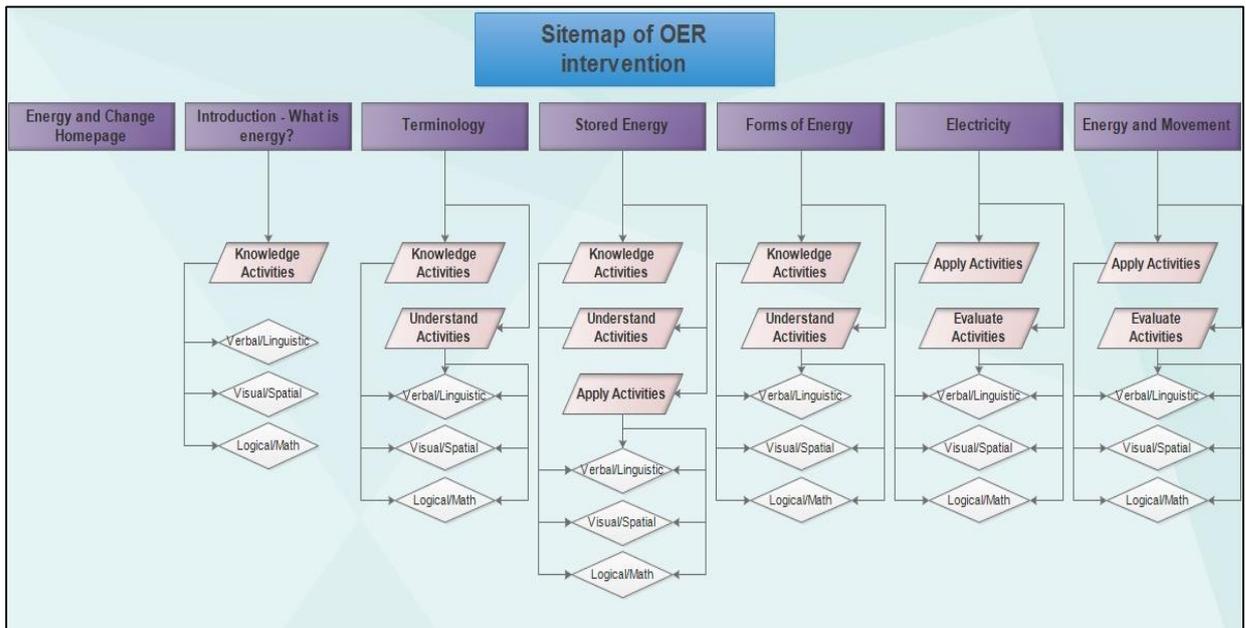


Figure 3.4 – Sitemap of OER intervention

Figures 3.3 and 3.4 are screenshots that illustrate how the physical OER looked from the participants' perspective. Figure 3.3 illustrates the layout of one of the KEs and the sub-menu buttons that guided the participants to the learning activities. Figure 3.4 illustrates how the activities were divided into the three intelligences.

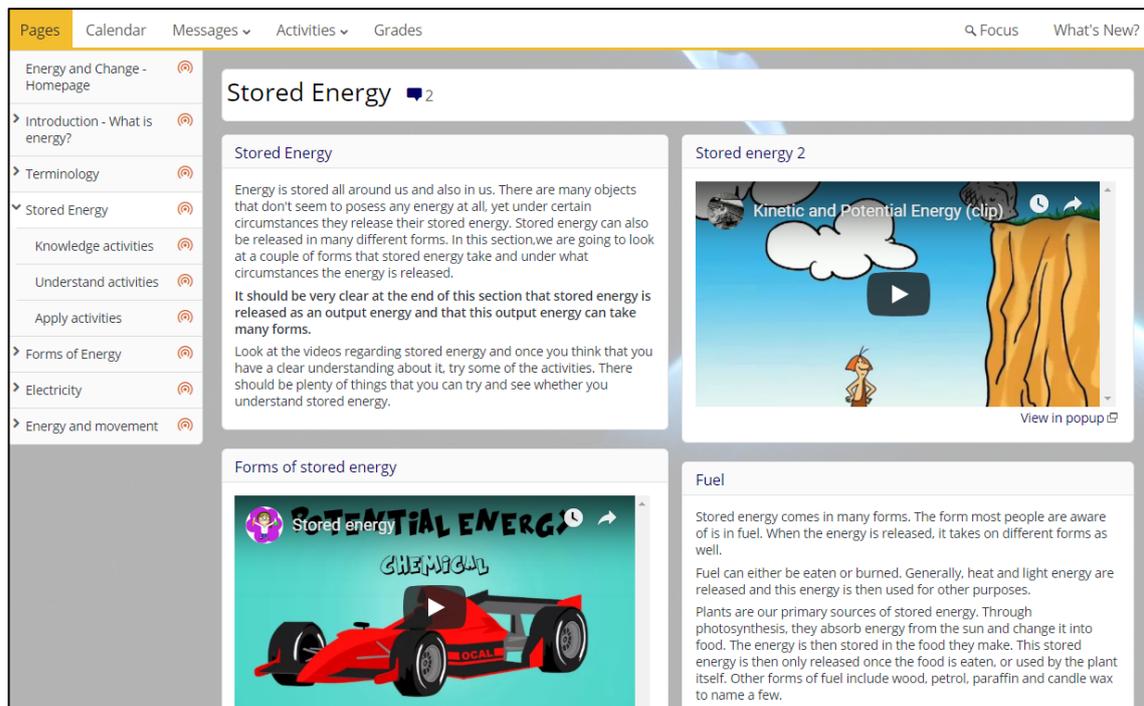


Figure 3.5 – KE screenshot with activity sub-menu

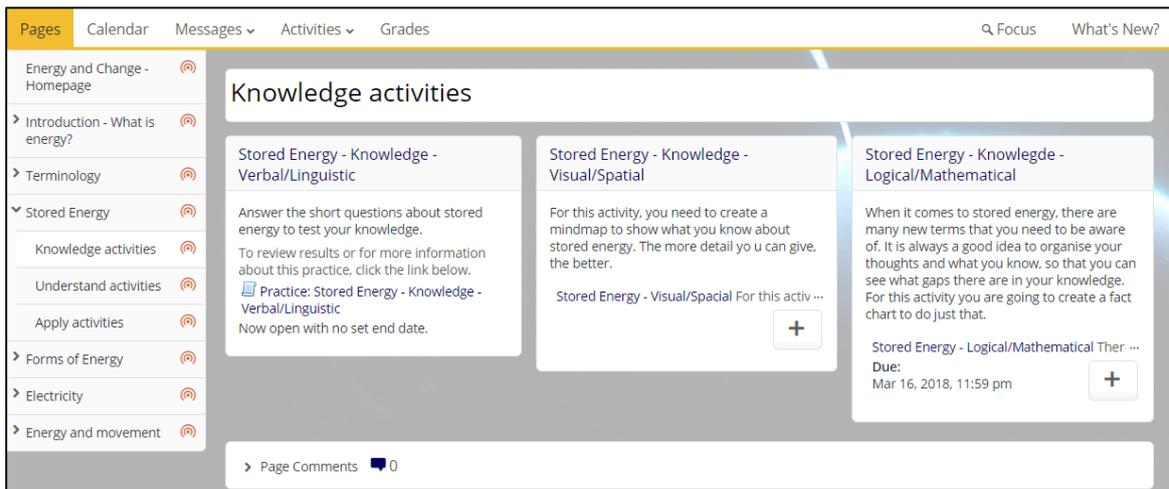


Figure 3.6 – Knowledge activities divided into three intelligences

As stated earlier, *PowerSchool* had built-in features that enabled the researcher to design an array of different assessments. The programme differentiated between assessments and assignments, based on what the learning activities required of the learner in terms of cognitive rigour. The lower order thinking activities were generally developed using the assessment category, whereas higher order thinking activities were designed using the assignment category.

Assessment category – The assessments were designed on the programme itself and provided the researcher with the tools to make short-answer type questions. Figure 3.5 gives an indication of the capabilities of this particular feature.

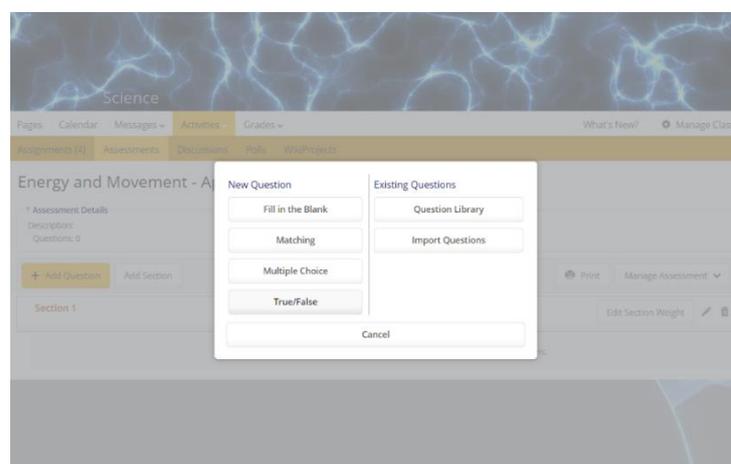


Figure 3.7 – Assessment question types

Assignment category – This category was reserved for higher order thinking activities and enabled the researcher to design activities that did not rely on the built-in software and assessment capabilities. When using the assignment category, he was free to redirect the participants to any online resource via a hyperlink. Depending on the activity, the participants had the opportunity to use either online or offline resources or programmes to complete their assignments and upload the finished product for assessment. Figure 3.6 is a screenshot of one of the assignments that the participants could attempt.

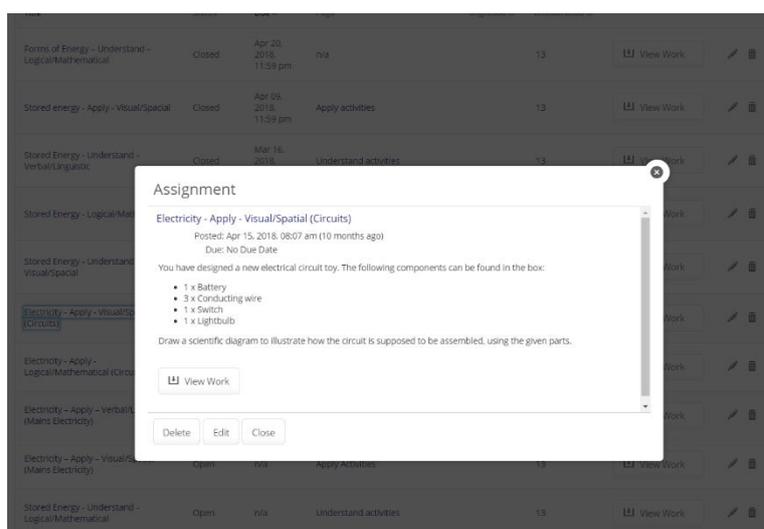


Figure 3.8 – Assignment category

The TIP model was constantly referred to during the design process, but more specifically, phase two and three. The decisions regarding objectives and assessments were largely influenced by the school curriculum and it was decided to mimic the design of the school curriculum to such an extent that all the labels resembled the headings and subheadings of the participants' textbooks. It was believed at the time that it would provide a sense of familiarity for the participant, based on the assumption that they had not worked on an OER intervention before.

After the initial intervention was completed, it was peer reviewed by the Science HOD and another science teacher to establish if the content and activities aligned with the school curriculum. After the review, adjustments were made and the resource was deemed ready for the participants to interact with.

3.5 Conclusion

In this chapter the theoretical framework that was used to design the OER intervention was briefly discussed. Thereafter, the intervention design was outlined and illustrations were provided to inform the reader about the design of the OER intervention. This intervention would form the basis on which data was to be collected.

4. Chapter 4: Methodology

The main question that the research sought to answer was how OER interventions could be designed (at the hands of the Bloom-Gardner Matrix) to facilitate for the cognitive-intellectual diversity in grade 5 Science learners? Due to the nature of the question, a qualitative research approach was necessary and is discussed at length in this chapter.

4.1 Research paradigm

According to Prof Paul Bloom, the two dominating factors that make people different is personality and intelligence. He further mentioned that intelligence involved abstract reasoning, problem solving, and the capacity to acquire knowledge. If people differ in intelligence, the rate at which they acquire new knowledge, the ease at which it is done, and the ability to solve problems would also differ (Bloom, 2015).

If people are then so different, it would be reasonable to assume that the way in which they experience OERs will also be different. For this reason, the researcher chose a qualitative approach to investigate how different learners experienced an OER that was designed to cater for diversity. This allowed him to apply an interpretivist paradigm or epistemological framework as a lens to interpret the results.

4.2 Paradigmatic perspectives

To ensure that the paradigmatic perspectives of the research study was aligned, Saunders, Lewis and Thornhill's Research onion was used as a structural tool (Saunders et al., 2019). Figure 4.1 illustrates the decisions that were made and how they relate to one another.

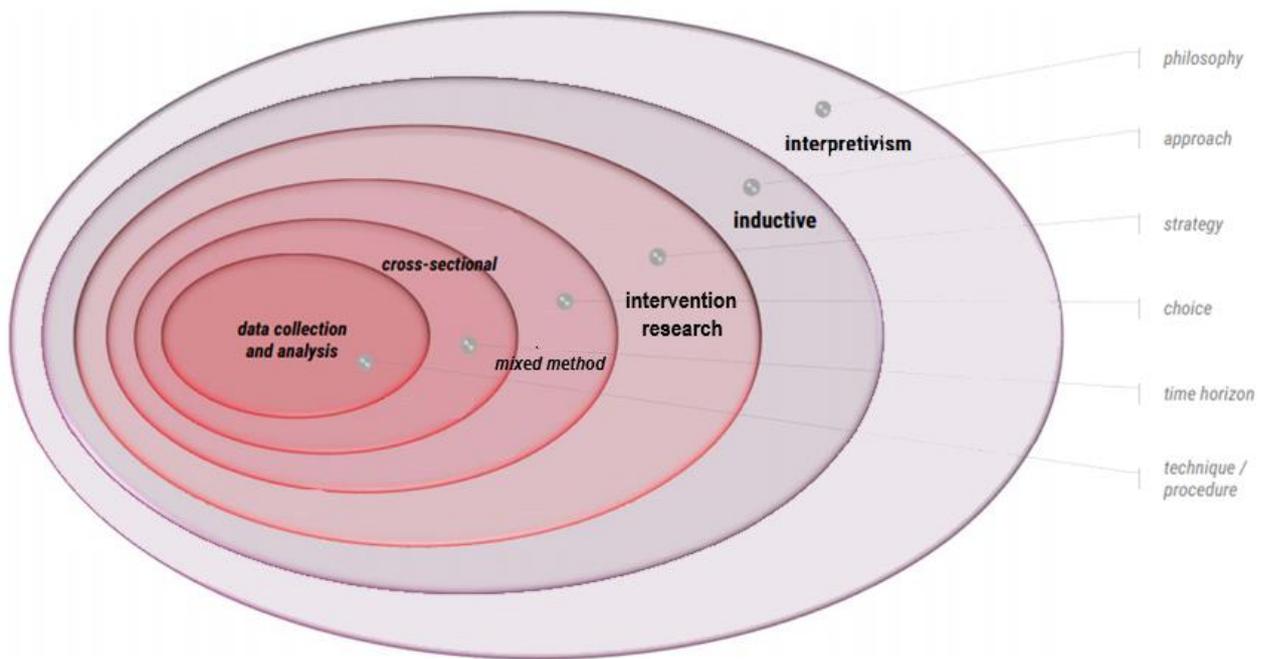


Figure 4.1 – The research onion

4.2.1 Philosophy: Interpretive

According to Athanasou and Maree (2012), the epistemological framework or paradigm is a lens through which the results of a study can be interpreted. It is through this frame of reference that the findings of the study are communicated to others. This study was of a qualitative nature and an interpretivist philosophy was applied as a lens to interpret the collected data. This philosophy sees the world as interpretations of experiences of people in terms of their interaction with each other and their wider social systems (Lincoln & Guba, 1984).

The study sought to interpret the experiences of the participants when they engaged with an OER. The aim was to determine how an OER could be designed to cater for diversity. By basing the research on an interpretivist paradigm, I was able to gather data from a number of different participants, each with his or her own version of truth (Thanh & Thanh, 2015).

The interpretivist paradigm seeks multiple perspectives and favours the use of iterative data collecting methods and active participants to promote holistic research (Willis, 2007, as cited by Thanh & Thanh, 2015). It is more inclusive and accepts different viewpoints from different people. This leads to a more comprehensive

understanding of a problem or situation (Klein and Meyers, 1999, as cited by Thanh & Thanh, 2015). In short, the main purpose of using the interpretivist paradigm was to get insight and in-depth information of OER design by analysing the perceptions and experiences of individuals (Thanh & Thanh, 2015).

4.2.2 Approach: Qualitative

The research was inductive in nature which is generally associated with qualitative research in that it explores and generates knowledge or theory emerging from the data (Gabriel, 2013). The research was aimed at how an OER could be designed to support diverse grade 5 learners with studying Science. Therefore, this study lent itself towards an inductive approach where the collected data was used to determine effective OER design. This was done by determining if there were any patterns in the learners' use of the OER and also analysing their personal experiences while working with the OER.

Inductive reasoning was used to arrive at conclusions and develop design principles for differentiation of OERs. Inductive research implies that the social world, and in this case, the OER, has to be interpreted and understood from the people's perceptions of it (Miller & Brewer, 2003). Nicholls (2017, p. 31) explains the journey of inductive reasoning as follows:

“Inductive reasoning begins with a problem—a germ of an idea—and undertakes a journey of discovery; mapping the local terrain, gathering data, listening, observing, retracing one's steps and, often, taking a different path. The goal of inductive reasoning is to arrive at some theoretical understanding of a problem or a phenomenon as a result of your exploration.”

The journey of this study started at the problem of designing OERs to cater for diversity. The map that was followed on this journey was an actual OER that was designed by applying the Bloom-Gardner Matrix. The observations, conversations and experiences of the participants were used to construct meaning as part of the discovery process (Nicholls, 2017). Ultimately, the aim was to generate theory as to

how OERs could be designed to cater for diversity. This was accomplished by using intervention design as a strategy.

4.2.3 Strategy: Intervention research

Intervention design was the strategy that was applied to conduct the research. In short, the purpose of intervention research is to establish, design and evaluate human interventions which are applicable to real-world situations, with the purpose of solving a particular problem and improving on the quality of life (Comer et al., 2004).

There are a number of models of intervention research, but for the purpose of this study, the Intervention Research (IR) Model was used. The model is divided into six phases, namely:

1. Problem analysis and project planning
2. Information gathering and synthesis
3. Design
4. Early development and pilot testing
5. Evaluation and advanced development
6. Dissemination.

Phase one of the IR model, ran in conjunction with the TIP model as it was used to determine the problem and initiate phase two. The literature review served as a basis by which information on the research problem was gathered. Phase three of the IR model utilized principles of design research to develop the OER intervention.

As stated earlier, the design of the OER intervention was based on, or guided by the TIP model. This model served as the compass and guided the decisions regarding the assessments, learning content and overall objectives of the OER.

Once the OER intervention was complete, it was given to the researcher's HOD and his peers to determine if any changes could be made to the OER. From there, phase five was initiated and the OER was changed according to the suggestions from the peer review. Thereafter the final stage began where the intervention was released to the participants.

4.2.4 Data collection

To support triangulation, data was collected using focus groups and also observations. The triangulation was critical for the facilitating of interpretive validity and to establish data trustworthiness (Maree, 2016).

4.2.4.1 Focus groups

The focus group discussions were semi-structured which gave the study a certain flexibility with regard to the information that was gathered. Maree (2016) advised to have guiding or base, open questions at the ready to steer the interview. These questions were then followed up by further probing and clarification. An example of the focus group protocol can be found in Appendix B.

The questions that were asked during the focus group discussions were aimed at gathering data to answer the main and supporting research questions. Figure 4.2 illustrates which focus group questions were aimed at answering which research sub-question.

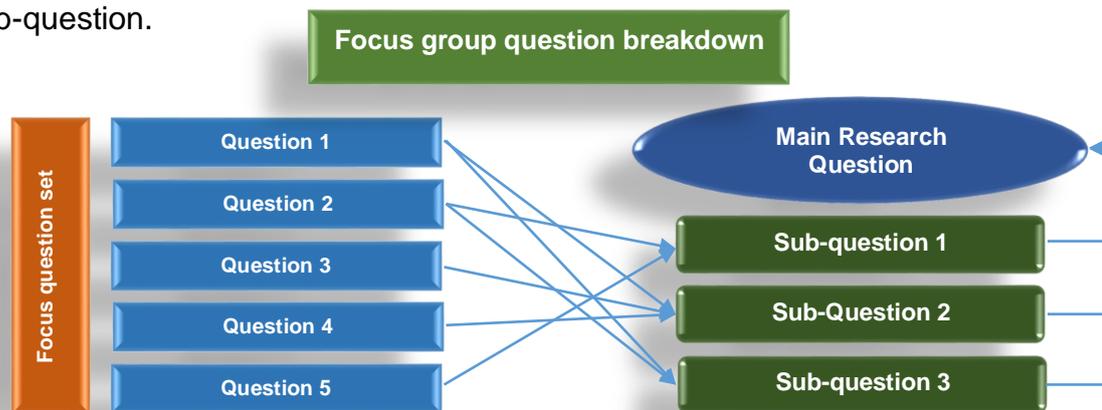


Figure 4.2 – Focus group question breakdown

Each of the focus group questions had sub-questions that provided information that was in turn used to develop a data pool to answer the various research sub-questions. The research sub-questions were then later used to answer the main research question.

4.2.4.2 Observations

The software on which the course was provided, enabled the researcher to observe the learners' use of the OER. The observation was done without interfering with, or influencing the participants. The risk of being biased towards a certain individual,

or focusing on a single event was also greatly reduced due to the fact that the observations were done remotely (Maree, 2016). The observations were not necessarily on the individuals themselves, but rather on the data that they produced as they engaged with the OER. The OER environment allowed the researcher to monitor and observe the participants' choice in activity, the time they spent on the activity, and also the assessment of the various activities.

Furthermore, the participants were also observed during their formal class time. The researcher observed when the participants started to use the intervention and also how the participants interacted with each other regarding the intervention. The entire population was observed during the course of the intervention.

Combined, these findings proved to be useful in determining whether the OER had to be adjusted and whether it was successful in catering for cognitive diversity or not.

4.2.4.3 Population and sampling

The intervention was made available to all the 85 grade 5 learners in the school, which constituted the population of the study. However, only the learners who were taught by the researcher received a letter of invitation to participate in the research study (See Appendix D). The reason for this selection was based on the fact that the researcher could observe them during their formal class time.

Those who indicated that they wanted to participate, received an assent form and their parents had to complete the consent form (See Appendix E and F). Ultimately, the participants of the study consisted of 37 grade 5 learners who were spread across the researcher's four classes. Three of the classes consisted of English speaking learners and one class consisted of Afrikaans speaking learners.

A purposive sampling method, but more specifically, stakeholder sampling was used to select the sample from the participants. Purposive sampling is not a randomized sampling technique and seeks a sample of participants that possess the necessary knowledge and experience to answer the research question (Etikan, 2016).

Stakeholder sampling involves identifying and selecting the major stakeholders who are involved in, and impacted are by the service or programme being administered

(Palys, 2008). Due to the fact that this study focussed on the design of OERs for grade 5 Science learners, purposive sampling was used to select a sample from the grade 5 participants that took part in the OER learning intervention.

The sample engaged with the resource and were in a position to give feedback on their experiences. In doing so, they provided great insight into answering the research questions. The sample was selected, based on the learners' participation and their use of the OER. Therefore, the six participants who interacted with the intervention the most in each class was selected to take part in the focus group discussion. The focus groups made up 64.8% of the participants and 43.5% of the total population.

The main disadvantage of using purposive sampling is that there is a great risk of bias, however, in this particular study that was not the case due to the focus of the study. In other words, the fact that the participants interacted with the intervention, gave them the ability to comment on their experience, as opposed to the participants who could not give an informed opinion due to not using the intervention. The intervention was specifically written for the grade 5 Science curriculum, therefore, it was only made available to the grade 5 learners of the participating school.

4.2.5 Time horizon

Due to time constraints a cross-sectional time horizon was used. The data could only be collected during the second school term, seeing that the Science module that the intervention was created for is done during the second term. Therefore, the participants could only use the intervention while the Energy and Change module was discussed in class. It gave them three months to interact with the resource and allowed the researcher to gather data during this time window. Furthermore, the TIP model requires that the program be run again, however, due to time constraints it was only run once.

4.2.6 Ethical considerations

As mentioned in Chapter 1, the research needed to be conducted without putting the participants at risk or endangering them in any way. Therefore, careful attention was paid to the ethical considerations.

4.2.6.1 Harm/Risk mitigation

The OER that the participants accessed was online and the main risk that needed to be addressed was exposure to unwanted material. Although the OER was located on an educational website, there was still a chance that they could wander from the prescribed work and view harmful material. To minimize this risk, the researcher needed to obtain informed consent from the parents of the learners, ensure their anonymity, avoid deceptive practices and provide the participants with the right to withdraw from the study ("Principles of Research Ethics," 2012).

Informed Consent and Assent

The consent form for this particular study included details as to the purpose of the research, the methods that were used and also the possible outcomes of the research. Furthermore, participants were also informed with regard to what was expected of them and the possible inconvenience they could face in accessing the online material. The potential benefits were also clearly stated in the consent form as well as a statement that enabled them to withdraw from the study at any time.

The age of the participants classified them as being vulnerable and therefore required the researcher to obtain their assent and also parental permission to take part in the study ("The Informed Consent Process with Children," n.d.). To obtain the participants' assent, the researcher provided them with the opportunity to read through the assent form and clarified any queries that they had regarding the research.

Anonymity and Confidentiality

Although anonymity and confidentiality are closely related, there are clear distinctions between the two principles. Anonymity is linked to a name or author that is unknown, while confidentiality refers to something that was spoken in confidence (Wiles et al., 2006). Wiles also mentions that confidentiality makes little sense in a research context seeing that the researcher has to report on his/her findings. This cannot be done if the gathered information is confidential. Researchers can however, ensure that the participants' identifiable information will not be disclosed in order to protect their identities. This is done through various processes that are designed to anonymize them.

It was of the utmost importance to protect the identities of the participants and also to ensure confidentiality. If this principal was not applied carefully, the participants would have been at risk of harm ("Principles of Research Ethics," 2012). The participants took part in the research on a voluntary basis and would have likely only felt comfortable if they were assured of their privacy. Therefore, all data that was collected was stored in a secure digital network. All names were removed from the research report and pseudonyms were provided. The participants' characteristics were also altered to further anonymize them (Wiles et al., 2006). Sensitive data was only disclosed if permission was given. The participants were also informed as to who had access to their data. These individuals generally only included those people who were actively involved in the research.

4.2.6.2 Conflict of interest

A conflict of interest occurs when the professional judgement regarding a primary interest is unduly influenced by a secondary interest (Lemmens, 1998). To preserve trust, and consequently, the integrity of the study, when a conflict of interest is identified the researcher needed to take the responsibility to disclose the secondary interest to the participants to preserve trust.

The researcher was also the teacher of the participants which could have had an influence on the outcome of the study. However, when the focus group discussions took place, the researcher conducted regular member checking to ensure that his opinions did not cloud his interpretation of what was said by the participants. Furthermore, his observations were also shared with the participants to establish whether they concurred with his opinions.

4.2.6.3 Beneficiation, reciprocity and remuneration

Beneficiation is the direct benefit for the participants, their community and also their organization as a result of participating in the research (University of the Free State, 2015). By taking part in the study there was a potential benefit for the participants with regards to science education. The school could also have potentially benefited, seeing that a new OER design were to be developed to improve the learning of their grade 5 learners. The knowledge gained from the research could be translated and applied to the other subjects in the school as well.

Concerning the reciprocity of the study, there was not an implicit benefit for the participants who took part in the study. However, given the nature of OERs, the participants had access to quality resources to do with as they saw fit. This could also have served as remuneration for taking part in the research seeing that there was no monetary remuneration for taking part in the research.

4.2.7 Data analysis

Coding was the main means by which both sets of data (focus group discussions and observations) was analysed. By coding the data from the focus groups and observations, I was able to identify themes and overarching connections and was able to come to various conclusions (Gibbs, 2013). Figure 1.2 is a visual representation of the focus group data analysis process.

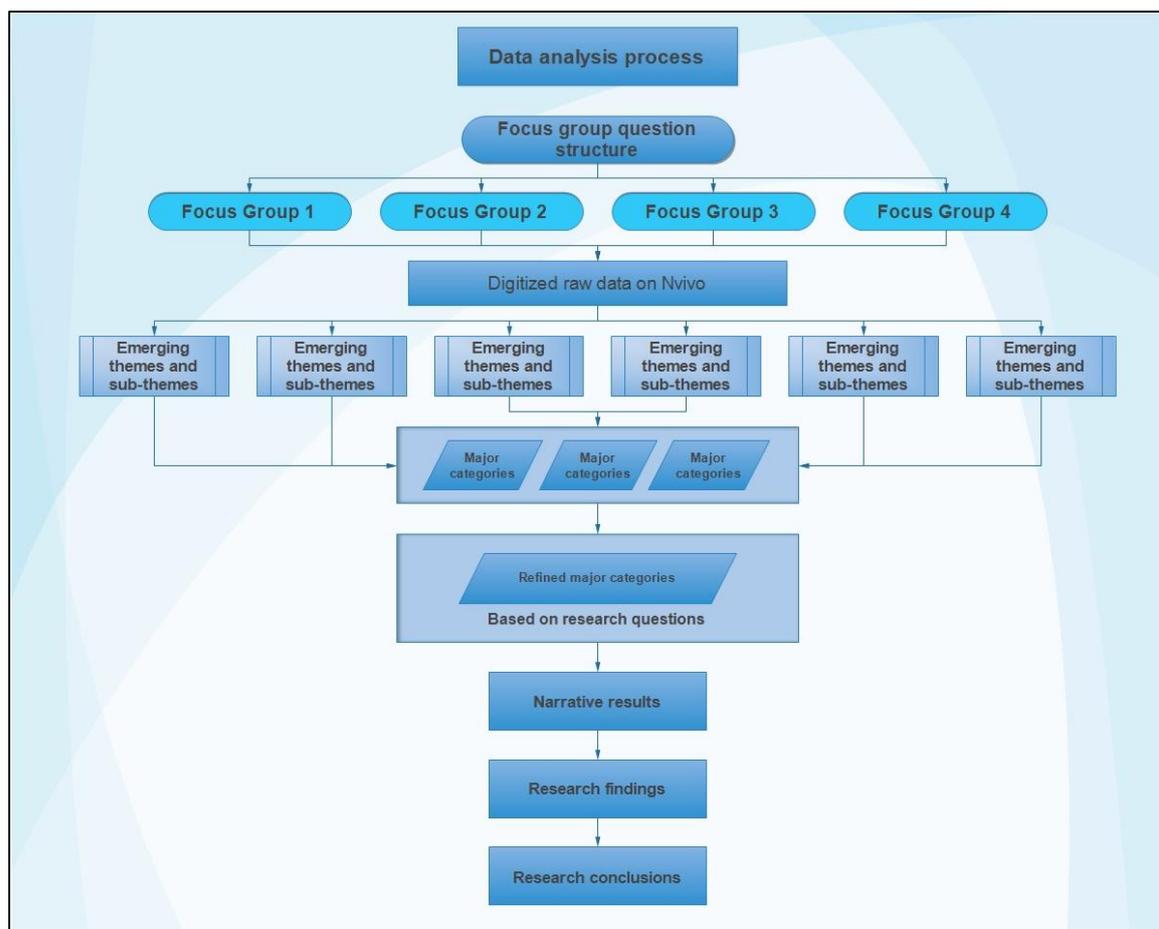


Figure 4.3 – Data analysis process

4.2.7.1 Focus group discussions

To better understand how an OER can be designed to facilitate for differentiation, the researcher conducted four focus group discussions where the participants responded to a semi-structured interview. There were a set of open-ended questions and the participants were encouraged to express their experiences, whether they were positive or negative. While the participants answered their questions, the researcher paraphrased what they had said and summarised their responses. To ensure that he paraphrased and interpreted their responses correctly, he read his notes back to them to ensure that he had not misunderstood their responses.

When all the focus group discussions were concluded, he converted his notes and the paraphrased responses into a digital format which he loaded onto **Nvivo**, a qualitative data analysis programme. Once all the responses were loaded up, he proceeded to give each participant a pseudonym.

He started to code all of their responses and emerged with a number of themes and sub-themes. To ensure that he did not miss anything, he also used the software's own theme generator. He did a comparison check between my own codes and those generated by the software itself and found that there was a high correlation between the two sets of code (**See Annexure A**). Table 5.1 is an extract of the correlation table that Nvivo creates to check similarities of codes between the manual codes and the codes that were generated by the software automatically.

Table 5.1 – Nvivo correlation report extract

Code	File	Agreement (%)	Disagreement (%)
Activities	Focus Group - 5A3	99.45	0.55
Activities	Focus Group - 5E1	99.37	0.63
Activities	Focus Group - 5E2	97.63	2.37
Activities	Focus Group - 5E3	100	0
Activities or Assessments	Focus Group - 5A3	99.15	0.85
Activities or Assessments	Focus Group - 5E1	100	0
Activities or Assessments	Focus Group - 5E2	100	0
Activities or Assessments	Focus Group - 5E3	100	0
Activities	Focus Group - 5A3	99.45	0.55
Activities	Focus Group - 5E1	99.37	0.63

The first column gives a description of the code that was created and the second column describes what file the code was created in. The names of the files were given for each of the focus groups. Focus Groups 5E1 – 5E3 were the focus groups that came from the English classes and Focus Group 5A3 was the Afrikaans focus group. The agreement and disagreement columns indicates how the two sets correlated. The higher the agreement percentage, the higher the similarities between the two sets of code (user generated and computer generated).

The calculations were done automatically by the software and only needed to be exported from the software.

The researcher then proceeded to group themes that were related to one another and created sections. These sections were organised in such a way that they addressed the research questions. The software also allowed him to draw various graphs and provided him with vital statistics and visual representations regarding the participants' responses.

4.2.7.2 Personal observations

The researcher also observed the participants and monitored their use of the OER. While doing so, he made notes of his observations and commented on their attitudes and their general use of the OER. These observations served the purpose of providing further data to answer the second research sub-question.

All of the coding data results were then written up in a narrative form and the structure or logical order thereof was based on the research questions. These results were then further condensed and the findings and conclusions were presented.

Furthermore, the analytics data, provided by the software, together with the submitted assignments and completed assessments, provided him with statistical information that was used to determine which activities were used more often than others. By analysing this data, he could determine which elements were used more frequently and consequently give an indication of which elements to include when designing an OER that caters for cognitive diversity.

The results of the activities and the feedback from the participants also made it possible to arrive at certain conclusions with regard to the revision of the intervention. Ultimately, the collected data pointed towards both the positive and negative aspects of the intervention and consequently provided insights as to how OER interventions could be designed to facilitate for cognitive-intellectual diversity.

4.3 Methods taken to ensure validity

According to Golafshani (2003), the nature of qualitative research requires that the traditional notion of validity be changed from its quantitative perspective. Golafshani goes on to say that validity is conceptualized as trustworthiness, rigour and quality in qualitative research and that it is achieved by eliminating bias and increasing the researcher's truthfulness by using triangulation. However, Leung (2015) stated that validity in qualitative research referred to the appropriateness of the tools, processes and the data. In terms of this research study, both views of validity were combined to ensure that the results, findings and conclusions were indeed valid.

4.3.1 Sampling

In general, purposive sampling is associated with bias, seeing that no randomizing strategies are used to select a sample. However, in cases like this particular research study, purposive sampling was used due to the ability of the participants to communicate their experiences and opinions in a reflective manner (Etikan, 2016). Their experience with the OER enabled them to comment on its efficacy and provide insights into how it could be improved.

The characteristics of the participants were diverse in terms of gender, language, culture and ethnicity, however, this was not the main reason why they were selected for the sample. Their direct interaction with the OER intervention made them ideal candidates for data collection. Seeing that the sample consisted of a group of participants from four different classes, they constituted a representative of the population and consequently provided external validation.

4.3.2 Focus group discussion

The purpose of the focus group discussions was to gather information on the participants' experiences, attitudes, beliefs and to triangulate the researcher's observations to ensure validity (Gibbs, 1997).

4.3.2.1 Researcher bias

The researcher was known to the students and this could have provided grounds for being bias. However, as mentioned in par. 4.2.6, member checking was employed to ensure that what the researcher recorded, was a true representation of what was said during the focus group discussions. To ensure that the participants were not coerced into participating, the researcher employed the help of the register teachers to recruit the participants on his behalf. The register teachers were to answer any queries that the participants might have had. If they could not provide an answer, they were to enquire of the researcher what the solution to the problem could be.

Furthermore, the intervention itself was peer reviewed to ensure that the content was age appropriate and that the assessments and activities mirrored the CAPS curriculum.

4.3.3 Analysing of data

Coding was used to analyse the data and more than one measure was taken to ensure the validity of the data analysis. Firstly, member checking was used to ensure that the notes that were taken during the focus group discussions, reflected a true account of what the participants said. (Creswell & Miller, 2000). Furthermore, the data was coded and returned to time and again to ensure that the themes, categories and other constructs made sense. According to Altheide and Johnson (1998), this process is called validity-as-reflexive-accounting.

Furthermore, the codes were also based on the conceptual framework and the supporting research question were used as a guide to develop the various themes that emerged from the codes.

4.4 Conclusion

In this chapter, the researcher presented a thorough account of how the research was conducted. He outlined how the population was structured and also how a sample was selected from the participants. Furthermore, he described how the data was collected and analysed. The following chapter contains the results from the research and is written up in a narrative form and includes tables and figures to illustrate the data that was collected.

5. Chapter 5: Research results

Participants were invited to interact with an OER that was designed to supplement their formal school work, more specifically the grade 5 Science module for *Energy and Change*. The design of the intervention and the theoretical framework that it was based on, is discussed in detail in Chapter 3. The participants were encouraged to use, navigate and critique the OER during a three-month period. In order to answer the research questions, data was collected by conducting four focus group discussions and observations. In this chapter the researcher began by breaking down the data that was collected over a three-month period and provided a summary for each of the data sets.

5.1 The research problem and question

The idea of OERs is a noble one and institutions like UNESCO who are driving international improvement in education are investing massive amounts of resources in OER development (UNESCO, 2015). However, since 2002 when they coined the term OER, very little quality research has been done on the use of OERs (Clark & Mayer, 2016). The main reasons why people access OERs are for personal enrichment, supplementing course work and planning for presentations or lessons. Other than that, very little research has been done on the efficacy of OERs.

Merely providing the resources is not enough. Richter and McPherson (2012) stated that providing the resources could be counter-productive seeing that they aren't necessarily designed with inclusion in mind. The very essence of the drive for OERs is built on the fact that they can be accessed by anyone, however, therein lies the problem. Felder and Brent (2005) stated that the users of OERs are just too diverse, therefore, a single OER will have very little chance of catering for this diversity.

To address this problem, the following questions were asked to establish how OERs could be designed to facilitate cognitive-intellectual diversity for grade 5 Science:

Main research question

- How can OER interventions be designed (at the hands of the Bloom-Gardner Matrix) to facilitate for cognitive-intellectual diversity in grade 5 Science learners?

Supporting questions

- Which activities can be designed in an OER intervention to support curriculum differentiation for science learning for grade 5 learners?
- How do learners utilize the OER?
- What design aspects have an influence on learning in this OER intervention?

An online intervention was designed, using elements of the Bloom-Gardner Matrix, to facilitate for differentiation. In so doing, the participants had ample choice on how they could utilize the OER to support their formal education. The resource was designed using the **PowerSchool K-12 Digital Learning Platform**.

With each section of work in the OER, the participants had the choice to do activities that ranged in difficulty. The activities were further differentiated according to three of the intelligences theorised by Howard Gardner. Participants had the opportunity to do either visual/special, mathematical/logical or verbal/linguistic activities. There was no set order in which they had to use the OER. Instead, they had the freedom to navigate the sections which they felt drawn to.

By observing the participants' use of the OER the researcher could formulate guidelines in terms of elements that they were more drawn to, as well as elements that deterred them from using the resource. The focus group discussions gave further insights and more detail as to what they found more useful. Out of each class (four classes in total), six participants were chosen to take part in the discussion. Three of the four classes consisted of participants who were native English speakers, however all the learners were bilingual to some degree. The remaining class consisted of participants whose mother tongue was Afrikaans, but they were also proficient in English. During the discussion, each participant had an opportunity to provide his or her account for every question that was asked.

5.2 Focus group results

By coding their responses, the researcher was able to draw up a number of themes that were grouped together into four sections. The emerging themes were grouped together in the following sections:

- The physical design and features of the intervention and activities
- The structure of activities or assessments
- Emotional observations
- The value of differentiation

Figure 5.1 is a diagrammatical representation of how the sections were created.

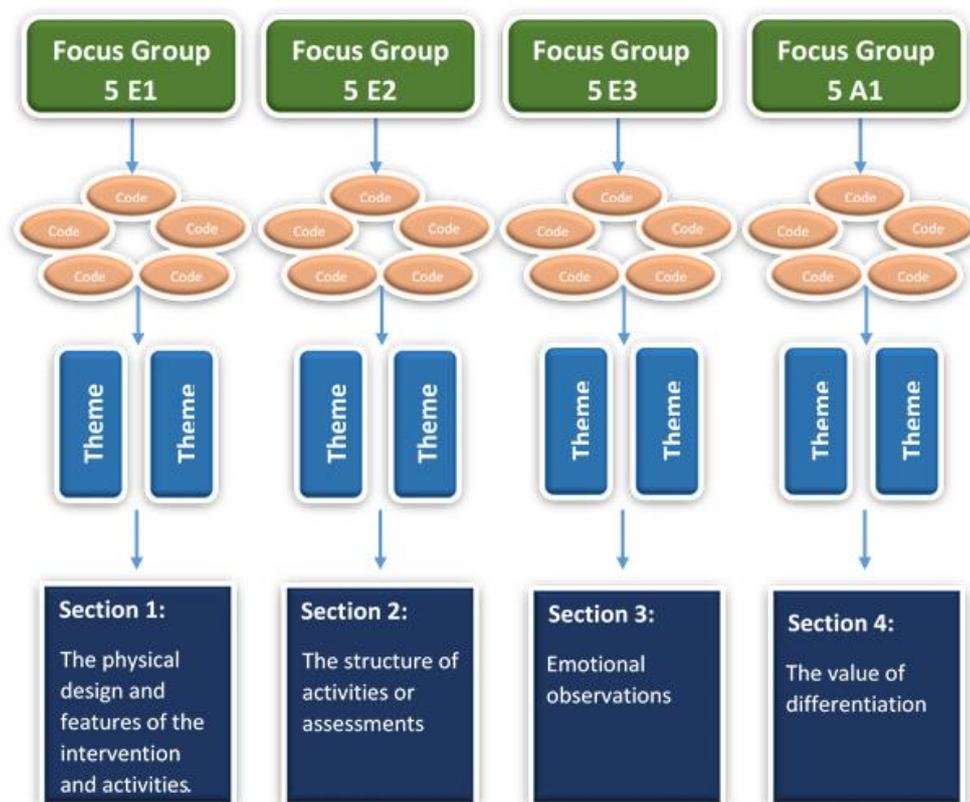


Figure 5.1 – Code section creation

Firstly, the researcher coded all the transcripts from the focus group discussions. All of the codes that related to one another were then grouped together to form a theme. The themes that related to one another were then grouped together in the above-mentioned sections. These sections were designed to group the data in such a way that the research questions could be answered. Any irrelevant data or code was discarded and not used in the data pool.

As mentioned earlier, there were four focus groups and the participants of the focus groups were chosen due to their use of the OER in each class or group. To ensure anonymity, each participant is referred to by a pseudonym.

Table 5.2 – Focus group participants

Group A3	Group E1	Group E2	Group E3
Lisa	Jane	Paul	Adel
Nathan	John	Kimmy	Amy
Bob	Danny	Dorothy	Barney
Billy	Peter	James	Marsha
Sally	Joyce	Ingrid	Molly
Mike	Sarah	Brad	Neval

5.2.1 Physical design and features of the intervention and activities

For the purpose of the study, the physical design aspects refer to the layout, colour, images and fonts. From the responses there were four main categories of the physical design aspects that overlapped, namely, the *physical design* of the intervention page, *browsing and navigation*, *useful features* and *missing features*.

5.2.1.1 Physical design

Based on the responses of the participants, the physical design of the OER intervention could be divided into two main categories:

- a) **The design of the intervention page** and;
- b) **The design of the various activities.**

In general, the participants found the overall layout of the intervention to be user friendly. It has to be said, however, that the vast majority of the sample were unfamiliar with OERs and it was the first time that many of them had utilized an OER intervention.

During the focus group discussions, the participants were asked if they had any prior knowledge of OERs. Their responses indicated that there were two main categories of users, namely, first time users and users with prior OER knowledge. Chart 5.1

indicates the percentage of first-time users as opposed to users with prior knowledge of OERs.

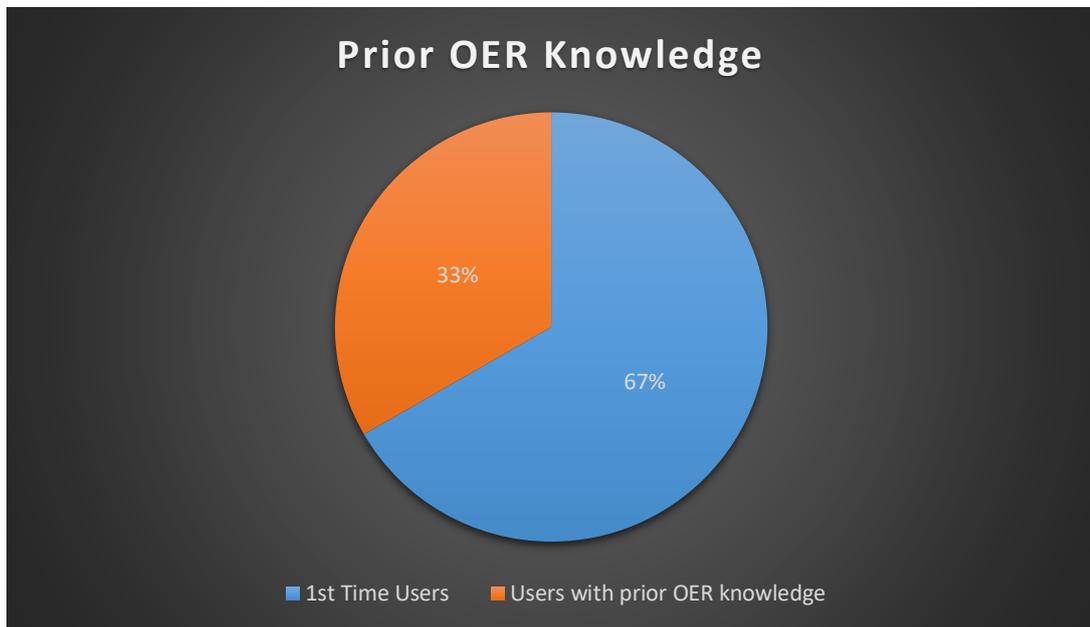


Chart 5.1 – Prior OER knowledge

That being said, of the 33% who had prior knowledge of OERs, only 25% had ever attempted to use an OER intervention prior to the research intervention that they took part in.

For instance, Peter mentioned that he “*never bothered using them*” and that he “*didn’t think that they would cover the work done in school*”. On the other side of the spectrum, Neval mentioned that he had known about OERs and always wanted to use them, but “*somehow never got around to it.*”

For the participants who had some prior knowledge of OERs, working with the intervention came more naturally and they also tended to be more confident in using it. On the contrary, the 1st time users found the intervention intimidating at first and grew into using it more freely and without fear.

Chart 5.2 gives an indication of the negative and positive emotional responses that the participants gave, but also highlights the participants who didn't have any previous knowledge of OERs. Whenever they gave an emotional response, it was coded and categorised into the groups indicated in the *Emotional responses and previous OER knowledge* chart (Chart 5.2).

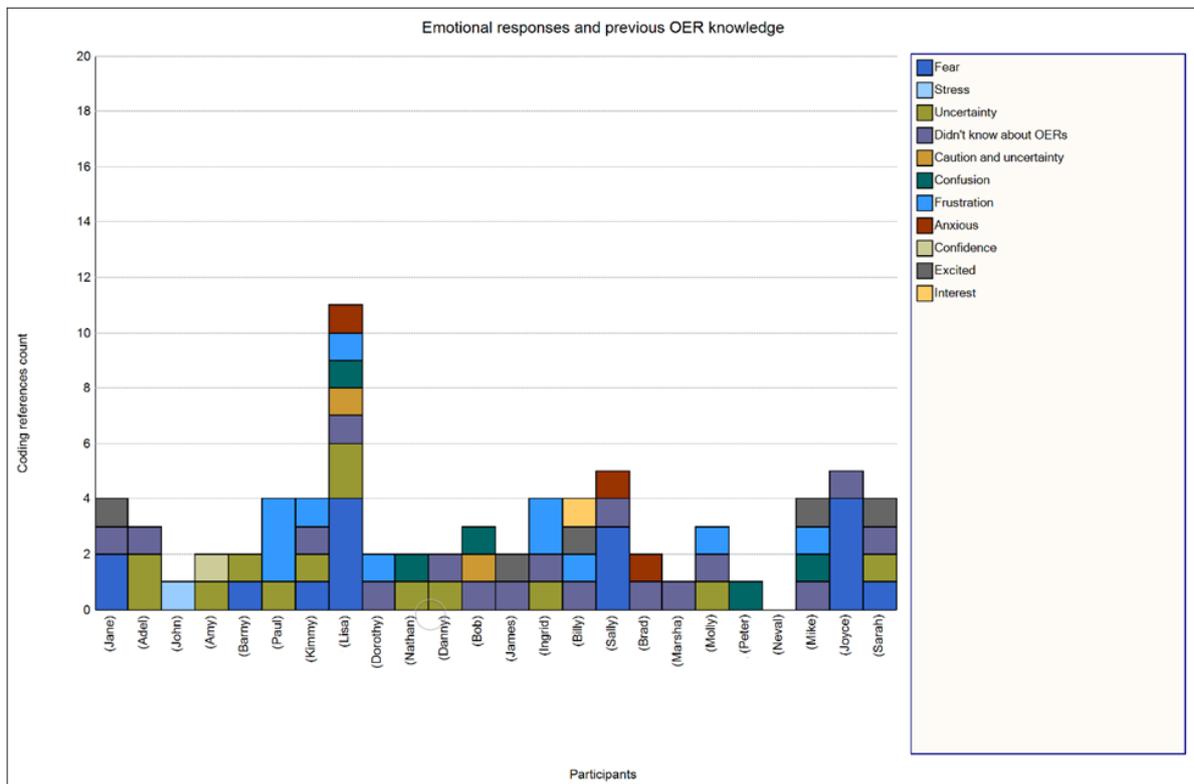


Chart 5.2 – Emotional responses and previous OER knowledge

From the above chart it is clear to see that the participants who did not have any previous knowledge or experience with OERs (those participants with a purple block in their bar of the chart), had some or another negative experience. Lisa and Joyce in particular made a number of references to fear or being afraid of something while they used the OER.

In Lisa's case, her reasons for her fear ranged from being a first time user to not wanting to miss anything. She also mentioned that she was afraid of breaking the intervention in some manner. Joyce also mentioned that being a first-time user was somewhat intimidating, but one of her bigger concerns was that she had to register on external websites in order to complete certain activities.

When I tried some of the activities I was sent to other pages that asked me to register and stuff. That scared me, so I left those activities.

a) The design of the intervention page

In general, the participants viewed this aspect of the intervention's physical design in a positive light. The participants found the layout of the page to be neat and uniform. The headings of the various sections stood out which made navigation easy.

The side menu bar was of particular value and gave the participants the confidence to use the resource more freely. Lisa made an interesting comment when she said:

I am also like Sally in that I had to read through everything. That was a bit of a bummer because there was just so much to read. I was too afraid that I would miss something or do something wrong. But when I started with the second section, I saw a pattern and felt a bit more confident.

Danny, Marsha, Amy, Barny and Sarah also noticed the pattern of the OER, especially with regard to the structure of the activities. They saw that the activities were arranged from simple to more complex. Danny alluded to the intelligences when he said that they were presented in “*three different ways*”. Sarah also mentioned something to the same effect when she said that she “*saw the three columns of assessments every time and also ranging in difficulty*”.

However, there were participants like Kimmy who found the page unattractive. They were of the opinion that the colours were plain and not many things stood out:

The whole page was bland and boring. It was easy to move around, but I can't say that too many things stood out besides the obvious pictures and stuff.

Adel also found the whole page to be boring. She was of the opinion that there weren't enough pictures and videos. However, her biggest problem with the intervention was that it was not a linear resource. She posed the question as to why all the information couldn't be sequenced underneath each other. However,

regardless of her dislike of the non-linear organisation of the content, the headings were sufficient for her to navigate with ease. Figure 5.2 is a screenshot of the homepage of the intervention:

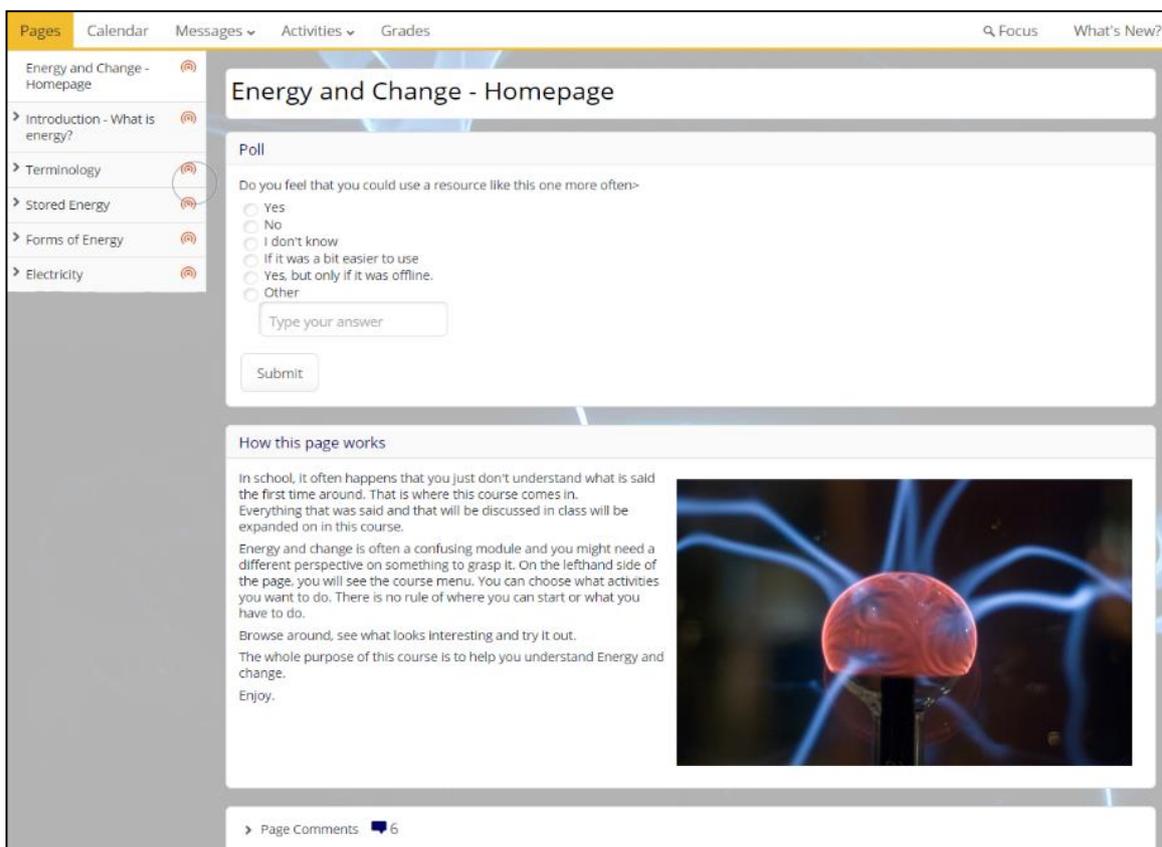


Figure 5.2 – Screenshot of OER intervention Home page

In terms of the content of the resource, the participants found the informational videos to be of great value. There wasn't a single participant who thought the videos were uninformative or didn't add value to the resource. On the contrary, there were four who felt that there weren't enough videos.

Another feature of the intervention that added value to the participants' experience of the resource was the fact that the labels of the different buttons resembled the labels of their curriculum. As Danny mentioned, navigation of the intervention was easy because he just looked for the familiar parts and worked from there.

When I got to the homepage I knew where to go, so I started with the work we just did in class.

The intervention contained a fair amount of text and it was mentioned by certain participants that the amount of reading was cumbersome and discouraged them. Sarah mentioned that “*if you don’t like reading, you would have struggled*” to use the resource. However, despite having to read through all the text, participants like Kimmy still enjoyed using the OER.

One part of the design that was flawed, however, was the links to external websites and resources that the participants needed to access in order to complete certain tasks. According to Bob, he “*struggled to find the links. The colour of the links were too close to the normal text colour.*” Jane, Paul, Ingrid, Adel and Dorothy had similar issues concerning the visibility of the external links. All of them were of the opinion that the links could have been highlighted better.

Assignment

Terminology Mindmap

Posted: Mar 06, 2018, 09:05 pm (about 1 year ago)
Due: No Due Date

Use one of the following online mindmapping tools to create a mindmap or an infographic about the terminology of energy. You should include any and all information about the terms that you know.

There is no fixed structure of how this should look. You can decide on how the information is represented.

The following terms should be included into your mindmap or infographic. You are more than welcome to add terms to the list that give you a better understanding about energy.

1. Fuel
2. Stored energy
3. Input energy
4. Output energy
5. Elastic
6. Transfer of energy.

Here are the sites that you can use:

- Mindmup
- Canva
- Bubble.us
- Vennage

Unclear links

View Work

Close

Figure 5.3 – Screenshot of OER links to external resources

b) The design of the various activities

As mentioned in the previous chapter, the intervention was designed using the Bloom-Gardner Matrix. The purpose of the matrix was to expose the participants to as many different types of activities as possible. In doing so, the researcher was able to establish how OERs could be designed to facilitate cognitive-intellectual diversity for grade 5 Science learners. Each study unit had Verbal/linguistic, Visual/Spatial and Logical/Mathematical activities. Each set of activities was aimed at answering the same question or targeting the same problem.

The participants were free to choose any and/or every activity and were not restricted in terms of progression. Therefore, any activity was available for them to do at any time. Together with having the freedom of choice, there was also no time-limit for completing the activities. This approach was met with mixed responses. Chart 5.3 outlines the number of times the participants alluded to having either positive experiences, negative experiences or mixed experiences.

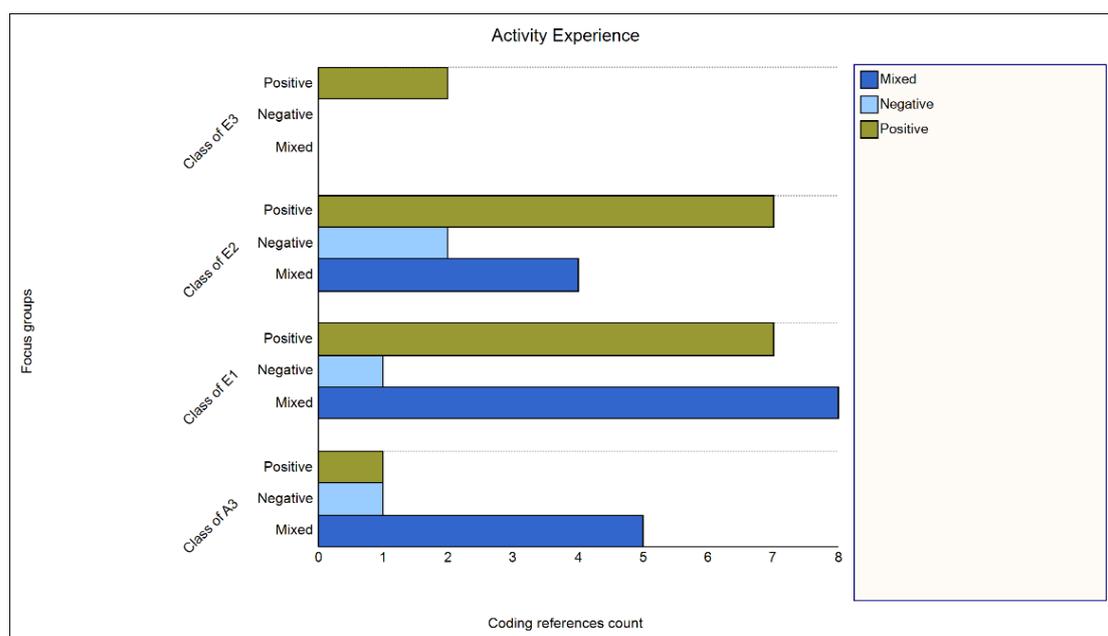


Chart 5.3 – Participants’ experiences of the activities.

Within each focus group, the researcher coded their responses as being either positive, negative or mixed. Whenever a respondent’s response alluded to a negative experience, it was coded as a negative experience whereas the opposite was noted for positive experiences. The mixed code was recorded when participants were undecided, or mentioned both negative and positive experiences.

In general, the participants experienced the activities very positively with 17 positive responses. The proportion of participants who had negative experiences, amounted to only four. It was, however, interesting to see the amount of mixed responses that the participants gave when asked how they experienced the intervention. These responses were equal to that of the positive responses. Their reasons for having mixed experiences were grouped together in five categories and were coded as such. Whenever a participant gave a reason for a mixed experience it was coded according to the various categories. Chart 5.4 provides a summary of all the reasons why some of the participants had mixed experiences.

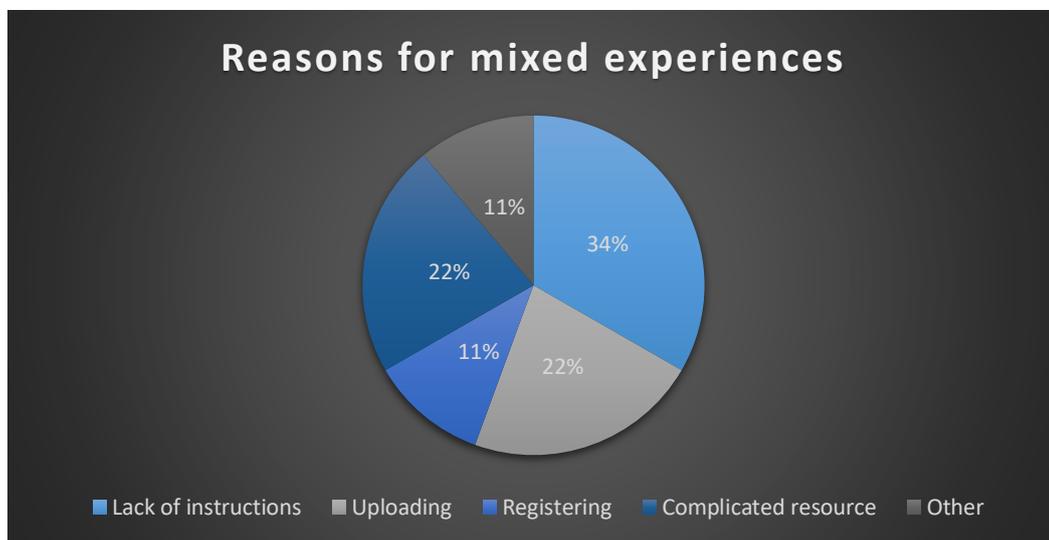


Chart 5.4 – Reasons for mixed activity experience

Although they found some of the activities stimulating, they were generally discouraged from doing particular activities where they had to leave the intervention page. The external sites where they had to register or learn how to use the resource was a particular deterrent due to the fact that the resources were too complicated. Activities where the participants had to upload their assignments were also not received with enthusiasm. For many of these participants, the process was unclear and they tended to pass on these activities.

The biggest reason for having mixed feelings about the assessments were the lack of instructions. Where some participants found that the instructions, as to what the activities required of them, lacked detail, other participants were more concerned about the lack of instructions on how to use the external resources.

Molly summed it up well in her response when she said:

Like the icon activity. How am I supposed to make an icon? I didn't even know that you could make icons. I thought only like computer people made them. A bit of guidance would have been nice.

Marsha also gave some good insights when she remarked that:

The instructions are the only thing that I would change. You don't have a teacher who can explain something if you don't understand. A tutorial would at least show you what was expected of you.

5.2.1.2 Browsing and Navigation

Before the participants were given access to the OER, they were told how to use the intervention. It was explained to them that they didn't have to follow a particular order of browsing. On the contrary, they were encouraged to do whatever they wanted, in whatever order they wanted. The Bloom-Gardner Matrix is designed with the intention of allowing a learner to choose a path of learning. However, in this case, the differentiation was used as a means to determine which activities, learners would prefer to have in an OER. Therefore, they were given the opportunity to explore the OER in whatever way they saw fit. Chart 5.5 indicates how the participants browsed the intervention and summarises the code count for the participants' browsing behaviour.

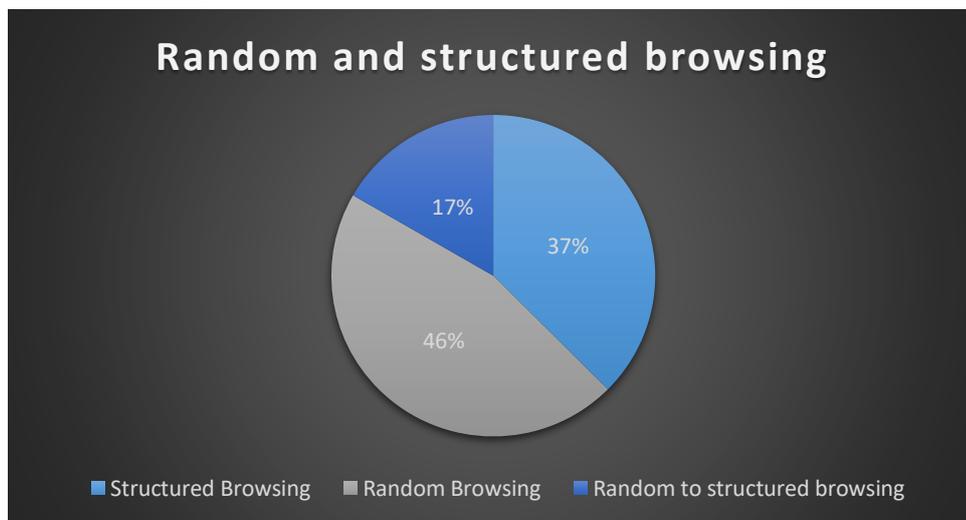


Chart 5.5 – Random vs Structured Browsing

a) Structured browsing

Even though the participants were given the opportunity to browse and use the intervention in any way they wanted, 37% of the sample still felt the need to browse and use it in a linear way. They worked from the top to the bottom in the order that it was given. One of the main reasons for their browsing was a fear of missing something important.

Nico stated that he was a bit nervous and overwhelmed by the amount of activities, whereas Sally mentioned that she wasn't sure what she was doing, so she just worked from the top down. In Kimmy's case, her fear of missing some important work forced her to work in a linear way, despite feeling discouraged.

I felt very unsure about the whole thing. I felt that I had to do everything and kind of got discouraged at times. Although there were choices and I didn't have to do everything I still felt like I would miss something.

The other main reason for their structured use of the OER was based on the work that was being done in class. Danny pointed out that the OERs headings were the same as the work that was done in class and just followed the course in that manner. Peter, Adel and Barny also structured their browsing, based on the work that was being done in class. This could point to a potential guideline when designing an OER intervention in that the intervention could run in conjunction to a particular unit of study in a course.

b) Random browsing

Forty-six percent of the participants enjoyed the fact that they were not bound to a specific structure. They enjoyed the freedom to browse and use the OER on their terms. Some of the participants mentioned that the structure allowed them to do only the sections that interested them or where they felt they needed more clarity.

Surprisingly, curiosity was the main reason for their browsing habits. Dorothy, Mike and Billy mentioned that their interest was sparked by things that looked important. Billy went on to say that in the end, he merely sought the videos out, stating that they were “cool”.

c) Random and structured browsing

By far in the minority in terms of browsing habits, was a group that started out on a random path, but soon found that they would be much more effective if they worked in a more structured manner. This was mainly due to the order in which the curriculum was being followed in class.

Molly captured the reasoning of this group when she said:

I started by just browsing here and there, but the sections on the left of the screen caught my eye because it was exactly like we did in class. From there I just followed at the pace of my school work.

5.2.1.3 Missing features

Although this was the first time that most of the participants worked on an OER, there were elements that they lamented for not being present in the intervention. In some cases, the participants compared the OER to other paid software and wanted the same functionality.

Although there were practical activities, eight of the participants felt that there needed to be more. However, there were also those who felt that there needed to be more activities that they could physically do. Peter said that he wished “*there were ones that we could physically do at home*”. Danny also mentioned that “*if there were more online experiments or practical activities that we could do at home, that would have been super cool*”.

James commented that he would have enjoyed a feature or activity where “*you had to make a home video or demonstration of something. Or if there was something that you could do with a friend*”.

James touched on another element that a number of participants would have enjoyed, namely, gamification or social interaction. Kapp (2012) states that gamification utilizes game mechanics, aesthetics and game thinking to encourage learning and academic interaction.

James, together with Peter, John, Kimmy, Brad and Adel mentioned that they wanted to compete against their friends. Together with gamification, they also wanted to be awarded badges and have the ability to personalise their profile by adding an avatar. John summarised their sentiment when he said:

I do wish, however, that there was a place where you could create your own avatar and chat with friends. It would make the whole resource a bit more social.

The other major missing feature was inadequate resource suggestions and availability. Some of the participants were hesitant in attempting some of the activities due to the fact that they didn't know what programme, application or online resource they could use to complete an activity.

Billy said that he felt lost at times and decided to "*Google the stuff*" that he didn't know, but soon found that the internet was full of resources and didn't know which ones to use. He then said that "*I would have loved it if there were more links to other websites. That would have been cool.*"

Sarah also would have liked links to other resources, however, she touched on downloadable software that could be used offline. She said that she wanted to "*Either use free downloadable programmes or websites if you needed to use other programmes*". John shared her sentiment and mentioned that he didn't always have access to the internet and would have done more of the activities if there was software that was free and downloadable for offline use.

Although some of the participants wanted to use resources outside of the OER interface, they raised the point that they didn't want to register or sign up for a service. Sarah was one of the participants that summed it up when she said, "*The fact that I could use other websites was really cool, but I didn't want to register to use them*".

The OER required the participant to upload some of their activities that they completed, however, the uploading process was daunting and confusing for many of them. Paul clearly described his sentiment when he said:

I think my main issue was with the activities that I had to upload. I didn't really know how to get the stuff that I made on the other sites onto the OER. I didn't really bother with trying to figure it out. It took too much time.

The participants felt strongly that the links to other resources had to have adequate instructions on how to use them as well. Merely providing the resource was not enough. Danny felt confident that he could figure out how to use the resource, but that *"tutorial videos would have saved a lot of time"*. Joyce also commented that she would have attempted more activities that required outside resources if there were sufficient examples and tutorials on how to use them.

The Bloom-Gardner Matrix allows a learner to choose a path of learning by providing him or her with numerous options or paths that can be taken to learn. There is no set structure or gradual progression as sections are finished. This is also a feature that was unfamiliar to the students and a few of them would rather have preferred that there be a gradual release of content.

Brad mentioned that, *"It would have been nice if there was some sort of progression though. I mean, like you can only go to the next section if you pass an activity."* Joyce also said that she didn't want to receive *"all the work in one go"*. Rather she would have preferred it if the content was released, section by section.

Lastly, there was a request that the resource be made available to be used on a mobile device. James noted that he *"wasn't at a computer the whole time, so a mobile version would have helped"*. Marsha also mentioned that her access to a computer was limited due to her parents using the computer most of the time. She suggested that the resource be available on a tablet.

Interestingly, Marsha raised the point of having a section where common mistakes could be listed. She said:

I think that there should have been a small section here and there that explained the common mistakes people make, sort of like a sticky note. It's always nice to know that you are on the right track.

Chart 5.6 is a summary of missing features and how many times it was mentioned during the focus group discussion.

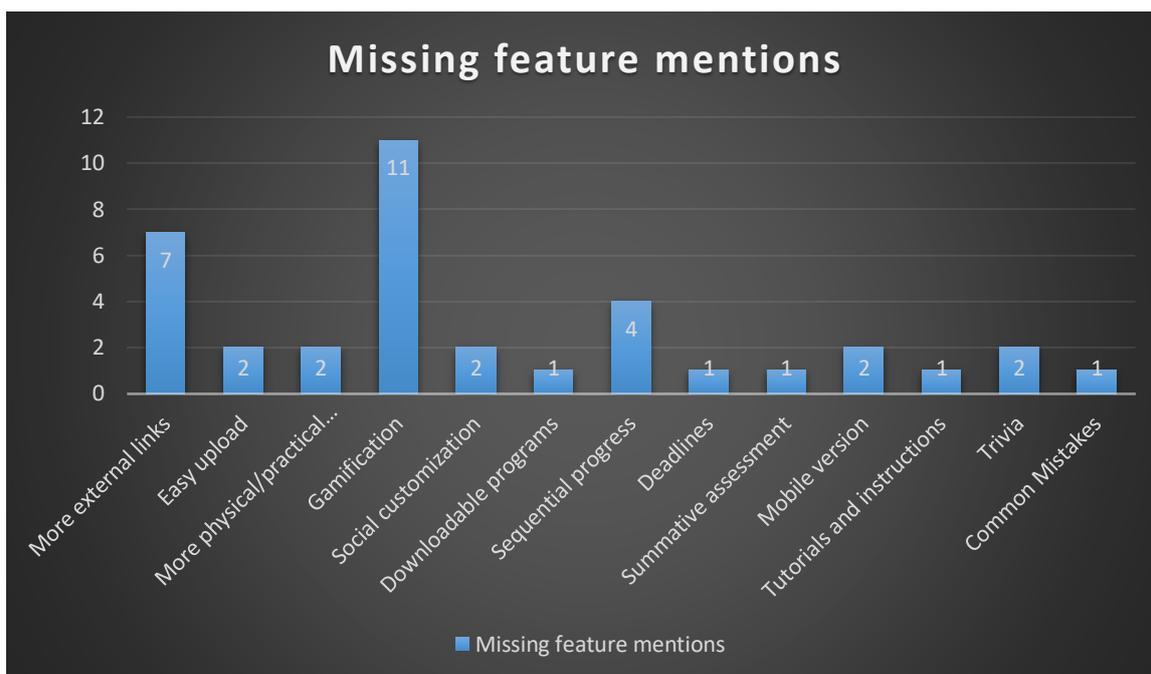


Chart 5.6 – Missing feature mentions

5.2.1.4 Useful features

Just as there were features that were missing from the OER, there were also features that the participants enjoyed. Some of these features have already been mentioned in the previous points and range from navigational features to assessments.

To begin with, Bob and Sarah appreciated the fact that they could leave comments. In Sarah's case, she left a comment for her teacher, who responded timeously and according to her, it assisted her in her studies. Interestingly enough, Bob's comments were one directional, but still sparked conversation:

The fact that I could leave comments helped me a bit though. My other friends who also did the course saw my comments and we chatted about it the next day at school.

Concerning the activities, the majority of the participants found the short assessment with the immediate feedback to be of great value. Joyce found that she could “*monitor*” herself and quickly see where she fell short. Sarah shared her sentiment when she noted that she “*could see*” where her mistakes were. James also said that it helped him “*to see if he was on the right track*”.

Mike and Bob were quick to point out that the small “*chunks*” of work that made up the activities were a great way for them to stay on track. It didn’t take up much of their time and Bob even compared it to a “*mini class test*”.

The side bar, or the navigation bar on the left-hand side of the screen was the feature that got most of the attention. According to the participants, it allowed them to find their way around the OER rather easily. However, it wasn’t just the menu bar itself that gave the participants the confidence to use the OER, it was the wording on the labels themselves.

Mike noted that the labels seemed familiar and that he “*recognised them from class*”. Molly also said that “*When I noticed that the menu on the left was the same as the work we did in class, I could easily go where I wanted to*”.

As mentioned earlier, the videos were of great value to the participants. They found the videos to be useful and informative. The external links were also touched on in the previous section. Most of the participants enjoyed having extra links to outside resources, but it was noted that these resources had to be registration free.

Surprisingly, John was the only participant who mentioned that he enjoyed the fact that he didn’t have to follow any sort of structure. He said that it “*was a first for me. Usually the teachers tell us to work from the top to the bottom*”.

The other lone mention was that of language. Barny felt that the language that was used in the OER was easy to understand. According to him, it made Science seem less complicated.

The language that was used in the resource was easy to understand. It made Science look easy and not that complicated as it can sometimes be.

Chart 5.7 is a summary of the features that the participants found useful and how many times it was mentioned during the different focus groups.

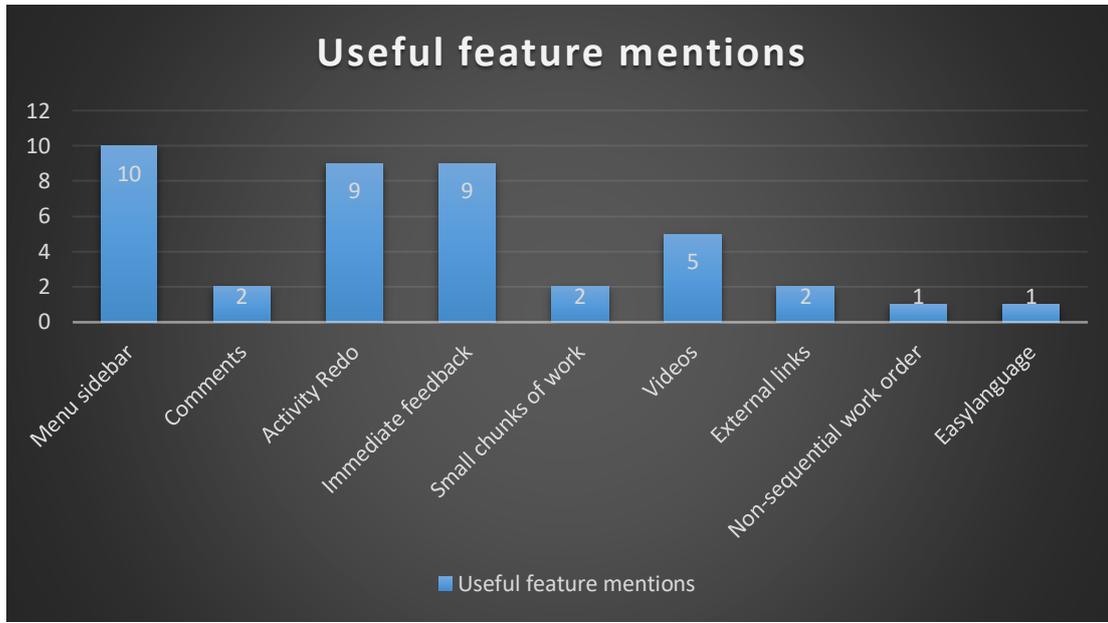


Chart 5.7 – Useful feature mentions

5.2.2 The structure of activities or assessments

The structure of the activities and assessments differ from the structure of the design in terms of the theoretical framework. The Bloom-Gardner Matrix provided for a means to differentiate learning material by structuring activities from simple to complex and also across multiple intelligences. Figure 5.4 is a visual representation of how activities range in complexity while also being differentiated according to Gardner's intelligences.

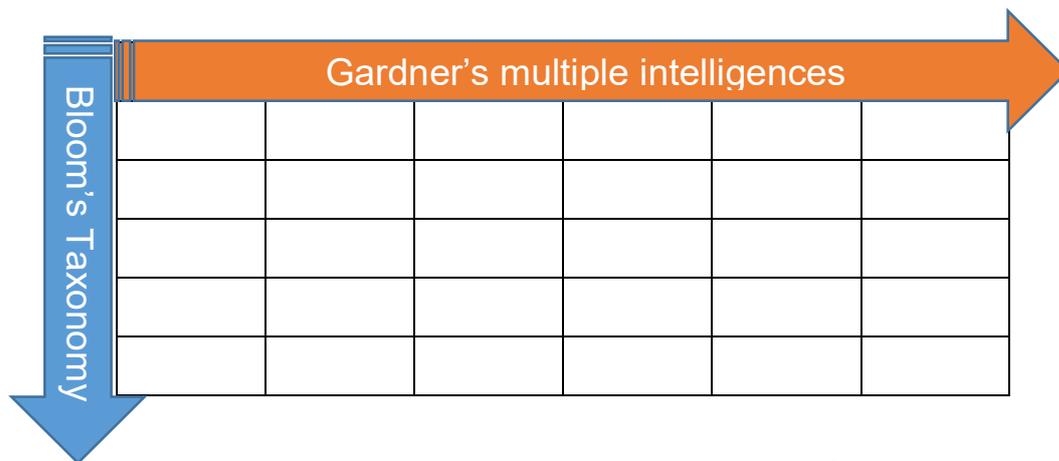


Figure 5.4 – Visual representation of the Bloom-Gardner Matrix
 Source: ("Blooms-Gardner Matrix - Steddie," 2016)

For the purposes of the study, only the **Verbal/Linguistic**, **Logical/Mathematical**, and **Visual/Spatial** intelligences were used (See Chapter 3 paragraph 3.3 for a discussion on the intervention design). Each section of the module had activities in each one of the intelligences and depending on the content of the section, the activities ranged in complexity according to Blooms taxonomy.

If a section only required the participant to remember certain terms, the activities would range between **Knowledge** and **Understanding** on Bloom's taxonomy. Likewise, if the section required a participant to use the information to answer a question, **Analysis** and **Application** type questions were asked.

The participants were told that they could choose any activity in any order that they saw fit. However, when the participants were asked if they noticed how the activities were structured, their responses put them in two distinct categories, namely, those who identified the structure, but didn't know what it meant exactly and those who understood how the activities were structured. Based on their responses, the researcher was able to group each participant in the focus groups according to two categories. Chart 5.8 provides a visual representation of the two camps that the sample of participants fell under.

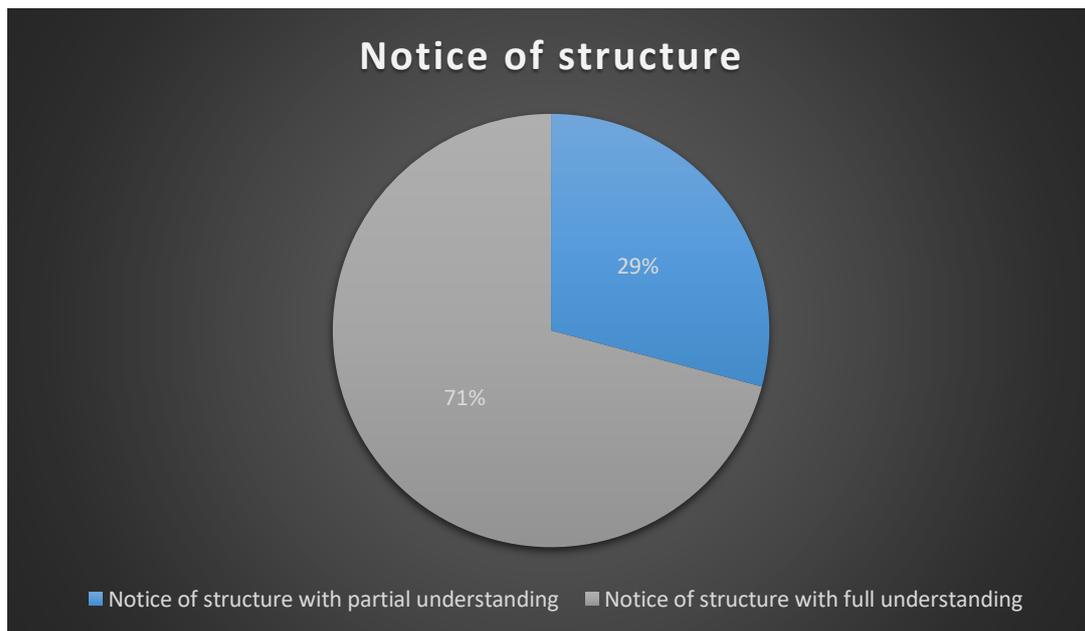


Chart 5.8 – Notice of structure

Mike, for instance, said that:

I just saw that there were like three different activities each time. I didn't really know what it meant. But I saw that some of them were like writing activities, others focused more on drawing and stuff and others wanted everything in boxes.

Nathan also shared Mike's sentiment in that he didn't know what the intelligences meant, but that he saw that the activities in the different intelligence groups asked similar questions. Ingrid summed their experience up when she said:

I just saw that I had plenty of options. I guess I could see that some were more focused on writing and others on more visual things. Like the cartoon one where you had to draw a form of energy.

Kimmy only noticed the differences later on, as she thought she just had to do everything. Joyce, on the other hand didn't notice the structure because she was "so busy trying to figure out how to register and use some of the programmes".

By far, the majority of the participants grasped how the OER was structured. Neval even went as far as stating that, "that is why I only did some of them. I chose the ones that I liked".

For Bob and Jane, the structure was very obvious. Bob said that you "just had to read" to figure it out. However, he also said that he didn't give it much thought and tried to do all of the activities. Danny, Brad, Dorothy and Molly said something to the same effect, but noticed the structure due to the labels on the sidebar.

5.2.3 Emotional observations

The interpretive nature of the study led the researcher to gather information on the emotional experiences of the participants. They were asked how they experienced the OER as a whole and also what activities they liked and disliked.

5.2.3.1 Overall experience

In terms of the participant's overall experience, it was interesting to see that there were slightly more mixed responses than overall positive ones. The participants who received the OER in a negative light were by far in the minority. Chart 5.9 is a summary of the overall experience code count that was recorded during the focus group discussions.

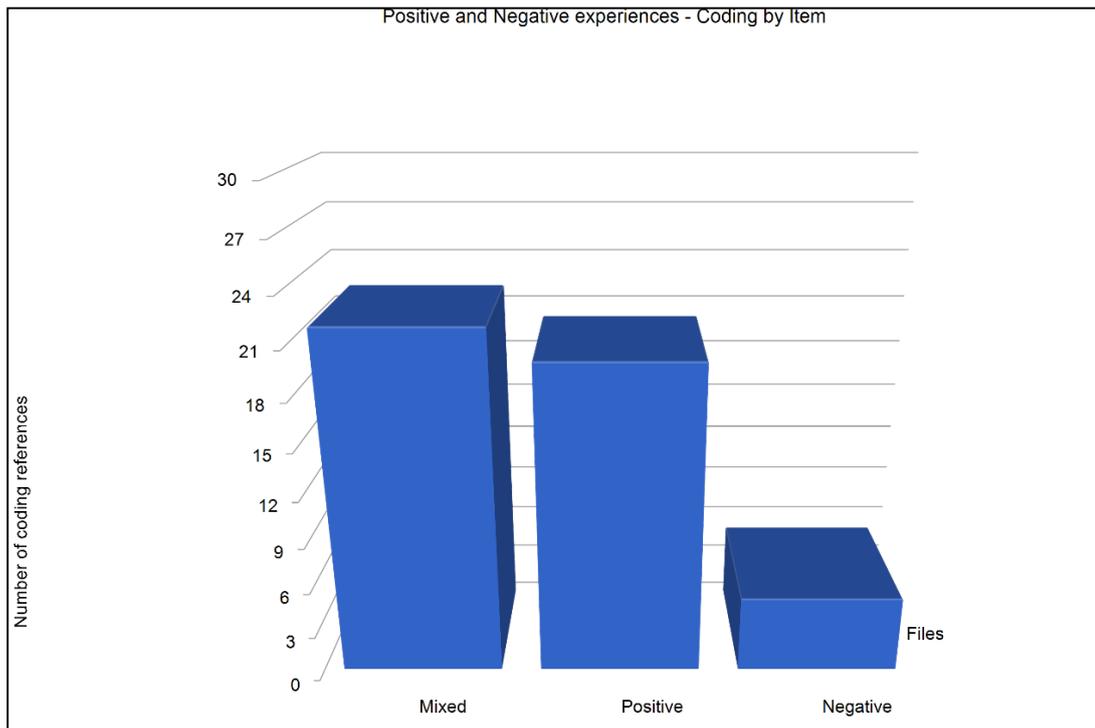


Chart 5.9 – Coding frequency of overall experiences

NEGATIVE EXPERIENCES – Although Kimmy expressed that the OER helped her, she found it stressful to use the OER and doubted that she would use such a resource again. The main reason for her negative experience was the fact that there were too many choices. For Brad, the choices were also cumbersome and he labelled them as “*a waste of time*”. Sarah on the other hand found the uploading portion of the OER too confusing.

POSITIVE EXPERIENCES – On the positive end of the spectrum, there were a couple of participants who enjoyed the OER purely because it was something different. Peter just enjoyed the fact that the OER was “*online*”. He also remarked that it was fun “*playing around*” with the resource and that it “*beat sitting in class*”. John said that it felt more like “*playing than studying*”.

A number of participants enjoyed the resource because it provided them with so many options. Ingrid was appreciative of the extra resources and mentioned that it was something different to what she was used to in class. She went further in stating that she wished that there were similar OERs for her other subjects. Brad was just grateful that he didn’t have to do the same thing over and over.

Neval, however, found value in the variety for a different reason. If there was an activity that he could not do, he knew he had other options. He said:

There were things that I couldn't do, but that isn't the same as not having a clue. What I mean is that if I couldn't do something, for whatever reason, at least I knew I had options and then I skipped it. Look, there were a couple of activities that I skipped easier than others because the instructions were so unclear.

That made it easy for me to decide not to do it.

MIXED EXPERIENCES – The participants who had mixed feelings about the OER enjoyed working with the OER, but there were elements that marred their experience. The elements gravitated around the shortcomings of some of the activities. Chart 5.10 is a breakdown of the reasons why the participants felt at odds with the OER and summarises the reference count of each of the reasons that were coded.

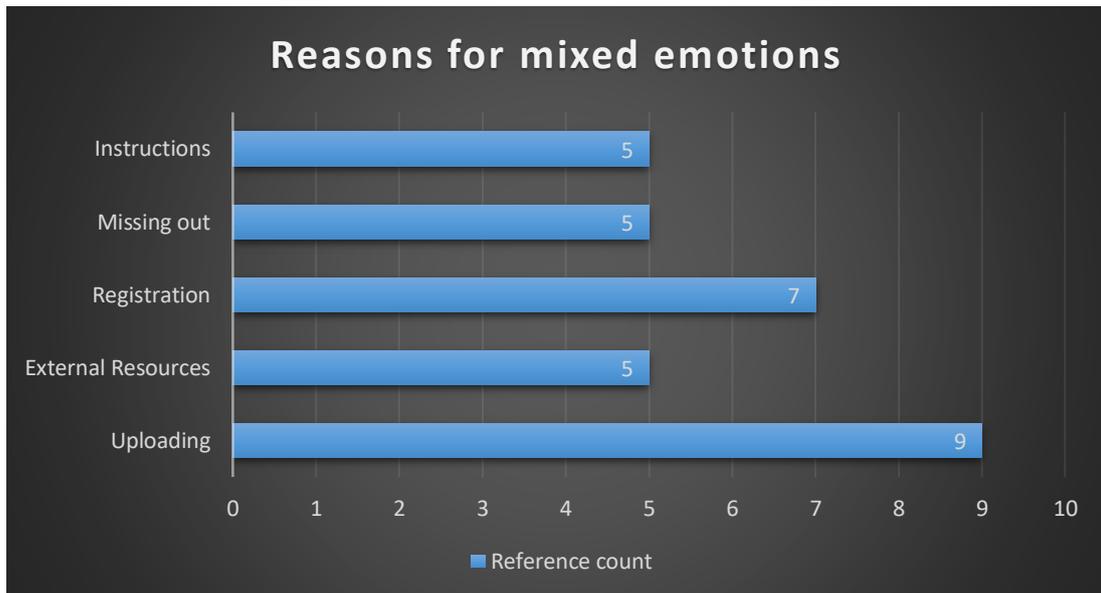


Chart 5.10 – Reasons for mixed emotions

Instructions – Sarah and Danny came to the conclusion that they had enjoyed the activities, but better instructions would have swayed them to do more. Sarah said that the lack of clear instructions was the “*only drawback*” and Danny said that, that was the only thing he would change.

FOMO, or the fear of missing out was a surprising response or reason why the OER was met with mixed emotions. Kimmy made it very clear that although there were a variety of options from which she could choose, she still felt there would be something that she would miss. She said:

I felt very unsure about the whole thing. I felt that I had to do everything and kind of got discouraged at times. Although there were choices and although I didn't have to do everything, I still felt like I would miss something.

Sarah and Bob said something similar, however, Sarah also mentioned that if she had read the instructions on the homepage, she would have felt more at ease. Sally, on the other hand was also afraid of missing something initially, but saw the pattern in the way that the resource was designed and gained confidence as she went along.

Registration – Most of the external resources (those that the learners had to access via external links) required the participants to register to use the resource. Bob was quick to point out that he enjoyed the outside resources, but that he disliked the websites that “*wanted you to register before you could use the software*”. Sally mentioned the same grievance, together with uploading assignments.

Sarah and John also mentioned that they didn't enjoy registering and suggested an alternative. Sarah said:

The fact that I could use other websites was really cool, but I didn't want to register to use them. I think that is the only thing I would change. Either use free downloadable programmes or websites if you need to use other programmes.

Joyce even went as far as saying that registering on external websites induced a fear of using the resource. She said that registering “scared” her which led her to skip activities that she would otherwise have attempted. Dorothy and Adel also skipped activities that required registration on external resource pages, but enquired whether there were similar resources that did not require registration.

External resources – Apart from registering, there were certain participants who just didn’t want to leave the OER and work on external resources. Bob and Nathan enjoyed the simple activities. Nathan argued that the questions were challenging enough and he didn’t have to learn how to work with a new programme.

I also enjoyed the activities that were on the site itself. They were easy to do. Some of the questions were difficult, but I didn’t have to learn a new programme to answer it.

Mike, Amy and Marsha mentioned that although they used external resources, they would have preferred that the activities were included in the OER itself. The main reason for their preference was because the uploading procedure was somewhat confusing.

Uploading – By far, the biggest reason for the participants’ mixed emotions was the fact that certain activities required them to upload their work, regardless of whether they did the activity on an outside resource or the OER itself.

Mike didn’t mind registering on an outside resource page, but the uploading process was too “confusing”. He said:

The upload activities were difficult. I didn’t have a clue how to do them. I know what they wanted me to do in the activities, but I don’t know how to create it on the computer, like the mind map activities. I also know how to make a table in word (sort of), but the upload thing is confusing.

He did, however, also mention that if there were better “uploading instructions” that he would have felt more confident in attempting them. Amy concurred with Mike and mentioned that there should have been “better upload instructions”.

Bob, Brad and Sarah also mentioned that they didn't know if they "*did them correctly*". However, Sarah and Dorothy mentioned that they would have attempted more of them if there were better instructions. Sally mentioned that she "*felt lost*" and decided to skip activities where she had to upload files altogether. Paul shared Sally's sentiment, however, he also said that he didn't even try to "*figure it out*" seeing that there were so many other options.

5.2.3.2 Liked and disliked activities

Concerning the activities themselves and what they required the participants to do, regardless of whether the activity required the participant to navigate to an external source, the responses were rather even.

The Mathematical/Logical activities were only slightly more favoured than the Visual/Spatial and Verbal/Linguistic activities. There were also some participants that were indifferent in terms of their activities of choice. The Chart 5.11 provides a summary of the preferred activities, according to the different intelligences proposed by Gardner.

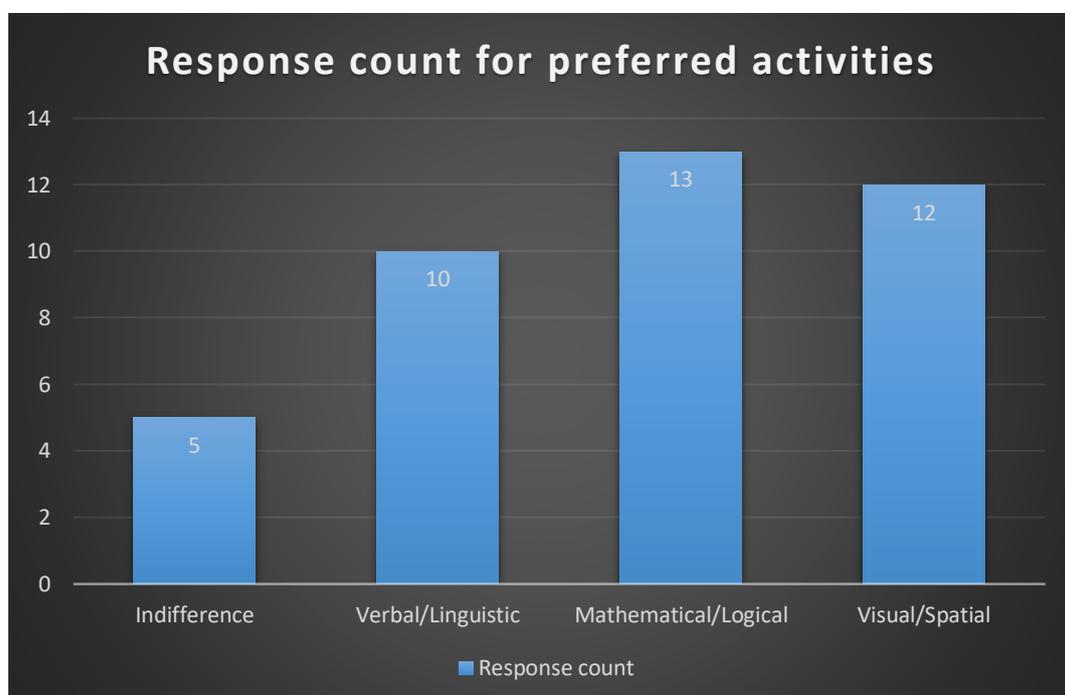


Chart 5.11 – Preferred activities

When the participants were asked why they preferred these activities, they gave a range of responses. Interestingly enough, a number of participants enjoyed the multiple choice, close test, and short answer type activities. These type of activities were included in all three of the intelligences. The fact that these activities gave them immediate feedback and were easy to complete was the predominant reason for their choice.

Joyce summarised their sentiment when she said:

I think I enjoyed the mix and match, column A and B and close test activities the most. They had challenging questions, but it wasn't complicated to complete.

Nathan added to Joyce's response by saying that the questions were challenging, but he didn't "have to learn a new programme to answer it". Sarah also added that the ability to "redo" the short answer type activities was a feature that she valued.

Verbal/Linguistic – Kimmy, Dorothy, Amy and Jane clearly preferred the writing activities because they enjoy writing. Kimmy was of the opinion that when she "makes up" her own stories, she "remembers stuff easier". Amy said that she could better express what she thought when she wrote about it. Jane said the following:

There are so many things that go through my mind. At least when I write them down, I can go over it again and see if I made sense to myself.

Mathematical/Logical – The participants, like Neval, who preferred the activities in this intelligence enjoyed them because they could solve problems. Billy and John on the other hand gave similar responses in saying that it gave them a visual representation of a problem. Interestingly, both of them also mentioned that they didn't always have all the materials to solve a problem and that the OER gave them the opportunity to duplicate the solution to a problem in a digital format. Billy's response was as follows:

I also don't have all the things you need to make a circuit so it was fun to have that opportunity. I think I like these types of activities because it's not just words. I can see what they mean - if that makes sense.

Visual/Spatial – Those who preferred the visual/spatial activities generally found that visual representations of the theory helped them organise their thoughts. Mike said that he remembered things better when he could “*picture*” them. He gave a practical example where he mentioned the following:

... sometimes I remember things easier if I can picture it. Like the definitions activity. I struggle to remember all those terms, but when I draw them, it just becomes easier.

Marsha and Ingrid's responses concurred with Mike's response. Both of them alluded to the fact that they understood concepts better if they could “*organise things*”. Marsha said that she likes “*for things to be in some sort of order*” and that it made it easier for her to “*figure stuff out*”.

Indifference – Barny stated that he enjoyed most of the activities, but that the length of the activity swayed him into doing them. Molly, however, was very clear about not having a preference. She was just appreciative of the fact that she could choose anything:

I also didn't really have one specific type that I liked more than the other. I just liked the fact that I didn't have to do same type. For one section I would do multiple choice, for another one I would draw and then I chose the writing one for other sections.

Sally, however, just enjoyed the fact that the resource was in a digital format. Being able to work on a computer made the activities “*fun*”.

5.2.4 The value of differentiation

The Bloom-Gardner Matrix's original purpose was to provide a way for learning material to be differentiated in complexity as well as different intelligences. However, for the purpose of the study, the matrix was used only as a theoretical framework

with which a wide selection of activities could be designed to establish how an OER could be designed to facilitate for a diversity in learners.

That being said, the participants were still asked how important it was that the intervention was differentiated. Their responses divided them into two distinct groups, namely those who felt that variety was more important and those who felt that differentiation was more important.

Variety – It was interesting to see that 13 of the respondents preferred a variety of activities rather than it being differentiated. In other words, as they progressed through the OER, they would have been content with having one activity per section of work, however, the activities had to differ in type. Nathan encapsulated this sentiment when he said the following:

I enjoyed the choice, but I also think that having a variety of questions is more important. It should be like a broken down test. You don't get the same questions the whole time, so I think that if you break the activities down so that it functions like a test, you'll have easier and more difficult questions.

Sally was more concerned with having the ability to actually do an activity. In her opinion, if the OER provides variety, it should also come with clear instructions on what to do and how to do it. In other words, if one is required to use an external resource to do an activity, clear instructions need to be given on how to use the external resource.

Kimmy felt that variety was more important because she felt overwhelmed with differentiation. She ended up trying to do everything for fear of missing something. She was adamant that if you “*vary the question types, that would be enough*”. Likewise, Dorothy felt that differentiation “*wasted a lot of time*” and if you didn’t have a choice, you were “*forced to do*” what was given to you.

Differentiation – Eleven of the participants believed that differentiation was important, however, there were some of them who provided conditions under which it would be beneficial. For instance, Bob and Joyce shared the sentiment that differentiation would only be beneficial if there were adequate instructions. They lamented the fact that there were so little instructions on how to use the outside resources.

Paul on the other hand also felt that differentiation was important, but that there had to be a “*time frame*” in which to complete activities. Seeing that there were no time constraints in this OER, he became “*lazy at times and opted for the easier ones instead*”.

Lisa on the other hand felt that if you differentiate an OER, then it should be done in a scaffolding manner. In other words, instead of differentiating in terms of intelligence, one needs to differentiate in terms of difficulty. She said:

If you want to differentiate, just make things more difficult and take baby steps as you do so. I would rather have more of the same and make sure that I know the work. Kind of like doing the same type of math sums, just with different numbers.

Of the 24 participants, only one of them was undecided. Sarah’s only requirement was that the resource had to have a summative assessment to test her overall grasp of the learning material.

5.3 Personal observations

The researcher observed the participants’ use of the OER when logging in to the teacher profile that **PowerSchool** provided. He was able to see when the participants logged in and what activities they attempted to do. He also observed the participants during their formal class time. During these times, he observed their emotional responses when asked about the OER and also how the participants interacted with each other with regard to the OER. To ensure that his observations were not bias, he made notes and related these notes and the observations back to the participants during the focus group discussions.

The participants were informed of the OER two weeks before the start of the Energy module in class. They were told how the OER was going to function and how they were to use the OER if they so chose. The researcher’s observations started with this initial introduction and continued until after the module was finished. Consequently, the observations were divided into four sections, namely; Pre-release observations, Release observations, Continuous observations and Post-use observations.

5.3.1 Pre-release observations

When the researcher introduced the population to the OER, the majority of them were unaware of OERs. Chart 5.12 provides a summary of the sample from the participants who had prior knowledge of OERs and those who did not.

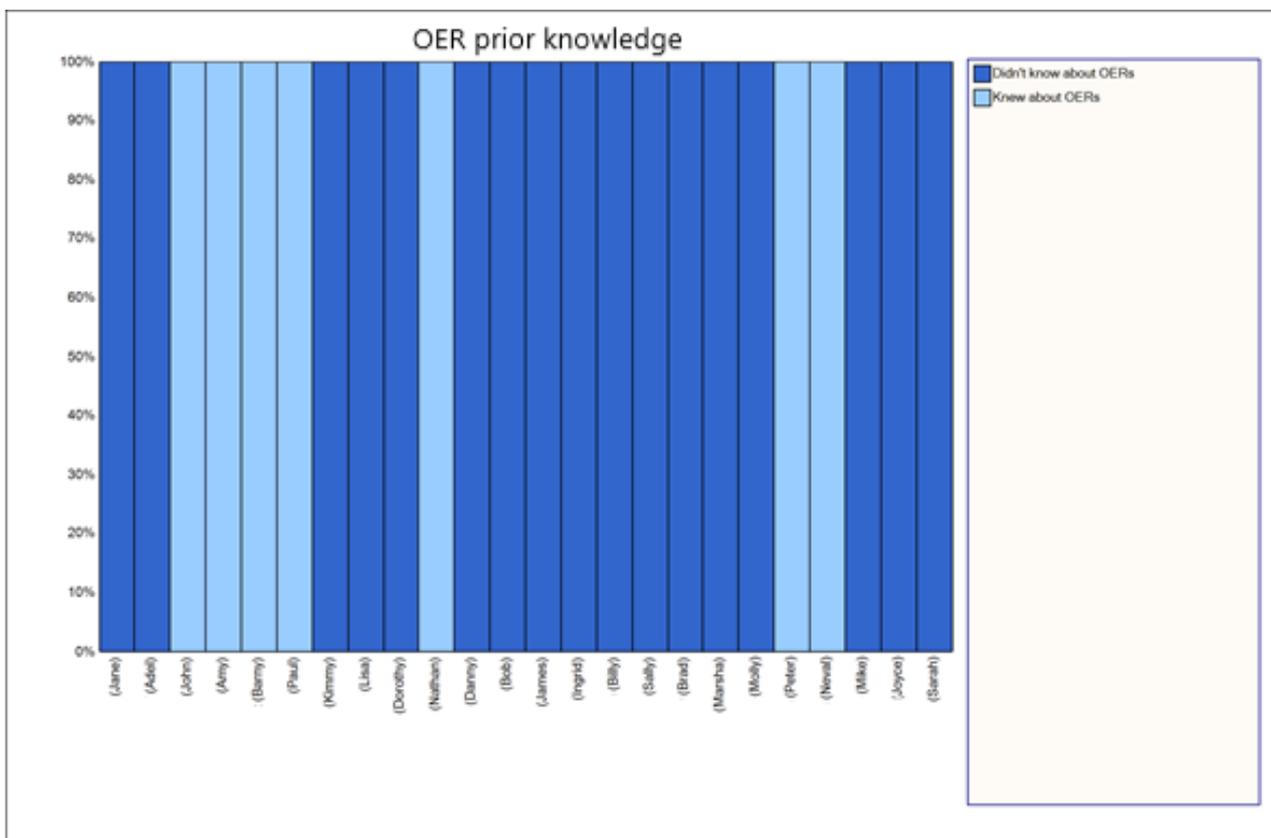


Chart 5.12 – OER prior knowledge

Only seven of the sample of participants had previous experience with an OER, or they were not even aware that they were in fact using OERs. However, the 37 participants showed much enthusiasm and met the OER with excitement. They were given their access details and left to attempt the login procedure on their own.

5.3.2 Release observations

Although the OER was met with excitement, when the resource was made available, there was very little activity on the resource. After a week, there were still only two users and they didn't attempt any of the activities. However, they did leave comments and one participant mentioned that "*this was going to be fun*".

The researcher decided to remind them of the resource again and "*showed off*" some of its features. When the researcher started to show them the content of the resource and how it concurred with what was being done in class, their interest seemed to be sparked again. One of the participants recognised the learning material and it seemed to dawn on him that the OER was something that he could use to address the gaps in his understanding.

After the demonstration, the researcher logged on again and began to see a rise in activity. The number of users started to increase, but there was still not much work being done. Most of the initial users were learners who generally performed well in Science. Three participants from the sample requested new login details, seeing that they had misplaced the hard copy that they had received earlier. There were also participants who struggled with the login procedure and asked for assistance in this regard. As the participants talked among each other, interest in the OER grew and more users started to activate their profiles.

5.3.3 Continuous observations

The researcher started to receive comments that the participants enjoyed the video material on the OER and noticed that their use of the OER focussed largely on seeking out the video material and not completing activities. Those participants who attempted activities, started with the short multiple choice, close test (tests that require the subject to fill in missing words to determine comprehension) and activities that provided immediate feedback.

It was interesting to observe that due to not receiving official credit for the activities in the OER, that most of the participants disregarded some of the activities. They seemed to place a very high value on their report card marks and did not see the point in doing something that didn't directly influence or improve their marks.

During their formal class times, they often asked whether an activity counted towards their formal credits. When they heard that it did not, they tended to do the activities half-heartedly or not at all.

After three weeks, the participants seemed to be working with the OER in conjunction with the work schedule in class. Their comments started to become more focussed on work and they discussed the resource and various activities in class. One participant left a comment for the researcher to which he replied and they discussed the issue further the next day in class.

They also started to attempt the more challenging activities, however, uploading their finished assignments posed a problem for the majority of them. One participant went as far as posting his whole assignment in the comment section and added that he did not understand how to upload it otherwise.

It occurred to the researcher that they only had basic computer skills and used their devices mainly for entertainment and social networking. As soon as they were required to do “work” it became a struggle and they lost interest. Merely explaining the uploading process verbally did not seem to encourage them to attempt the activities that required an upload. Some of the participants incorporated the help of their parents, but they were in the minority. Some of them also enquired whether the resource was available in a mobile format, seeing that they had limited access to a physical computer at home.

Most of the participants did not attempt the activities that required them to register or sign up on the external resources. Their age and the fact that they did not have email addresses hindered them in their attempts and it caused them not to complete certain activities. On the other hand, the activities that used external links that did not require registration were attempted more frequently.

One of the activities required the participants to create a flowchart, but they didn't know what a flowchart was. They also did not attempt to find out what it was and disregarded the activity. Likewise, when the participants were required to use an external resource that required them to “*learn*” a new programme, they opted to skip the activity. Other participants expressed their fear of doing something wrong or breaking their computers if they did something wrong.

5.3.4 Post-use observation

After the learning module was completed, there were requests for a formative assessment or a mock test with immediate feedback. They seemed to want to test out their skills and see how well they understood the learning material, especially with the term test that had been around the corner.

There seemed to be a clear distinction between the participants who used the OER and those who didn't. The OER users were much more vocal in class participation when they started to prepare for the term test. They seemed more confident with the learning material as opposed to those who did not use the OER.

It was interesting to find that there were requests for similar resources for the following Science modules and that their confidence in using OERs had grown over the course of the Energy module. What's more is that they wondered if there were similar resources available for their other subjects. In general, their experience of the OER was very positive and the majority of them expressed that they would definitely use something similar in future.

5.4 Conclusion

Based on the results of the observations and focus group discussion, the researcher has gathered enough information to compose his findings of the study. The following chapter will discuss the findings in depth, after which he will pose his conclusion of the study on How OERs can be designed (at the hands of the Bloom-Gardner Matrix) for cognitive-intellectual diversity in grade 5 Science learners.

6. Chapter 6: Research findings and conclusions

The previous chapter summarised the results from the data collection process. The results for both the focus group discussions and observations were written up separately. These results were analysed and were used to answer the main and supporting questions. In this chapter, the researcher started by writing down the findings to answer the supporting questions first and then the main research question. Thereafter, the conclusions and final thoughts were compiled.

Main research question

How can OER interventions be designed (at the hands of the Bloom-Gardner Matrix) to facilitate for cognitive-intellectual diversity in grade 5 Science learners?

Supporting questions

- Which activities can be designed in an OER intervention to support curriculum differentiation for science learning for grade 5 learners?
- How do learners utilize the OER?
- What design aspects have an influence on learning in this OER intervention?

By analysing the results, I was able to group information from both the focus group discussions and my own observations. I also compared my own observations to the results from the focus group discussions and used deductive reasoning to write up my findings. However, the responses from the participants also yielded information that was not part of the original question set, but also gave insight into answering the main research question and provide possible solutions to the research problem.

The findings for the supporting questions will be discussed first, as they point to the main research question. A separate section will also follow in which the unsuspected findings will be discussed. Thereafter, based on the findings, I will discuss the main research question and the limitations to the study and how the OERs can be designed.

6.1 Supporting questions

The supporting questions were asked to narrow down and hone in on the important aspects of the design of an OER that would allow for differentiation. The results that were formulated from the data, using coding, enabled the researcher to draw up findings that addressed aspects that ranged from the physical design, to the content and also the activities that can be included to diversify an OER intervention.

6.1.1 Activities that support curriculum differentiation

The theoretical framework on which the design of the resources was based, enabled the researcher to create a resource with multiple activities that varied in complexity (Bloom's Taxonomy) and also type (Gardner's Intelligences). This was done to give the participants as many options as possible to determine if there were activities that the participants would prefer to have in an OER intervention. The results from the data that was collected, yielded two major themes that would have an influence on the type of activities that could support curriculum differentiation. The two categories are ***mode of access and submission*** and ***physical activities***.

6.1.1.1 Mode of access and submission

In the previous chapter, it was noted that the participants generally had a positive experience with the OER. However, when the activities themselves were discussed, there were some mixed emotions based on the mode of access and submission. For the purposes of the study, **mode of access and submission** refers to how the participants accessed an activity and how their work was submitted.

The software that was used to develop the OER (*PowerSchool Learning*), enabled the researcher to design activities that could be done on the service provider's website itself, using their built-in assessment tools. The software also allowed the researcher to use external resources by placing hyperlinks to other websites in any of the designed activities. Whenever a participant needed to use an external resource to complete an activity, the finished product had to be uploaded for assessment.

Concerning the **mode of access** of the resources, there was a general consensus among the participants that they enjoyed using outside resources, however, there was a condition to the consensus. The participants did not want to register on the

external websites to use the resource. It is also important to take note of the age of the participants.

Seeing that the resource was designed for grade 5 Science learners, the majority of them did not have an email address, which is a prerequisite for registering on most of the resources. To assume that their parents would register on their behalf would also not be viable. In my observations, as well as responses from the participants, it was evident that their parents were largely uninvolved. There were only a few of the participants whose parents provided assistance in using the resource. Therefore, when using an outside resource, it needs to be one that can be used freely, without having to register and one that would not require parental guidance.

A number of participants provided another solution to the access problem in the form of free downloadable programmes or apps that did not require registration. If the programmes could be used offline, it would also solve the problem of not having 24-hour online access, which was one of the other concerns that some of the participants had.

Furthermore, they also struggled with uploading their finished work for **submission**, regardless of whether they had to register or not. Again, the participants ranged between the ages of 10 and 12, which means that their computer skills are still developing. Before the intervention they had very little exposure or experience in working with OERs. Although they are very proficient in using technology for social and entertainment purposes, they lacked the skills to use technology for learning, especially when having to use complicated resources.

The biggest problem with having to upload assignments and activities for submission was with the instructions. Some of the activities that required uploading were designed on *PowerSchool* itself and others needed to be uploaded from the external resources.

The participants felt that there were not adequate instructions in guiding them in the uploading process and a number of them suggested that tutorial videos on how to upload the assignments would be sufficient and encourage them to use the resources with more confidence. Another solution would be to write up instructions with visual prompts.

6.1.1.2 Physical activities

The physical activities refer to the activities themselves and what they required the participants to do. The results showed that there were activities that the participants generally attempted and others that they did not. The reasons for not attempting the activities were also recorded and gave insights into how to solve those problems (Chapter 5, paragraph. 5.3.1.b).

Attempted activities – *PowerSchool* enabled the researcher to design activities that provided the participants with immediate feedback, as well as the ability to redo activities. These activities were among the most attempted and ranged across all the intelligences proposed by Gardner.

With the right software, these activities are easy to incorporate into an OER, but lack in terms of the type of questions that can be asked. The immediate feedback question types are limited to close test, multiple choice, true and false, matching and rearranging questions. That generally limits that designer to the first three levels of Bloom's Taxonomy.

However, *PowerSchool*, also enables a designer to create activities that can address the higher cognitive levels of Bloom's Taxonomy, but requires an uploading process and does not provide immediate feedback. These activities were also largely ignored due to the uploading process. As stated earlier, this hurdle can be overcome by providing adequate instructions or tutorials.

The activities that required the participants to use outside resources where registration was required was also largely not attempted whereas the ones that could be done without registration or uploading was highly favoured. The *PheT Simulations* from the University of Colorado, was one such a resource that was highly used (University of Colorado, 2019).

One way in which a designer could incorporate a resource such as this would be to design a multiple choice activity where the participant would need to run simulations to get to the answer.

Although the OER was digital and online-based, there were participants who requested activities that could physically be done at home, like making a YouTube video or physically attempting experiments. Once again, however, the participants

would have to upload a submission and instructions would be required to complete the activity successfully.

The results showed that there was no clear preference in terms of Gardner's intelligences. There were near-equal responses in favour of all of the intelligences and also some responses that indicated no clear preference at all. Some of them enjoyed writing activities that required essay type responses and others enjoyed the mathematical/logical activities that required them to solve various problems and create tables.

Another group enjoyed visual/spatial activities where they were required to create mind maps and visual representations of terms. One activity in particular required the participants to create a flowchart, however, they did not know what a flowchart was.

This raises an important point when designing activities in an OER. These resources can be accessed by anyone, but when they are created with a specific audience in mind, one cannot assume that the users will have all the prior knowledge necessary to complete an activity. This means that the designer has to ensure that there are sufficient examples of what is required as to ensure that the participant is fully aware of what needs to be done to successfully complete an activity. This point reiterates what the literature stated in that OERs need to be contextualized in order to be used more effectively. Figure 6.1 provides a visual representation of the findings and can be used as a guide when developing and deciding on activities that can be included in an OER intervention to promote differentiation.

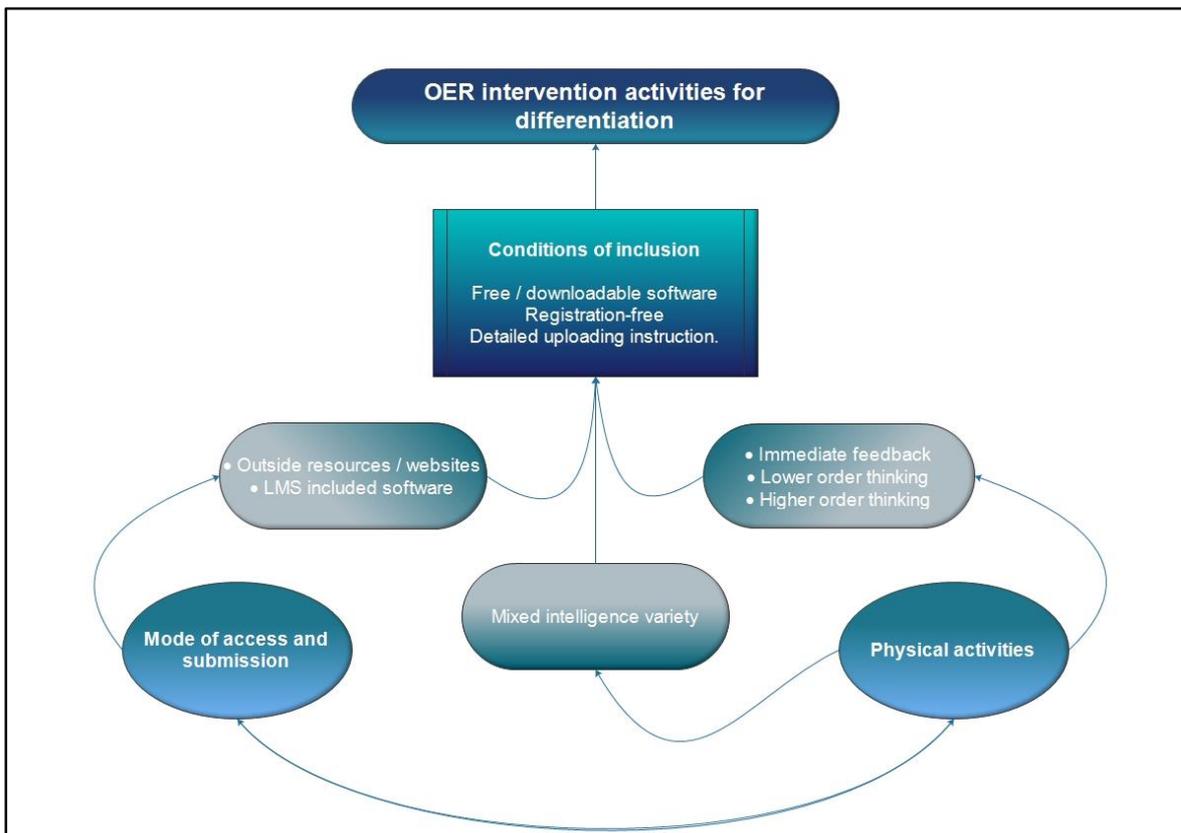


Figure 6.1 – OER intervention activities for differentiation

6.1.2 How learners utilize the OER

As mentioned in the literature study, there has been little research done on how users utilize an OER. This led the researcher to investigate the gap in the literature and include this question in this research study, because it could give some insight into how involved users are when they use an OER. It could also point to aspects that would encourage better utilization of an OER, and in this case, how an OER could be differentiated to encourage use.

This particular OER intervention was designed to resemble an online course, with both learning content and assessment activities. Both the browsing habits of the participants, as well as the activities that they attempted were monitored and investigated and the results from the data that was collected yielded the following findings.

6.1.2.1 Browsing

Seeing that the participants were only in grade 5, their formal learning had not yet exposed them to non-linear approaches to using resources. For this reason, they opted for **structured browsing** of the resource. In a way, they have been taught to use resources by following a top-down approach. My observation of their use of the OER confirmed my assumption, seeing that the majority of the participants followed a linear approach to browsing the resource. They have yet to experience discovery learning and investigate new resources where they are encouraged to make discoveries and formulate relationships between their existing background knowledge and new concepts. Discovery learning can be described as a learning strategy where the learner actively participates in the learning process instead of receiving knowledge by an instructor (Brown, 2006). In other words, they have to engage in a resource and make individual choices regarding their understanding and way forward.

It was also noted that many of them feared that they would miss something and not be able to complete certain sections of work, thus they browsed in a structured manner. Their fear is not groundless, seeing that most of them had never worked with OERs of this nature and the uncertainty of things made them behave cautiously.

More exposure to these types of resources would make them more confident in using it to its full potential. In the researcher's post-observations, as well as the feedback from the focus group discussion, it was clear that the participants felt more confident with the resource after the three-month period. This point was further strengthened due to the fact that their interest in using OERs in their other Science modules, as well as their other subjects grew.

There was also, a small percentage of the users who started out with browsing the OER randomly, but soon after, reverted to a linear, top-down approach. They deemed it a waste of time and rather opted to follow the resource in concordance with what was being taught in the classroom.

This is not necessarily a negative aspect. When a resource is designed with a particular audience in mind, it could be tailored to run in conjunction with a curriculum. Based on the result from the focus group discussion, this would

encourage a user to utilize more features of an OER. It also provides a further dimension of contextualisation as mentioned in the literature.

The participants who chose **random browsing** as a way to explore the resource did so more out of curiosity than anything else. They enjoyed the freedom to explore and sought out videos and other elements that drew their attention. The other group of “random browsers” were more methodical in that they only sought out sections that addressed areas of the module with which they struggled.

Ultimately, the margin between the participants who chose random browsing as opposed to structured browsing was too small to come to a definite conclusion in terms of design. Therefore, it would be up to the designer of the OER to decide on whether the end-users would be able to browse freely or linearly.

6.1.2.2 Activities

The purpose of the Bloom-Gardner Matrix was intended to provide the participants with a multitude of options to assess their grasp of the learning content, however, this seemed to be counter-productive. The number of different activities that they could choose from, proved to be overwhelming for some of the participants. Although the activities tested the same content and skills, there were some who felt that they needed to do all the activities for fear of missing something important. This led them to feel discouraged and view the OER in a negative light.

The other feature of the Matrix is that it allows for non-linear selection of activities. Nothing has to be done in a specific order. The assumption was that the learners would choose activities that they felt comfortable with and discard the rest. However, their responses showed that the choices were distracting and seeing that they were not used to discovery learning, or choosing their own learning path, the options were seen as more of a distraction (see Chapter 5 paragraph 5.3.3.1 and Chart 5.10). They felt that it wasted time when searching for something that they enjoyed and would rather have had a gradual release of content.

What was interesting, was that the participants weren't concerned as much with differentiating a single activity. They would rather have had a variety of activities that ranged in difficulty or cognitive ability they could do. In other words, instead of

having three sets of activities, they would have enjoyed one set of activities, but varying in intelligence and difficulty.

Based on their responses, the Bloom-Gardner Matrix could then be used to draw up a number of activities that the designer could choose from to populate a resource. This does not mean that the designer has to use all of the proposed activities. Table 6.1 serves as a visual representation or example of how a designer could choose activities for an OER of this nature.

Table 6.1 – Visual presentation of activity selection

Bloom – Gardner Matrix	Intra-personal	Inter-personal	Visual / Spatial	Body / Kinaesthetic	Musical / Rhythmic	Verbal / Linguistic	Math / Logical
Remember	Activity	Activity	Activity	Activity	Activity	Activity	Activity
Understand	Activity	Activity	Activity	Activity	Activity	Activity	Activity
Apply	Activity	Activity	Activity	Activity	Activity	Activity	Activity
Analyse	Activity	Activity	Activity	Activity	Activity	Activity	Activity
Create	Activity	Activity	Activity	Activity	Activity	Activity	Activity
Evaluate	Activity	Activity	Activity	Activity	Activity	Activity	Activity

One clear oversight of this intervention was in the instructions of the activities themselves, but also in the use of the external resources. It was assumed that the participants would have the skills to upload their finished assignments, but this was not the case.

From the results it was clear that the activities' instructions were insufficient, especially when uploading and where the external resources were concerned. The results showed that instructions on how to use external resources should be included in the activity brief. It also showed that video tutorials or guides with visual prompts would have encouraged the participants to use more of the outside resources. The same goes for uploading instructions, especially when the uploads needed to be done from the outside resources.

However, creating tutorials and guides for all of the external resources could become cumbersome for the designer. Therefore, when choosing external resources, it would be recommended that the resource be multi-functional and be used for more than one particular activity.

From the above findings, one can apply the saying that “less is more”. In other words, when an OER is designed for differentiation, the activities need to be varied across all the intelligences proposed by Gardner and also range in difficulty according to Bloom’s Taxonomy. Together with the variation in activities, one can consider not to release all of the content at once, but rather follow a gradual release path. That being said, when using external resources, they should also be accompanied with thorough instructions on their use and also uploading.

6.1.3 The design aspects that influence learning in OER interventions

The results from the data collection showed that there were positive aspects, as well as negative aspects and consequently, aspects that could be changed. When the design aspects were addressed, there was a clear distinction between the design of the resource as a whole, but also the activities themselves, both of which had an influence on learning.

6.1.3.1 Activity design

Chapter 5, paragraph 5.3.1 indicated both the useful and missing features of the intervention and activities. These results were analysed and used to answer the final supporting research question.

As mentioned in the previous point, the fact that all the content was immediately available, proved to be distracting for some. Although there were others who enjoyed being able to do what they wanted, there was no clear evidence that would suggest that not having the freedom of choice, would negatively influence their learning.

The results clearly showed that the majority of the participants found the external resources helpful. However, the results also showed that some of the links were not clearly visible. This meant that not all of the resources were explored. Therefore, the links should clearly be visible and distinguishable from the rest of the text.

The results showed that immediate feedback was a feature that all of the participants found helpful. It provided them with a means to track their understanding of the learning material and identify gaps. Unfortunately, this feature could not be

included in all the activities, especially those that required open responses. Therefore, it is a limiting design feature, but should be exploited as far as possible.

Another useful feature of the activities was the comments section. The results showed that being able to leave a comment for response was helpful when a participant was at odds with an activity. Although this is a handy feature, not all open software has this imbedded feature. The designer of the OER will also not necessarily be available to respond to a query timeously. Therefore, this feature could only successfully be employed if the designer is also the educator of the target audience of the OER.

Although there were links to external resources for some of the activities, others did not have suggested programmes or links. This was deliberately done to encourage the participants to explore on their own and find relevant resources that they could use to complete activities. Unfortunately, this proved to be discouraging for the participants. It was noted in the results that it was too time-consuming or overwhelming to search for appropriate resources. The internet is too vast and finding a suitable resource proved to be disheartening.

Another oversight was that all of the suggested resources were online. Therefore, it required the participants to have a permanent internet connection. It was assumed that all of the participants would have permanent access, but this was not the case. It was suggested that offline resources be available or downloadable in order for them to be used offline. This would enable the users of an OER intervention to complete assignments and upload it when they have internet access (given that upload instructions are also given).

The activities were also given with minimal examples of a completed assignment. This choice in design of the activities was deliberately done to encourage independent learning and spark conversation in the comments section. The results proved that this approach was not applicable to the age group for which this OER was designed. Instead, they were discouraged from attempting an activity and moved on to other simpler ones. Ultimately, they missed out on valuable learning experiences. The results showed that if there were more examples, the participants

would have attempted some of the more challenging activities, thus giving them a more enriching experience.

To summarize the findings of the design aspects, when a designer creates the activities of an OER, he or she should firstly take the age and computer skills of the target users into account. The target users may not have had adequate experience in using technology for education and one cannot assume that they have the necessary skills to work with a complicated resource. When external resources are used, they should be carefully selected and accompanied with thorough instructions on how to use them. If at all possible, the resources should also be able to function offline. There should also be adequate examples of what is expected of the learners as this will give them a point of reference and guide them in completing their assignments correctly.

6.1.3.2 Resource design

PowerSchool is a digital learning platform with many built-in and design features. As a designer, one should first become acquainted with the software and determine the strengths and weaknesses of the software. This will enable the designer to determine which elements and features can be included in the resource. The results from the study provided insights into what features the users of an OER would find helpful in aiding them in their studies.

Physical design – The results proved useful in determining which design features could have an influence on learning. The physical design was well received and easy to understand. Although it was the first time that participants had used the resource, they navigated it with ease, which gave them more confidence in exploring the resource. The biggest standout feature was the navigation or menu bar that was always visible. It enabled the users to find relevant information with ease. Furthermore, the uniform design and layout of the page gave the participants more confidence in exploring the resource. The fonts and colours were neutral and legible and displayed clearly which further enhanced the ease of use.

Seeing that the OER was tailored for a specific audience, all the labels in the navigation bar were designed to resemble the learning content of the *Energy and Change* module that the participants were busy with in class. This proved to be

useful as it improved familiarity and gave the participants more confidence in using the resource. However, it isn't always possible to design a resource that resembles class content, but should be considered when designing the resource.

Learning content – The informational videos that were included in the resource were by far the most beneficial for the participants. Together with the videos, the illustrations also proved useful for the participants. The learning content was also broken down into smaller chunks which was accompanied by smaller assessments. This proved to be useful and encouraged the participants to attempt the activities. The results showed that the amount of reading that the participants had to do was off-putting and inhibited use.

Missing features – When a designer of an OER chooses the design software, he or she should determine which features are included in the software package and determine if it will be adequate for the resource. That being said, *PowerSchool* had a number of features that were useful and some that were not fully explored.

The results showed that the participants lamented the fact that there were no gamification elements included in the resource. However, the software had gamification features that could have been included in the resource. After analysing the results, the conclusion was made that gamification could have a positive influence on learning. The results revealed that the participants would have eagerly competed against each other for badges and achievements which would benefit learning. They revealed that this element had been successfully employed in Mathematics where they take part in math competitions against each other. Ultimately, the software and the skill of the designer would determine if this feature would be viable for a planned OER.

Mobile version – This particular resource was designed to be used on a stand-alone computer or laptop. However, the results revealed that a mobile version would have influenced some of the participants' learning. They did not always have access to a computer and in some cases, their time on their home computers was limited. This confirms the statistics that were presented in the literature and how it could have an influence on the use of OERs.

PowerSchool has the ability to convert an OER that is designed for a computer to a mobile version. However, this poses a challenge for the designer in terms of external resources and activities that would be incorporated in the resource.

Therefore, when a designer is in the planning phase of the design of an OER, he or she should determine whether to design the resource for computers or mobile devices. Both platforms have strengths and weaknesses, but how the target audience will access the resource will ultimately determine the platform of the OER.

To conclude, the designer has to take the physical design of the OER, as well as the design of the activities and learning content into account. The results showed that these design elements have a clear influence on learning as it either encourages or discourages use of the OER. Figure 6.2 serves as an illustration of the two design aspects that an OER designer needs to take into account. These features won't necessarily differentiate the intervention, but has the potential to encourage use of the OER.

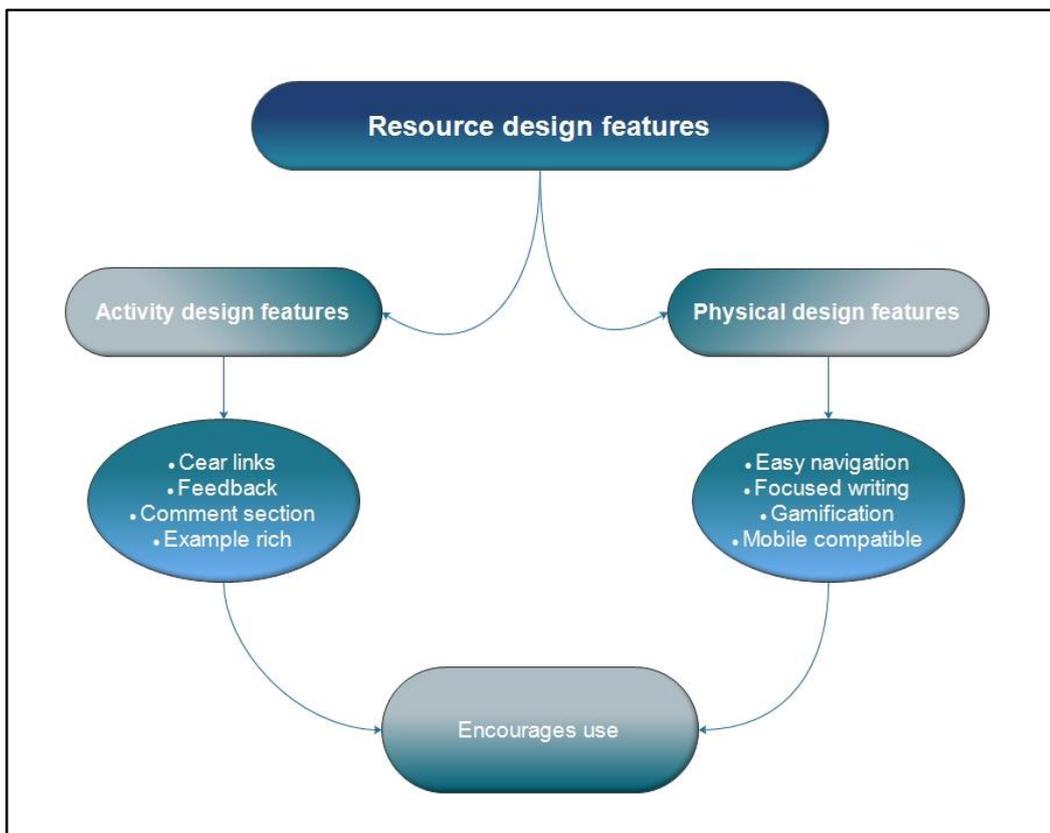


Figure 6.2 – Resource design features that encourage use

Both the activity design features and the physical design features play a role in encouraging the use of an OER. If the OER is confusing, it would be fair to assume that the user might be deterred from using it. However, when these aspects are taken into account, the user might feel comfortable enough to work with the OER and attempt the complex activities.

6.2 Unexpected findings

Apart from the supporting questions, the results from the collected data revealed some unexpected findings. These findings also proved useful in answering the main research question.

Firstly, the age of the participants was a major factor that had an influence on their use of the OER, but more importantly their computer skills. It was assumed that they possessed the necessary skills to work with the resource in its entirety, but it became clear that they lacked not only basic computer skills, but also logical thinking, problem-solving skills and digital competencies. Their prior experience was not enough to give them the confidence they needed to utilize the OER fully.

Very few of the participants attempted activities that involved an uploading process. Whenever they were faced with such an activity, they opted to move on to another activity. Very few of them could apply basic problem-solving skills and attempt an upload. They deemed the process too difficult and even when the process was verbally explained, it still seemed too confusing. This is an issue of great concern and deserves further investigation.

Another aspect that was influenced by the participants' age was their prior knowledge. Not necessarily their prior knowledge of the learning content, but rather that of what was required in some of the activities. It was assumed that the participants were familiar with all of the responses that the activities required, but again, their age and lack of exposure rendered them unable to complete an activity.

As mentioned before, OERs are open to anyone and one cannot make assumptions about prior knowledge, learner ability, parental involvement or computer skills. When the designer over-estimates the capabilities of the students, he creates a barrier to learning and the resource becomes less efficient. Figure 6.3 illustrates the effects of assumptions on learning outcomes that are set in an OER intervention:

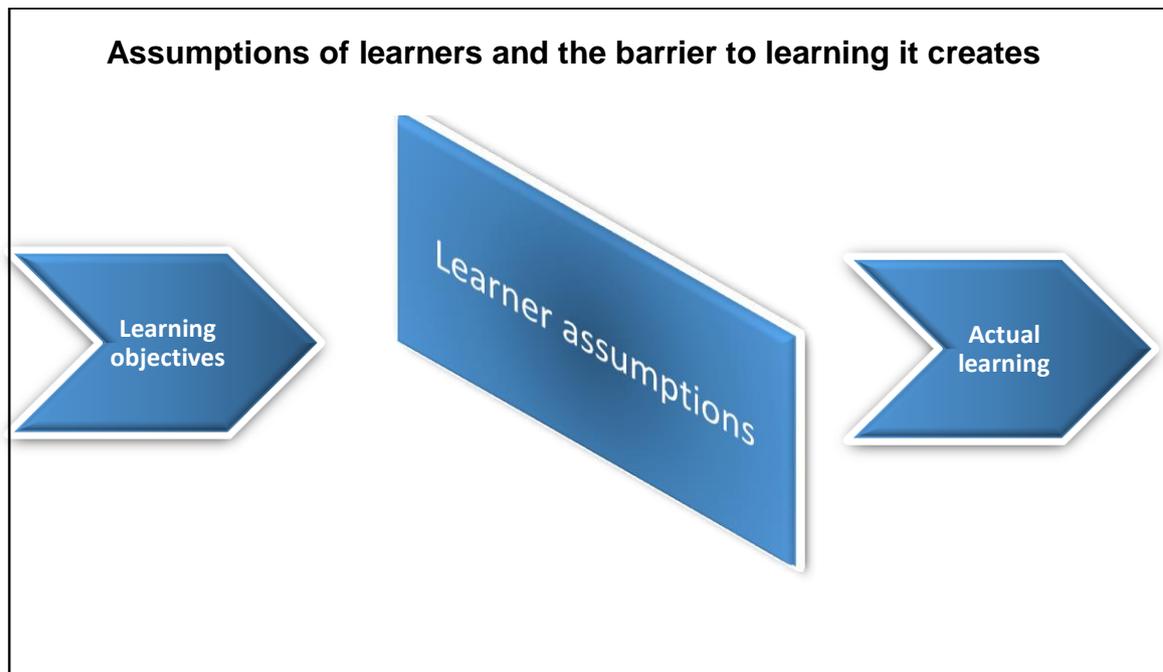


Figure 6.3 – The effects of assumptions on the use of OERs

As mentioned earlier, the participants had very little to no experience with discovery learning and seeing that the resource was designed with open browsing and use in mind, it proved to instil a feeling of fear and anxiousness in the participants.

Up until when they were exposed to the OER, all of their previous formal education had been guided and had formed an expectation of how a resource should work. The freedom of choosing a path of learning was initially foreign to them. However, as they used the OER and became more familiar with the structure of the resource, they also gained confidence in exploring.

The OER provided the participants with ample links to external resources, but there were also activities that were designed to encourage the participants to seek outside resources of their own. This was not met with enthusiasm and was deemed time consuming. Not only that, the sheer amount of resources that are available overwhelmed them and again, they were dissuaded from doing certain activities. Their internet browsing skills were left wanting and it is another aspect that can be investigated further.

On the other hand, it was assumed that the parents of the participants would be more involved and assist them in their attempts to complete their assessments, especially, seeing that the majority of the work had to be done online. It is no secret that the internet is a volatile environment and one should navigate it with care.

Finally, the most disturbing finding from the data was the value that the participants placed on grades and not necessarily on learning itself. From the results, it was apparent that some of the participants did not attempt certain activities because it did not have a direct influence on their grades. If it did not contribute to their final grade on their report, it was deemed a waste of time. This is a point of major concern, seeing that it seems that the emphasis of a grade is misplaced and is seen as an achievement, rather than a quantified representation of skill level.

From the above findings, as well as those that were derived from the supporting questions. Enough information was gathered to answer the main research question and provide a possible solution to the research problem.

6.3 Main Research question

The main research question was posed to determine how OER interventions could be designed (at the hands of the Bloom-Gardner Matrix) to facilitate for cognitive-intellectual diversity in grade 5 Science learners. As noted in the literature study, OERs comprise of more than just articles, worksheets or educational videos, but include complete educational courses. In light of this, the research focussed on an intervention that covered an entire module in the grade 5 Science curriculum of South Africa.

The findings gave insights into how an intervention could be designed in terms of the layout of the intervention, the features that could be included and also the various activities that would promote cognitive-intellectual diversity.

6.3.1 Intervention layout and design

Although the layout and design of an OER would not necessarily influence or promote differentiation, it would encourage a potential user to interact with an OER. Although OERs have officially been around since 2002, there is still very little awareness of their existence and there is little research to support how these resources are utilized. Ultimately, an OER is only of any use if it is being used. Therefore, it has to be designed in such a way that will promote user interaction.

It has to be mentioned, that it was the first time that the participants interacted with a resource of this nature and it was met with a mixture of excitement and fear. The findings revealed that the fear dissipated due to the design and seeing that it was navigated with ease. Consequently, they grew in confidence as they interacted with the resource.

From a layout design perspective, an OER intervention of this nature needs to have a menu or index that is visible and easily accessible from anywhere in the resource. This provides the user with a way to navigate the resource without getting lost. That being said, the menu labels need to be clear, easy to read and also stand out. If the target audience is known to the designer, it would be highly recommended to use the same wording for the labels in the intervention as what is used in their formal curriculum.

It would also be advisable to include an introduction to the resource and how it functions in the home screen or landing page. Furthermore, depending on the length of the introduction, it would be wise to either have a visual guide or guided video imbedded in the resource to explain how it functions. That being said, the detail of the video or visual guides depend on the skill of the designer, but more importantly, the age and the relevant experience and exposure of the intended target users.

When an intervention is designed for grade 5 learners, one cannot assume that the learners will have parental guidance or assistance when they interact with the resource, therefore the wording of the content, instructions and activities need to be age appropriate.

Lastly, as a designer, a decision needs to be made to either tailor the intervention for mobile use or stand-alone computers. However, based on statistics, opting for a mobile friendly design would be the better choice. That being said, each platform has pros and cons and it is up to the designer to determine which platform would suit the resource better.

6.3.2 Features to consider

The features that need to be included in an OER intervention that will promote differentiation will largely depend on the software package that the designer uses. Therefore, the designer needs to do some research on the software prior to its design. He or she will have to determine whether the software has the necessary features which need to be considered for the resource.

In using the Bloom-Gardner Matrix to differentiate an OER intervention some of the activities that are designed will be dependent on outside resources. Therefore, the software package that is used to design the OER needs to have the ability to include hyperlinks. On that note, these links need to be distinguishable from the rest of the text.

The outside resources also need to be carefully considered before they are included in the OER. This study focussed on grade 5 learners and as mentioned before, their computer skills are still limited. They also don't necessarily have the means to register if an email account is needed. If the resource is too complicated for the intended audience, it could potentially discourage the user from attempting an activity and consequently miss out on a valuable learning experience.

To ensure that the users utilize the outside resources, a guide or tutorial needs to be included in an activity brief that explains how the external resource works. Furthermore, instructions on how to upload an activity for assessment also needs to be clear and written in simple terms. One has to assume that the users have minimal computer skills and that every effort is made to assist them in completing activities.

The designer needs to assume that the users do not have unlimited internet access and it would, therefore, be wise to consider using offline resources in the form of freeware and open software. This entails that the designer will have to screen the downloadable software to ensure that the software is virus free and safe for home use.

To differentiate the OER, the designer would also have to differentiate the learning material. It needs to consist of written, audio and visual material to promote differentiation. Again, outside resources with interactive elements would further promote differentiation and essentially provide the users with enough variation in content to support their learning.

Whereas some of the features that need to be present will promote differentiation directly, others will have an indirect influence on differentiation. What this means is that there are features that need to be present that promote more interaction which could lead to better utilization of the resource.

In choosing the design software, it is advisable to use software that has the ability to provide immediate feedback to the users once an activity is complete. This enables the users to measure their understanding of the learning material. However, immediate feedback is not always a viable option. In these instances, a comments section is helpful and allows the user to post comments and questions that will assist them in their learning.

Gamification is another element that could be considered to incorporate in the OER, seeing that it promotes participation. Again, this feature does not have a direct influence on differentiation, but sparks conversation among users and also gives the OER a social element that, according to the findings of this research study, would increase the user's interaction and use of the OER.

The findings of the research showed that when a designer is familiar with the target audience and the curriculum they are busy with; the curriculum structure could be used as the backbone of the OER. In other words, the OER could be designed to run in conjunction with the school curriculum. Furthermore, if the same terms that are used in their formal curriculum is used in the OER, it gives the users more confidence to use the OER without restraint. In most cases, the target audience would not have had contact with a resource of this nature and anything that is familiar to them leads to confidence and ease of use.

Finally, it is the designer's prerogative to design the resource in such a way that the content be released gradually or all at once. Overstimulating the new OER intervention users could be counterproductive and lead them to feel discouraged and not use the OER. However, the software that is used to design the intervention will determine if this is even possible, seeing that not all software packages provide this feature.

Figure 6.4 provides a summary of the design aspects that need to be taken into account when differentiating an OER intervention. These design aspects will either have a direct or indirect influence on differentiation.

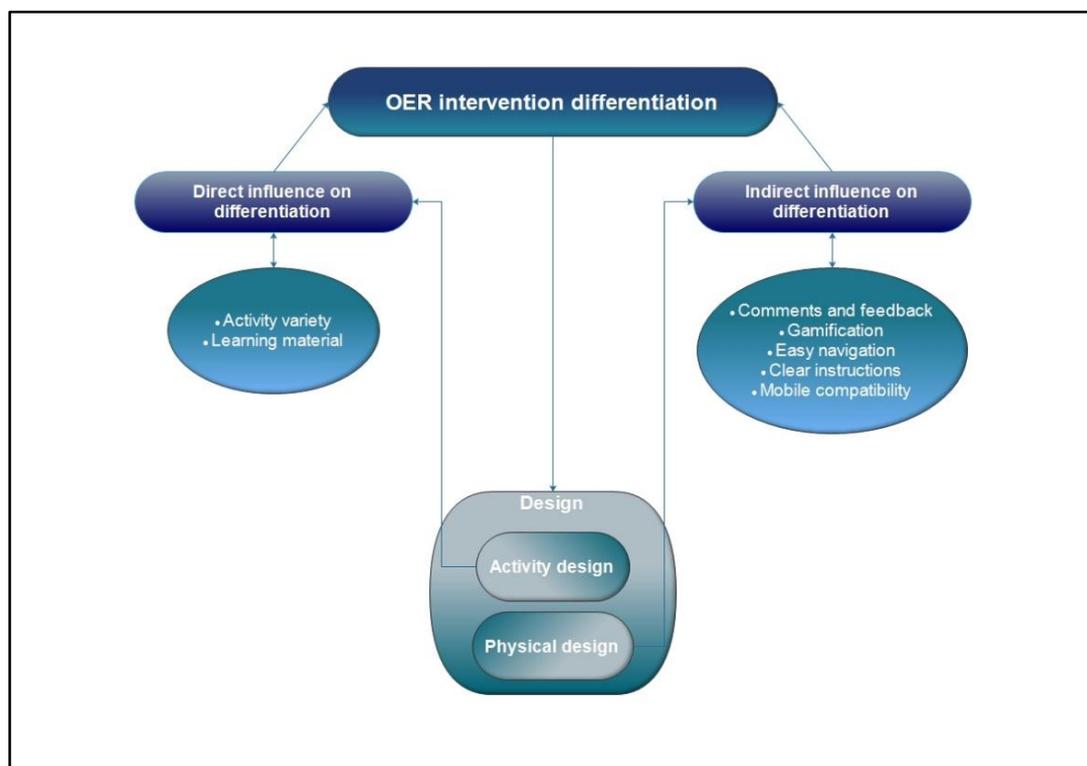


Figure 6.4 – OER intervention differentiation

6.3.3 Activities to consider

To begin with, the theoretical framework that the study was built on, was used to provide the users with multiple options of activities that they could complete to assist them in their studies. The findings of the research revealed that differentiating a single unit of study is not as important as differentiating the intervention as a whole. This means that there needs to be variety in terms of difficulty and intelligence throughout the entire intervention.

The learning content and the outcomes that the resource is intended to achieve will determine the level of difficulty of the activities. However, the designer will need to decide on the intelligence and also which intelligence lends itself to the content. However, concerning the activities themselves and what they require of the users, there are a couple of aspects that need to be taken into consideration when designing the activities. Figure 6.5 illustrates how variety can be equal to differentiation.

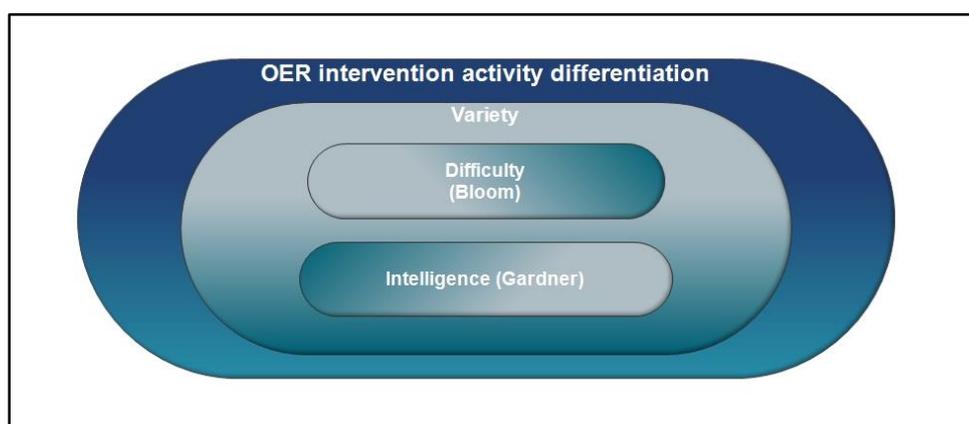


Figure 6.5 – OER activity differentiation through variety

First and foremost, it is important not to assume that the users will know what is expected of them. One can also not assume that they have had exposure to a certain type of activity before. Therefore, each activity brief will need to have an example of what is expected of the user. It would also be advisable to include a glossary of terms that could potentially be unfamiliar to the users. As the findings pointed out, parental involvement is not something that the designer can count on. The online nature of the OER will also mean that the users will most likely access the resource when a teacher is not available to explain terms and concepts.

According to the findings, short answer questions are highly favoured, especially when the software provides the option of giving direct feedback to the user. However, these question types generally only cover the first three levels of Bloom's taxonomy. Although it will take a considerable amount of time for the designer, using the outside resources as a tool to answer multiple choice questions, it will enable the design of higher cognitive level activities.

Although OERs are of a digital nature, the designer could consider incorporating activities that require the user to physically attempt, for example an experiment or building project. Although these activities would not necessarily be assessable, it would still provide the user with meaningful learning experiences.

On the other hand, the findings also showed that if the OER intervention's activities could be used to supplement the learners' formal grades, they would be more inclined to attempt the activities.

Furthermore, the findings of the research showed that users prefer variety and are not necessarily drawn to one specific intelligence. The designer could then use the Bloom-Gardner Matrix to create a variety of activities and then use a selection of these activities that range across the intelligences to be incorporated in the eventual OER intervention (See Table 6.1).

6.4 Limitations to the study

The research problem that this study sought to address was to determine how an OER intervention could be differentiated to accompany a more diverse pool of users. Previous research showed that merely providing a resource is not enough to cater for diversity and seeing that these resources are intended for anyone, diversity is inevitable (Richter & McPherson, 2012). However, there were some limitations to the study which could not be addressed in this study.

Firstly, there was a specific audience that the resource was designed for and only addressed the diversity of this particular group, namely grade 5 Science learners. It would, therefore, be difficult to determine whether the findings could be generalised to other groups of users or diversity as a whole.

Another limitation to the study was the software that was used to create the intervention. There are other digital learning platforms which would not necessarily have the same functionality as *PowerSchool Learning*. On the other hand, the software itself had limitations and could only be accessed by the specific group of participants. Although all of the resources and content of the intervention were “open”, access to the resource was granted only to the participants of the study. Alternatively, the intervention could be hosted on an open network like Udemy (Udemy, 2019). However, the assessments could become challenging to assess.

If it was designed on a learning platform that was open to public access, a number of the assessment activities would not have been viable, unless the designer intended to assess all the users that accessed the resource.

Even though gamification was mentioned as a feature that the participants would have enjoyed, it would pose a challenge for a designer to incorporate it into an intervention. However, if he or she knows the target audience, like a teacher designing the resource for his or her students, it could be accomplished. Furthermore, the designer also has to establish if the design software has gamification capabilities before it can be included in the OER intervention.

Designing the resources was a time-consuming endeavour and would be difficult to duplicate on a regular basis. This could potentially pose a problem for a would-be designer. Depending on the computer skills of the designer, it could potentially take even more time to develop seeing that the software would have to be mastered first.

Although the study was aimed at grade 5 learners, their prior experience was another limiting factor that only became apparent when they started to explore the external resources that required registration. It inhibited their use and could have been averted if the researcher had known that the registration for resources would have had such an impact on their use of the OER.

Although these were limitations to the study, it also gave insight into gaps in the literature that needs further investigation.

6.5 Conclusions

The research study sought to establish how OER interventions could be designed to cater for diversity. The data that was collected and the findings that were derived from the data gave some insights in addressing the problem. The two main aspects that need to be considered when designing an intervention which caters for diversity is the **layout and features of the intervention** itself and the **design and features of the activities**.

6.5.1 Intervention design

The design and features of the intervention differs from the design and features of the activities in that it is the package that holds everything together, whereas the activities and learning material provide differentiation in terms of assessment.

The findings showed that there were no clear preferences in terms of the intelligences, proposed by Gardner. However, variety is a key aspect that will promote interaction with the resource. The learning content or material needs to vary between written text, audio visual material as well as interactive material. This can be achieved by incorporating external resources via hyperlinks that are imbedded in the learning content.

The aesthetics of the resource is also an important factor that will influence the user's interaction with the resource. To enable the users to use the intervention with confidence, it needs to be easily navigable. This is achieved by having a prominent menu or sidebar that the user can refer to. It increases the navigability of the intervention and puts the user at ease when moving around the resource.

Emphasis should be placed on important elements like hyperlinks and clickable features by highlighting the text and changing its colour. Furthermore, uniformity in text colour, font and size is also important. It allows the users to notice patterns in the intervention such as sections and sub-sections. It decreases the time it takes for the user to become accustomed to the layout of the intervention and also increases navigability.

One has to assume that the users have limited computer skills and that it would possibly be the first time that they access a resource of this nature. Therefore, an

introduction to the resource should be included to explain the inner-workings of the resource.

Other notable mentions that could be incorporated into an OER intervention would be gamification and mobile versions of the designed resource. The abovementioned aspects won't necessarily address differentiation directly, but the findings showed that users are more eager to work with a resource if it can be used with ease and confidence.

Every effort should, therefore, be made to ensure that the users are at ease when they interact with the resource. This will encourage better utilization of the resource and make for a richer learning experience.

6.5.2 Activity design

The OER intervention that was designed for the study utilized the Bloom-Garner Matrix to differentiate the learning content and learning activities. It was done in order to establish which activities could be designed to promote differentiation.

However, the findings showed that it isn't necessary to provide the users with choice in activities, but rather just variety. When an OER intervention is planned and designed, the designer needs to ensure that the difficulty in activities varies, but that there also be variety in terms of Gardner's intelligences. The Bloom-Garner Matrix should ultimately just serve as a tool for the designer of the OER to develop the variety of activities that are needed for the intervention.

The most important aspect of the learning activities that requires meticulous attention and planning is the instructions. This is especially true when external resources are incorporated to complete activities. The designer needs to assume that the users lack the skills to work with the external resource and should therefore include a guide that will assist them in their endeavours.

Depending on whether the designer intends to design the resource for a mobile platform or for access via a computer, the external resources should be chosen with care. If registration is required, the age of the users could render the external source useless due to restraints that their age brings.

Lastly, if the designer is familiar with the target audience, he or she could utilize a comment-and-feedback section that some of the digital learning platforms provide. It gives the users the opportunity to air their grievances, concerns and other uncertainties.

6.5.3 Prior knowledge

Before one can address how OERs can be differentiated, the issue of prior knowledge of OERs or OER awareness needs to be addressed first. The findings of the research showed that the participants were not aware of OERs. Thus, even if OER interventions exist that cater for diversity, the potential beneficiaries of the OERs would not even be aware of their existence.

Therefore, the researcher has come to the conclusion that an awareness campaign of these resources should be considered to make people aware of OERs and the potential benefit it holds for their studies, be it for personal enrichment or formal studies.

The internet has an abundance of resources and there are also various repositories which host collections of resources that could be accessed at any time. However, it would be fair to assume that there are individuals who could benefit from the resources but lack the skills in searching for them. That being said, conducting further research into the skills needed to scour the internet for appropriate OERs could be worth investigating.

6.6 Final thoughts

The results from the research provided ample suggestions on how an OER intervention could be designed to differentiate an OER intervention. However, the question needs to be asked if it is a viable solution to the problem? The reason for the question is purely based on the effort and time it takes to develop a differentiated OER intervention.

In short, it is worth the effort. The designer might have to take some time to develop a resource of quality, but it only needs to be done once and thereafter it only needs to be updated. Furthermore, the need for these resources are immense and it would provide a great number of people access to resources that would otherwise be lost to them due to their financial circumstances.

Ultimately it is not only the target audience who could benefit from the design of such a resource, but the designer as well. It takes careful planning and consideration to develop an OER intervention that caters for differentiation and if the designer is up to the task, he/she could acquire valuable computer skills along the way and continue to be a lifelong learner.

Furthermore, the designer of the OER could also investigate adaptive learning (AL) which has already been extensively researched. In short, AL is a learning method that utilizes software-technology to provide the learners with content, but also tailors the content according to the individual learning requirements of each student (Kakish & Pollacia, 2018).

The learners' responses to questions, tasks and other practical activities informs the software as to what the learner has already mastered and what the learner still needs to achieve. This is all made possible through well-defined goals and course-objectives. Although a lot of time will be spent on developing the resource, the target audience will have a better opportunity to reach their individual goals, which is why the resource is designed in the first place.

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7. Appendix A – Coding correlation extract

Code	File	Agreement (%)	Disagreement (%)
(Jane)	Focus Group - 5A3	100	0
(Jane)	Focus Group - 5E1	85.99	14.01
(Jane)	Focus Group - 5E2	99.87	0.13
(Jane)	Focus Group - 5E3	100	0
(Adel)	Focus Group - 5A3	100	0
(Adel)	Focus Group - 5E1	100	0
(Adel)	Focus Group - 5E2	100	0
(Adel)	Focus Group - 5E3	85.46	14.54
(John)	Focus Group - 5A3	100	0
(John)	Focus Group - 5E1	83.32	16.68
(John)	Focus Group - 5E2	100	0
(John)	Focus Group - 5E3	100	0
(Amy)	Focus Group - 5A3	100	0
(Amy)	Focus Group - 5E1	100	0
(Amy)	Focus Group - 5E2	100	0
(Amy)	Focus Group - 5E3	86.69	13.31
(Barny)	Focus Group - 5A3	100	0
(Barny)	Focus Group - 5E1	100	0
(Barny)	Focus Group - 5E2	100	0
(Barny)	Focus Group - 5E3	83.7	16.3
(Paul)	Focus Group - 5A3	100	0
(Paul)	Focus Group - 5E1	100	0
(Paul)	Focus Group - 5E2	85.6	14.4
(Paul)	Focus Group - 5E3	100	0
(Kimmy)	Focus Group - 5A3	100	0
(Kimmy)	Focus Group - 5E1	100	0
(Kimmy)	Focus Group - 5E2	86.16	13.84
(Kimmy)	Focus Group - 5E3	100	0
(Lisa)	Focus Group - 5A3	85.45	14.55
(Lisa)	Focus Group - 5E1	100	0
(Lisa)	Focus Group - 5E2	100	0
(Lisa)	Focus Group - 5E3	100	0
(Dorothy)	Focus Group - 5A3	100	0
(Dorothy)	Focus Group - 5E1	100	0
(Dorothy)	Focus Group - 5E2	84.09	15.91
(Dorothy)	Focus Group - 5E3	100	0
(Nathan)	Focus Group - 5A3	83.9	16.1
(Nathan)	Focus Group - 5E1	100	0
(Nathan)	Focus Group - 5E2	100	0
(Nathan)	Focus Group - 5E3	100	0

(Danny)	Focus Group - 5A3	100	0
(Danny)	Focus Group - 5E1	86.2	13.8
(Danny)	Focus Group - 5E2	100	0
(Danny)	Focus Group - 5E3	100	0
(Bob)	Focus Group - 5A3	87.35	12.65
(Bob)	Focus Group - 5E1	100	0
(Bob)	Focus Group - 5E2	100	0
(Bob)	Focus Group - 5E3	100	0
(James)	Focus Group - 5A3	100	0
(James)	Focus Group - 5E1	100	0
(James)	Focus Group - 5E2	88.08	11.92
(James)	Focus Group - 5E3	100	0
(Ingrid)	Focus Group - 5A3	100	0
(Ingrid)	Focus Group - 5E1	100	0
(Ingrid)	Focus Group - 5E2	85.67	14.33
(Ingrid)	Focus Group - 5E3	100	0
(Billy)	Focus Group - 5A3	85.6	14.4
(Billy)	Focus Group - 5E1	100	0
(Billy)	Focus Group - 5E2	100	0
(Billy)	Focus Group - 5E3	100	0
(Sally)	Focus Group - 5A3	86.09	13.91
(Sally)	Focus Group - 5E1	100	0
(Sally)	Focus Group - 5E2	100	0
(Sally)	Focus Group - 5E3	100	0
(Brad)	Focus Group - 5A3	100	0
(Brad)	Focus Group - 5E1	100	0
(Brad)	Focus Group - 5E2	84.89	15.11
(Brad)	Focus Group - 5E3	100	0
(Marsha)	Focus Group - 5A3	100	0
(Marsha)	Focus Group - 5E1	100	0
(Marsha)	Focus Group - 5E2	100	0
(Marsha)	Focus Group - 5E3	86.96	13.04
(Molly)	Focus Group - 5A3	100	0
(Molly)	Focus Group - 5E1	100	0
(Molly)	Focus Group - 5E2	100	0
(Molly)	Focus Group - 5E3	84.96	15.04
(Peter)	Focus Group - 5A3	100	0
(Peter)	Focus Group - 5E1	86.35	13.65
(Peter)	Focus Group - 5E2	100	0
(Peter)	Focus Group - 5E3	100	0
(Neval)	Focus Group - 5A3	100	0
(Neval)	Focus Group - 5E1	100	0
(Neval)	Focus Group - 5E2	100	0
(Neval)	Focus Group - 5E3	85.78	14.22
(Mike)	Focus Group - 5A3	85.18	14.82

(Mike)	Focus Group - 5E1	100	0
(Mike)	Focus Group - 5E2	100	0
(Mike)	Focus Group - 5E3	100	0
OER design	Focus Group - 5A3	100	0
OER design	Focus Group - 5E1	100	0
OER design	Focus Group - 5E2	100	0
OER design	Focus Group - 5E3	100	0
Omolemo (Joyce)	Focus Group - 5A3	100	0
Omolemo (Joyce)	Focus Group - 5E1	85.35	14.65
Omolemo (Joyce)	Focus Group - 5E2	100	0
Omolemo (Joyce)	Focus Group - 5E3	100	0
Shilovo (Sarah)	Focus Group - 5A3	100	0
Shilovo (Sarah)	Focus Group - 5E1	85.62	14.38
Shilovo (Sarah)	Focus Group - 5E2	100	0
Shilovo (Sarah)	Focus Group - 5E3	100	0
Activities	Focus Group - 5A3	99.45	0.55
Activities	Focus Group - 5E1	99.37	0.63
Activities	Focus Group - 5E2	97.63	2.37
Activities	Focus Group - 5E3	100	0
Activities or Assessments	Focus Group - 5A3	99.15	0.85
Activities or Assessments	Focus Group - 5E1	100	0
Activities or Assessments	Focus Group - 5E2	100	0
Activities or Assessments	Focus Group - 5E3	100	0
Activities or Assessments\Activity Length	Focus Group - 5A3	97.66	2.34
Activities or Assessments\Activity Length	Focus Group - 5E1	100	0
Activities or Assessments\Activity Length	Focus Group - 5E2	100	0
Activities or Assessments\Activity Length	Focus Group - 5E3	100	0
Activities or Assessments\Activity structure and wording	Focus Group - 5A3	95.54	4.46
Activities or Assessments\Activity structure and wording	Focus Group - 5E1	100	0
Activities or Assessments\Activity structure and wording	Focus Group - 5E2	100	0
Activities or Assessments\Activity structure and wording	Focus Group - 5E3	100	0
Activities or Assessments\Disliked activities	Focus Group - 5A3	99.17	0.83
Activities or Assessments\Disliked activities	Focus Group - 5E1	99.54	0.46
Activities or Assessments\Disliked activities	Focus Group - 5E2	99.78	0.22
Activities or Assessments\Disliked activities	Focus Group - 5E3	99.76	0.24
Activities or Assessments\Disliked activities\Reasons for dislike	Focus Group - 5A3	95.76	4.24
Activities or Assessments\Disliked activities\Reasons for dislike	Focus Group - 5E1	98.2	1.8
Activities or Assessments\Disliked activities\Reasons for dislike	Focus Group - 5E2	97.91	2.09
Activities or Assessments\Disliked activities\Reasons for dislike	Focus Group - 5E3	99.8	0.2
Activities or Assessments\No clear preference	Focus Group - 5A3	99.29	0.71

Activities or Assessments\No clear preference	Focus Group - 5E1	100	0
Activities or Assessments\No clear preference	Focus Group - 5E2	100	0
Activities or Assessments\No clear preference	Focus Group - 5E3	100	0
Activities or Assessments\Positive and Negative experiences	Focus Group - 5A3	94.39	5.61
Activities or Assessments\Positive and Negative experiences	Focus Group - 5E1	90.79	9.21
Activities or Assessments\Positive and Negative experiences	Focus Group - 5E2	91.3	8.7
Activities or Assessments\Positive and Negative experiences	Focus Group - 5E3	95.49	4.51
Activities or Assessments\Preferred activities	Focus Group - 5A3	96.67	3.33
Activities or Assessments\Preferred activities	Focus Group - 5E1	98.49	1.51
Activities or Assessments\Preferred activities	Focus Group - 5E2	97.34	2.66
Activities or Assessments\Preferred activities	Focus Group - 5E3	96.56	3.44
Activities or Assessments\Preferred activities\Reasons for preference	Focus Group - 5A3	93.63	6.37
Activities or Assessments\Preferred activities\Reasons for preference	Focus Group - 5E1	93.87	6.13
Activities or Assessments\Preferred activities\Reasons for preference	Focus Group - 5E2	95.93	4.07
Activities or Assessments\Preferred activities\Reasons for preference	Focus Group - 5E3	95.94	4.06
Activities or Assessments\Progression vs Choice based on preference	Focus Group - 5A3	93.89	6.11
Activities or Assessments\Progression vs Choice based on preference	Focus Group - 5E1	91.53	8.47
Activities or Assessments\Progression vs Choice based on preference	Focus Group - 5E2	96.95	3.05
Activities or Assessments\Progression vs Choice based on preference	Focus Group - 5E3	93.69	6.31
Activities or Assessments\Unclear activities	Focus Group - 5A3	98.49	1.51
Activities or Assessments\Unclear activities	Focus Group - 5E1	100	0
Activities or Assessments\Unclear activities	Focus Group - 5E2	100	0
Activities or Assessments\Unclear activities	Focus Group - 5E3	100	0

8. Appendix B – Focus group discussion protocol

Focus group Protocol Form

Project: Designing OERs to facilitate for cognitive diversity in grade 5 science learners.

Date _____

Time _____

Location _____

Group _____

Interviewee _____

Consent forms signed? _____

Notes to Focus Group:

Thank you for your participation. I believe your input will be valuable to this research in helping to design Open Educational Resources more effectively.

Confidentiality of responses is guaranteed.

Approximate length of focus group session: 30 minutes, five major questions.

Purpose of research:

The main purpose of the research is to establish how OERs can be designed to facilitate for cognitive diversity in grade 5 science learners.

OERs are freely available and can be used by anyone to develop their education. There are, however, concerns as to the effectiveness of the use of OERs with regards to their design and context.

The key aspects that the focus group will touch on include:

1. The ease in which the OER was accessed.
2. The preferred activities
3. How the OER was used
4. Was there an improvement in Science understanding?
5. The importance of differentiating with intelligences and Bloom

1. Apart from me telling you about OERs, were you previously aware that there existed OER to assist you in your education?

- How easy or difficult did you find it to access the OER? Explain your answer.
- How did you navigate the course/intervention page?
- What items drew your attention?
- Was there anything within the course page that you were unsure of where to find?

Response from focus group transcription:

Reflection by interviewer

2. What activities did you tend to enjoy more?

- Why did you prefer doing these activities?
- What activities did you attempt first and why?
- Did you feel confident in attempting some of the more difficult activities in a certain intelligence group?
- If you answered yes in the previous question, explain why.

Response from focus group transcription:

Reflection by interviewer

3. Can you walk me through the personal learning process you have gone through as a participant in the OER?

- How did you feel in the beginning, middle and end of the course?
- Was there a stage where you felt lost or didn't know what to do?
- How did you find the assessments in the course?
- Do you feel you have a more solid grasp of the science content?

Response from focus groups transcription:

Reflection by interviewer

4. Was there an improvement in your Science understanding with regards to the intervention topic?

- In what way has your understanding of the given topic improved/or not?
- Given the knowledge that you gained, do you feel that you can merely recite the facts, or explain the scientific phenomenon?
- How did the assessments improve your knowledge of the subject matter?

Response from focus groups transcription:

Reflection by interviewer

5. How important was it that the intervention was differentiated?

- Were you drawn towards a particular intelligence and why?
- Did you notice a difference in the way the activities were structured?
- Were you able to relate to a certain intelligence or more than one intelligence?
- What effect did this have on your learning?
- Were you challenged to do the more difficult activities in the intelligences that you related to?

Response from focus groups transcription:

Reflection by interviewer

- Closure
 - Thank you to focus group
 - reassure confidentiality
 - ask permission to follow-up _____

9. Appendix C – Peer review protocol

Comment on the content of the intervention. Does it align with the school curriculum and is it appropriate for the specific grade?

--

Are the assessment activities appropriate? If not, please explain and make suggestions on how the assessments can be improved.

--

Comment on the navigation of the intervention. Explain how difficult or easy it was to navigate.

--

Comment on the aesthetic design of the intervention. Was all the information clear and easy to read? Was the intervention logically designed? If not, explain your experience.

--

10. Appendix D – Letter of invitation

To whom it may concern.

You are hereby invited to participate in an academic research project that aims at improving Open Educational Resource (OER) design.

You will be required to engage in an online learning intervention that covers the grade 5 Science module for Energy and Change. Whilst engaging in the intervention, you will be required to critically analyze the intervention and ensure that the content corresponds with the school curriculum and that the difficulty level is appropriate for the grade. You will also need to comment on the physical design of the intervention and make suggestions if improvements are needed.

The intervention is designed to facilitate for diversity in terms of levels of difficulty, practical activities and various assessment opportunities.

Your feedback on the intervention will be used to refine the design of OERs so as to cater for a more diverse audience.

Should you wish to participate in the research, please complete the section below.

I (name and surname) _____ am interested in participating in the research project and would like to schedule a meeting to discuss the details of my involvement.

Signature: _____

Date: _____



Hanno Tromp
hannotromp@gmail.com

Dr. R. Callaghan
ronel.callaghan@gmail.com

11. Appendix E – Learner assent form

LETTER OF ASSENT

April 2018

Project Title: *Designing OERs to facilitate for cognitive-intellectual diversity for grade 5 Science learners.*

Investigator: *Mr. H. Tromp*

Dear Participant

I am doing a research study about development of Open Educational Resources (OERs). Basically, these are resources that you can find online and use to help you in yours studies. This research study is a way to learn more about how you learn and how resources can be designed to fit your learning needs. If you decide that you want to be part of this study, you will be asked to participate in an online intervention or study program that will assist you in your science module. You will be required to do a number of assessment tasks regarding your science module and give feedback on how you experienced the intervention. You will also be required to complete a questionnaire. Lastly, you will take part in a focus group discussion to express how you experienced the whole intervention. You might also be randomly selected to take part in a one-on-one interview.

There are some things about this study you should know. You will need access to the internet to participate in the study. Not everyone who takes part in this study will benefit. A benefit means that something good happens to you. I think that the main benefit is that you might understand the science module much better and that your marks will improve.

When we are finished with this study we will write a report about what was learned. This report will not include your name or that you were in the study.

You do not have to be in this study if you do not want to be. If you decide to stop after we begin, that's okay too. Your parents know about the study too.

If you decide you want to be in this study, please sign your name.

I, _____, want to be in this research study.

(Sign your name here)

(Date)

12. Appendix F – Consent form

LETTER OF CONSENT

April 2018

Dear Parent

Open Educational Resource design

I am in the process of doing research regarding the development of Open Educational Resources (OERs). I request that your child participate in research where I shall explore challenges, developments, implementations and the impact of open educational resources in the South African context. The specific aspect investigated in this part of the research is the creating, sourcing, evaluation and implementation of open educational resources, linked to the curriculum.

I would like to involve your child in this research through the *creating, sourcing and evaluation of open educational resources, in planning innovative interventions that utilize these applications in teaching and in observations, a survey and/or focus groups on experiences with these applications in teaching.* The results of the research will inform educators as well as developers with regard to the selection, use and development of e-resources.

The activities will be that your child will source, evaluate and use resources for his/her own learning, and/or that he/she will apply it in his/her classroom setup, or in the online environment. This implies that I would like to track or observe learners'/students' use and experiences of the resources as well.

Should you agree to have your child participate in the research, please read the following and sign the letter of consent:

- I consent that data can be collected from activities and reflections on the activities, as well as from the survey/focus groups and observations.
- I authorize the researchers to use class/online activities and reflections on the activities, as well as the results from the survey/focus groups.

I acknowledge that:

- I have been informed that participation is voluntary and I am free to withdraw from the project at any time without explanation or prejudice and to withdraw any unprocessed data previously supplied.
- I have been informed that the confidentiality of the information collected will be safeguarded.
- My child's educational environment as well as my child will be referred to by pseudonym or code name in any publications arising from the research.

We look forward to learning with you!

Kind Regards

Master's Student: Mr. Hanno Tromp
Supervisor: Dr. Ronel Callaghan

E-mail: hannot@midstreamridgeprimary.co.za