

INSEPARABLE SIAMESE TWINS FOR TECHNOLOGY EDUCATION TEACHERS: TECHNOLOGY PROCESS AND TECHNOLOGY PRODUCT

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Abstract

Technology education is crucial to social and economic development of a nation. However education systems in South Africa face numerous challenging factors, which include but not limited to: lack of resources, shortage of well trained teachers in the areas such as mathematics, science and technology education, that impact so much on the quality of education and learners' performance. It is against this background that this paper intends to share light on how technology activities - processes and products are inseparable if applied well by contextualising both pedagogy and didactic of technology. The two activities should complement each other rather than one supersedes the other. The aim of the paper is to report on the extent at which technology teachers ignore the technology process in favour of the technology products. Interviews, field notes and observations were used as instruments to gather data. This was an action research study with four schools in Limpopo Province. Action science theory underpinned the study while cooperative enquiry paradigm became useful since I was researching 'with' teachers as co-researchers rather than researching 'on' them.

Keywords: Action Science Theory, Co-operative Enquiry Paradigm, Action Research Co-researchers

1. INTRODUCTION

Teachers around the world are concerned about the need that exists to equip learners with a type of knowledge-in-action which will allow learners to develop purposeful and effective problem solving skills (Pool, Reitsma and Mentz, 2011). Technology Education (TE) has infused such skills mentioned by Pool et al within its curriculum. It's upon the TE teachers to inculcate the technology knowledge-in-action upon their learners especially during the technology process and product construction. Even though technology education is a late comer in many school curricula both locally and globally, (Rauscher, 2010; Mapotse, 2012b), teachers are still grappling with its implementation (Pudi, 2007). In this study, I sought to collaboratively engage senior phase technology teachers of selected schools in Limpopo Province of South Africa in Action Research for emancipation purposes of relating technology process well with technology products. This engagement exercise is prompted the intention of making schooling better by National Ministry of Basic Education in South Africa under the Schooling 2025 and 2014 Action Plan. The

national Department of Education (DoE) has unveiled the Schooling 2025 and the 2014 Action Plan (The South African Schools Collection, 2012; Department of Basic Education [DBE], 2012). The plan outlines what the government will be doing to make Grade R to 12 schooling better. It is encouraging to note that the plan also explain how every one of the stakeholders in the schooling communities could contribute towards making the goals of the plan achievable. It is upon this background that in this article I intend sharing the negligence observed from technology teachers when undertaking to do technology projects, and to share my inputs of conscientising technology teachers with the value of assessing each and every step of the technology process as the stakeholder in the education ministry.

Action Research (AR) was sought to meet the obligation of achieving the goal DBE. AR is the systematic study of attempts to improve educational practice by groups of participants whom are engaged in their own practical actions which led to their own reflection upon the effects of those actions, (Ebbutt, 1985). The identification of technology teachers' ignorance of the technology process during product making prompted the application of appropriate action research-based intervention strategies to improve their educational practice. To fill these ignorance gap and conscientise these technology teachers with the importance of monitoring the technology process, an AR cycles of spiral activities were undertaken during the design process. The **Design Process** (Investigating, Designing, Making, Evaluating and Communicating – **IDMEC**, (DoE, 1996; 1997 DBE/Curriculum and Assessment Policy Statement [CAPS], 2011) forms the *backbone* of the subject and should be used to structure the delivery of all the learning aims. Learners should be exposed to problems, needs or opportunities as a starting point. Learners should further be engaged in a systematic process that allows them to develop solutions that solve problems, rectify design issues and satisfy needs, (DBE/CAPS, 2011).

Technology or design process is the moral fibre approach for teaching technology education. In this study I will use the both technology and technology education wording interchangeably. Technology teachers need to expose their learners to all the steps of the technology process. A sample of these technology teachers from selected schools were more interested in the technology products developed by their learners rather than observing the learners' technology process. This ignorance of teachers' succinctly checking and approving each and every technology/design process step of their learners undermine the aim of technology education. TE, aims at providing an opportunity for students to learn about the process and knowledge needed to solve problems and extend human capabilities", (Ohio Department of Education, 2007).

Majority of teachers have a limited understanding of the technology process, because their in-service training that is being provided is more theoretical than hands-on (Nkosi, 2008). It is against this background that the study intends to share some light on an instrument developed to assess the technology process during learners' technology product construction as a new

contribution in the field of technology education teaching. This will be a proof that both the process and the product in technology education are inseparable.

There has been a trend of technology studies conducted to address diverse issues around technology education in relation process and product. Nkosi (2008); Mapotse and Gumbo (2011); Pool, Reitsma, and Mentz (2011); De Jager, (2011); Mapotse (2012a); Kufaine and Nyirenda, (2013) have attempted to raise some aspects of these Siamese twins in technology education, the product and the process. However, little research has been conducted on technology education using action research as a methodology to deal with teachers' ignorance of assessing technology process progression steps. Therefore I want to attempt to fill that gap.

2. THEORETICAL FRAMEWORK

The study intends to investigate why technology teachers ignore the technology process and focus only on the technology product. To examine the above stated problem, I used Chris Argyris Action Science theory to underpin this study.

Chris Argyris' (Action Research, 2010) Action Science theory begins with the study of how human beings design their actions in difficult situations. Human actions are designed to achieve intended consequences and are governed by a set of environment variables. The human beings referred to in this study are senior phase technology teachers. Intended consequences refer to technology teaching emancipation. The teachers' environmental variables include but are not limited to technology challenges which range from being under resourced to lack of support. Action science is different from experimental research, in which environmental variables are controlled and researchers try to find out cause and effect in isolated environment. Action science was applied in the study after analyzing the participants' (technology teachers) reconnaissance data, which became clear that they experienced similar challenges even though the participants' are from different schools. Data analysis results pointed out that the participants found themselves in a challenging situation of grappling with the linking technology process to technology product. The whole team of co - researchers (participants) and I should design an action to get out of that difficult situation. The how of getting out of this challenging situation of separating technology product from the process needed some cooperative enquiry paradigm from all the AR role players of the study.

Cooperative enquiry paradigm, also known as collaborative enquiry (Action Research, 2010), was first proposed by John Heron in 1971 and later expanded by Peter Reason. The major idea of cooperative inquiry is to research 'with' rather than 'on' people. It emphasizes that all active participants are fully involved in research decisions as co-researchers. We (the senior phase technology teachers and I) jointly outlined the plan of action to tackle what was regarded as hindrances to deliver technology assessment instrument. Cooperative enquiry creates a research

cycle among four different types of knowledge: propositional knowing, practical knowing, experiential knowing and presentational knowing. The research process included these four stages at each cycle with deepening experience and knowledge of the initial proposition. I engaged the co-researchers within this paradigm as it stresses that I have to research with them. Through this collaborative/co-operative enquiry paradigm the research team (the participants and I) created knowledge within practical knowing and the experiential knowing domain of technology policy interpretation and implementation. This exercise of requesting participants to let their learners design a project by using readily available resources from their local context inspired participants to realise the importance of the technology process when engaged in technology product.

2.1 Problem statement

Employed by the University of Limpopo between 2004 and 2007, I lectured pre-service student teachers enrolled for the Bachelor of Education in Technology Education. During the pre-service assessment of student teachers in different schools, I observed quite a number of challenges from in-service teachers in the field. I will mention few of my observations in this section: I observed lack of knowledge in the teaching and practice of technology by veteran teachers in the field. I observed that the assigned mentor teachers to pre-service student's teachers were not using the technology policy document to serve as a guide to what to teach each phase and grade. I also observed that there was no phase or grade joint planning as teachers were teaching different topics within a term and learners were writing tests on different topics. This was slightly cumbersome for the student teachers from the University of Limpopo (UL) as they had to prepare different lessons for the same grades but different classes. The student teachers contend that they observed that senior phase learners were asked to do projects by their teachers. When the student teachers asked about a rubric to be used to assess their learners per stage of the product, there was none.

The observation outcomes point out that student teachers were more knowledgeable about their subject of technology than their assigned mentor teachers. They eventually changed their role to mentors and their mentors became their mentees as the situation demanded. This reversal confirms the DoE's (2003) declaration that: "Whilst educators in South African schools are qualified to teach a variety of subjects, many of the educators of technology are uncomfortable with the pedagogy of technology".

2.2 Aim of the study and research question

The aim of this article is to report the gap that were identified in the teaching of technology by senior phase teachers at Mankweng Circuit of Limpopo Province who separate technology product from technology process. Action science theory was constructive in helping the technology teachers to design their own actions in an under-resourced environment whereas

cooperative enquiry paradigm became valuable since in this study I was researching ‘with’ both teachers as co-researchers rather than researching ‘on’ them.

This study endeavoured to respond to the following specific research question:

What would constitute effective action research intervention strategy for technology teachers to follow the steps of the technology process when developing the technology product?

3. THE TECHNOLOGY PROCESS AND TECHNOLOGY PRODUCT

The product in technology is the output of the process undertaken whereas the process is the journey travelled, time spends and material resources utilised to come up with a product. People have for ages used knowledge, skills and available resources to develop products to meet their needs and wants. This quest for developing a product has now been brought into a classroom situation under the subject technology education and named the technology process. This should be done during TE classroom time.

Within the current debate on the nature of technology and the appropriate form and content of school curricula for technology education, there is a recognition that values are a central component: There is a sense in which technology, both its products and its processes, represents the embodiment of the culture. Technology scholars create the things we value, the things we think beautiful or useful. The scholars creatively devise tools, machines and systems to accomplish the ends they value (Conway, 1994). Creativity in technology is prompted by the fact that is the process where humans change what is around them to meet their desires. On contrary National Academy of Engineering (NAE) in 2010 describe technology as both the process and product. NEA state that technology is a *product* of engineering and science, the study of the natural world and is the *process* by which humans modify nature to meet their needs and wants.

What ensue in the next section is the research design and methods used to collect data which respond to the research question.

4. RESEARCH DESIGN AND METHODS

A reconnaissance or preliminary study as the first cycle stage of action research Phase 1 was instrumental in identifying the gap of ignoring the technology process. Observations, interviews and field notes were employed in gathering data from the teachers of four sampled secondary schools.

4.1 Action research cycle for feedback and reflection activities

Figure 4.1 shows that the AR activities are circular and if the activity is repeated then it become spiral in its nature and the AR practitioner can follow the same pattern for each cycle so as ultimately emancipate the participants.

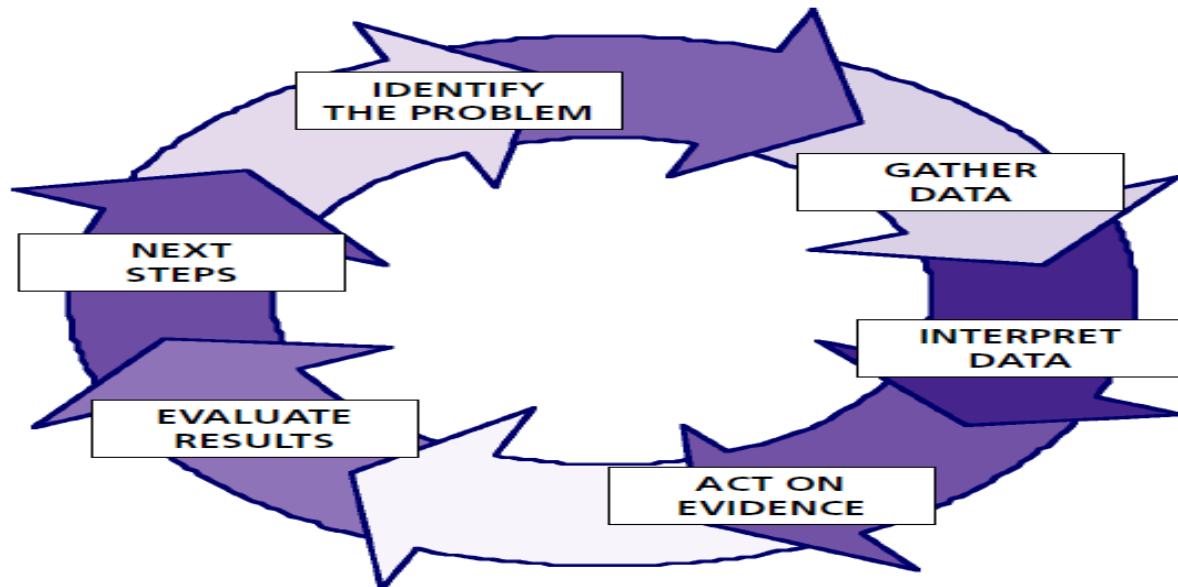


Figure 4.1: Action Research cycle (adopted from Ferrance, 2000)

Ebbutt (1985) and McNiff (1988) add that feedback within and between each cycle are important since it facilitates reflection

4.2 Research approach

An Action research (AR) approach was used during the study, the purpose of which was to solve classroom problems through the application of a scientific method. It was concerned with a local problem and conducted in a local setting. The primary goal of AR is to find a solution to a given problem and its value is confined primarily to those conducting it (Gay, 1987). I applied the AR approach as follows:

- Purpose: In my first meeting with technology teachers I realised that they acknowledged their lack of knowledge in the teaching of TE. AR was proposed and explained to them, and their consent given. The purpose was to solve the TE challenges of following the technology process when constructing a product as an encounter in their technology classrooms.
- Concern: The teachers were advised to contextualise their teaching of technology, and told that AR would be applied in their local schools as a means and guide to realise the importance of the technology processes.

- Goal: I negotiated contact sessions with the teachers in order to address their challenges and called for their commitment to the AR activities after all the ethics protocol was observed.
- Value: The teachers and I valued our availability to the course of emancipation and committed to contribute positively to all the AR cycles and activities. We agreed to be present at all the contact sessions.

I hoped that both the novice and experienced teachers involved in this AR study would be empowered to teach technology in the General Education and Training [GET] band, irrespective of their contextual setting. The study would contribute significantly to action research studies in the field of technology education.

The next section focuses on the limitations of the study based on population and sampling procedure.

4.3 Population and sample as the parameters of the study

The sample was drawn from the Capricorn Region of Mankweng District choice prompted by the lack of technology knowledge I had observed during the evaluation of University of Limpopo’s student teachers teaching practice. It is against this backdrop that this study was deemed crucial to making a contribution to emancipate to follow the technology process when teaching technology. With the guidance of the circuit manager, the four schools indicated in Table 4.1 from Mankweng Circuit were chosen for their contextual location, convenience in conducting interviews and easy convening a common venue for contact sessions of AR cycles and activities.

Table 4.1: Sample of selected schools and technology teachers

SCHOOL NAME	Total	Grade 8	Grade 9
KMK Sec	7	3	4
VMV Sec	3	1	2
RMR Sec	3	2	1
BMB Sec	3	1	2

With pseudonyms assigned for the purposes of anonymity, the schools were chosen within a radius of not more than 100 kilometres. According to Tashakkori and Teddlie (2003), sampling involves selecting units of analysis (people, groups, artefacts, settings) in a manner that maximises the researcher’s ability to answer the research question. In this study, I used cluster sampling (Gay, 1987) among the cohort of teachers who were together in the GET band, namely senior phase technology teachers. Members of the selected groups had homogeneous

characteristics (Maree and Pietersen, 2010) in that they all faced some challenges of following the processes in their teaching of technology. In cluster sampling the researcher identifies convenient naturally occurring groups units, such as neighbourhoods, schools, districts, or regions, from which a random selection is made (McMillan and Schumacher, 2001).

5. DATA ANALYSIS

Data was collected with the following aim in mind: “To establish intervention strategies to empower and emancipate senior phase technology teachers in Mankweng Circuit of Limpopo Province from the constraints that they faced in following the process when teaching technology. Mentioning the aim of the study at this stage helped me organize my data set accordingly and focus my analysis as stressed by McNamara, (2012).

I adopted ‘interim analysis’ method during the implementation of my data sets. Interim analysis according to Miles and Huberman (in Burke and Larry, 2004) is cyclical or recursive process of collecting data, analyzing the data, collecting additional data, analyzing those data, collecting additional data, analyzing that data, and so on throughout the research project.

I will integrate themes as challenges for teaching technology with data collected per cycle for ‘interim analysis’ purposes and reflect what I have learned from those data. This will be classified as ‘data set’ but the themes are attended to during the implementation stage of this analysis method as displayed in Table 4.4., since ‘interim analysis’ is cyclical or recursive process of collecting data and analyze that data, this is in line with the AR process for each cycle.

Table 5.1: Data analysis methods

DATA SET	INTERIM ANALYSIS METHOD	IMPLEMENTATION
Observation	Using observation grid	During the 1 st and 5 th cycles. These two cycles were used to measure the extent of participants’ emancipation.
Field Notes	Textual in conjunction with the observation grid.	These were jotted down during observations in all the contact sessions.
Scheduled Interviews	Standard questions asked at the end of each cycle to reflect on the cycle.	Sets of interview schedules. First set was implemented during the end of the 3 rd till the last (5 th) cycles.

Laufenberg (2009) argue that the teacher is at the heart of good education. If the schooling communities are going to expand their understanding of students in the field of technology it will be because of the insight and excitement of great teachers. Great teachers lead their learner to follow the technology process when they embark on technology product making. The task of being the great teacher in the complicated world is awesome.

6. RESEARCH FINDINGS AND DISCUSSION

I have interacted with senior phase TE teachers in Grades 8 and 9 as participants in this study since these grades are placed at high schools in Limpopo Province and that enabled me to break even the senior phase. The findings revealed teachers' incapacity in terms of their knowledge and teaching of technology in the areas of contextualising their teaching of technology need special attention. In responding to the findings, the results prompt the development of the recommendations of a technology rubric to ensure all the construction process steps are followed when constructing the technology product. The positive findings suggest that promotion of action research among senior phase technology teachers could lead to positive outcomes in teaching and learning of technology Siamese twins of technology education: technology process and technology product. Action research contribute to a more engaged, goal directed and reflective teach.

6.1 Findings from Non-Participative Observation

Babbie (1998) coined the term **observation** to refer to 'being there' as a powerful technique of gaining insight into the 'nature of human affairs'. Some observations statements are listed in Section 2.1 'Problem Statement' as I was there with the participants. An observation grid was prepared in advance before the schools' visits. AR Cycle 1. From the completed grids and my physical observation of the four identified schools, the following were captured and witnessed respectively:-

- ❖ Most classes are overcrowded, teachers teach more than one class, with a minimum ratio of 1: 60 and maximum of 1: 90 per class.
- ❖ Technology teachers do not have resources (tools & materials) to do some hands-on activities.
- ❖ Only teachers from one school – BMB had some technology textbooks and the rest from other schools had none.

Observation is essential data gathering technique as it holds the possibility of providing an insider perspective of group dynamics and behaviours in different settings (Nieuwenhuis, 2010). In establishing **trustworthiness**, I decided to employ of variety data collection instruments along

with observation which in turn call for multiple analyses of data. Mouton and Marais (1990) avers that, ‘the inclusion of multiple sources of data is likely to increase the reliability of the observation’. Nieuwenhuis, (2010) further offers a useful advice in suggesting that researchers need to learn the discourse and language that the participants use, so as to apply that when an observer conducts interviews.

Structured interviews were conducted after the observations as a follow up tool, since I was able to use the participants’ language. I conducted structured interviews with the co-researchers. What follows is the analysis, interpretations and findings of those interviews conducted.

6.2 Discussion of Findings from Structured Interviews

Data could be collected through interviews which could be structured, that is, the interviewer asks each respondent the same questions in the same way (Nkatini, 2005). Same questions which were prepared in advance were asked to all participants. McMillan and Schumacher (2001) support this view that, ‘structured interviews is an oral, in-person administration of a standard set of questions that is prepared in advance’. There was a direct verbal interaction between myself and the respondents in support of the study central objective.

The respondents are given codes per transcript that start with the coded school name followed by IP and the number, e.g. KMKIP - 06 i.e. interview person (IP) no. 06 from KMK high school. Each interview with the informant could take an average time of 15 to 20 minutes. The interview schedule had four prescribed themes with five questions per theme. These preconceived themes are (a) General – which covers technology teaching experience; (b) Technology Policy related questions Findings from the above themes are presented below:-

➤ **Theme 1: This covers more of technology teaching**

In responding to the question, ‘Why are you teaching this learning area?’ these is what the respondents have to say:-

Respondents from BMB high school as an example:-

- BMBIP – 01.... *‘It was just allocated to me’.*
- BMBIP – 02.... *‘Just given it to teach’.*
- BMBIP – 03.... *‘We don’t have an educator in technology’.*

All these teachers are from one school and from their responses one can read that none has any qualification in technology let along the interest.

Let me go on to pick others from different schools.

- VMVIP – 01... *‘Ask to teach it on the basis of my computer science background’.*

- RMRIP – 02... *‘I was given technology on arrival from my previous school, though History and Afrikaans are my specialization’.*
- KMKIP – 05 ... *‘Told it was linked to my consumer studies’.*

Majority of the respondents find technology teaching quite challenging due to less experience, under qualified, coerced into teaching the subject or given to teach it so as to complete the school staff establishment.

There are those who have shown passion and interest for technology teaching even though they are less than five. For a mere fact these is action research study they will be more valuable during the combine contact sessions in sharing some of the themes they are well grounded on.

Let me cite only three available examples:-

- *‘It’s fun, interesting and compels one to be innovative’.... VMVIP – 03.*
- *‘I love it, technology teachers are few’.... RMRIP – 01.*
- *‘It’s one of my major subjects at MASTEC (Mathematics, Science & Technology College)’.... KMKIP – 03.*

6.3 Discussion of the Reflective Questionnaire Findings

Findings in and of themselves are not interesting. Only when they are analyzed do they have meaning, and only when that analysis is used for a particular purpose, do they become interesting (Hofstee, 2006). The qualitative reflective questionnaires were analyzed using thematic. I numbered the questionnaire based on the respondent’s school e.g. **KMKQR=1**, this means that the teacher is from **KMK** school and the teacher is **Questionnaire Respondent number 1**. The sample of the technology teachers in this study do not have clue that planning should start from a policy document to learning programme to workschedule and lastly to the daily planning based on the relevant text books.

➤ Theme 2: Under resourced and teachers incapacity

Participants argued that hand tools such as pliers needed to be purchased for future use. They also emphasized that consumable materials should always be available in order to speed up the learners’ project turnaround time as it was felt that there was shortage of materials and lack of participation. These teachers’ responses revealed that learners could not measure accurately and could not convert the units of measurements, e.g. centimetre to millimetre. One participant actually identified technology process as a matter of teacher unpreparedness and much attention given to product:

“Educators still need to be empowered more about the concepts, skills, technology steps and others”.

➤ **Theme 3: Teachers experience during project rollout with their learners**

The technology teachers gave the learners two weeks to design, complete and submit their projects. That was our agreement in the previous cycle. Nonetheless, learners' turnaround time differed from one school to another. At one school, one teacher responded, "my learners took a month and few days but only 70% of projects were submitted". Teachers responded further that majority of their learners showed commitment to their projects and were capable to deliver an envisaged project per grade. For this project in particular, resources were not an issue as learners' utilized recyclable material from their surroundings except those that reside in the school hostels.

Even though most of the learners projects where completed, I asked how they monitored the learners' progress when they work on their product, none of the educators come forth with any instruments to monitor the technology process. One teacher boosted about the learners' product by saying:-

My learners are now lately good in making a project...just tell them what you want them to do, they will really impress you.

The educators noticed their weakness of not monitoring the technology process during technology product construction hence an instrument was recommended.

7. CONCLUSIONS AND RECOMMENDATIONS

The conclusions arrived at in this study are based on the findings previously discussed within the study. Previously found ideas are synthesised to come up with recommendations of this study.

7.1 Study conclusions

The conclusion drawn from this study is that action research could lead to technology teacher intertwine the technology process and technology product when constructing a technology project. Action research does give both the action research practitioner (I) and co-researchers (technology teachers) reflective skills during the cyclical and spiral activities. Amongst the multiple challenges that can be mentioned, teacher development and empowerment become prominent as it is technology teachers that are placed at the forefront to teach learners this relatively new subject.

Action research was instrumental as the methodology to emancipate and equip teachers to follow the technology process when designing and making the technology product. The process in technology leads to the product. The product in technology is the end results of the process that

was followed. Technology product and technology process are inseparable Siamese twins in the didactic and pedagogy of technology education as reflected in the Action Science theory.

7.2 Recommendations

This AR study does not blame the limited teacher training in Technology Education as its intention was to empower such. From the findings of the study point of view it has been proven that the AR approach study can be used to emancipate technology teachers to consider monitoring the technology process. Hence, one of the teachers has this to say at the end: “Now, I’m very confident to teach this subject to my school. I now have the knowledge and understanding or what is required about the subject and how to follow the technology process during the technology product. The skills from our Mentor has also contributed a lot to the little that I had, I’m now skilful than before” MVMQR=4. With such positive notion from the teachers I therefore recommend the instrument below (Table 7.2) to the technology teachers.

7.3 Mapotse Technology Assessment Process Instruments or Mapotse TAPI

It is recommended that if the rubric in Table 7.2 can be adopted by the provincial district circuits, institutes of higher learning and the national ministries of education as a support tools to empower technology teachers then technology teachers will confidently teach technology process to their learners. This tool should be implemented after the need or the want has been identified and specifications outlined. Even though this was used with a small group of teachers it can be improved or modified to suit the context of its use.

Project name:.....

Need/Want/Desire being addressed:.....

.....

.....**Specifications:**.....

.....

.....

Table 7.1: An instruments to assess both the technology process and product

THEMES	FACETS	STAGES	COMPETENCE
ASSESSING THE STAGES OF A PORTFOLIO			
Investigation	Brief interpretation		
	Product Research		
	Three Ideas		

	Choice of Materials		
Design	Thinking with a pencil for ideas		
	Final idea of choice		
	Specifications		
	Dimensions Materials		
Make	As per drawing		
	Stable and rigid		
	Aesthetics		
	Ergonomics		
Evaluate	Serve the purpose		
	Limited to specifications		
	Creativity		
	Innovation		
Communicate	Portfolio of evidence		
	Presentation of the product		
	Market value		
	Product Sustainability		
ASSESSING THE ARTEFACT OR PROTOTYPE			
Artefact	Drawings		
	Measurements		
	Constructing		
	Final Product		

I will call Table 7.1 ‘**Mapotse-TAPI**’, which stand for Mapotse Technology Assessment Process Instruments. On the stages you sign once you have seen the learner/student stage, if not yet satisfied you write on comment say for example, ‘Revise’ the stage. If the technology teacher is satisfied with any stage you sign and put a stage under the stage column and comment ‘Proceed’.

In this study culminating into critically reflecting as a team on the cycles, phases, outcomes and/or process of the research, I have been through the AR spiral but separate cyclical activities with teachers during the enquiry. Together we critically reflected on the outcomes per Cycle 4. I recommend the Mapotse-TAPI instrument to assess the technology process during the technology product. Cooperative or collaboratively paradigm was handy in engaging technology teachers as co-researchers. Action Science theory was instrumental in exposing the teachers

ignorance of playing down the assessment of the steps in the technology process when their learners are embarking on product making activity.

8. REFERENCES

- Action Research. (2010) Major Action Research Theories. Accessed on: 25/02/2012. Available at: http://en.wikipedia.org/wiki/Action_research
- Altricher, H. & Gstettner, P. (1993). Action research: a closed chapter in the history of German social science? *Educational Action Research*, 1(3): 329-60.
- Athimoolam, L. (2012) Empowering rural teachers to conduct action research in their classes. In Education Handbook Nelson Mandela Metropolitan University.
- Babbie, E.R. 1998. The practice of social research (8th Edition). Belmont, CA: Wadsworth, Inc.
- Burke, J. & Larry, C. 2004 (2nd Edition). Educational research: Quantitative, qualitative, and mixed approaches. Boston: Pearson Education.
- Conway, R. (1994). Values in Technology Education. Coordinator, Special Interest Group: Values in Technology Education, Selly Oak Colleges, Birmingham, UK. In *International Journal of Technology and Design Education* 4, 109-116, 1994. Netherlands: Kluwer.
- Curriculum News. (2010): Improving the quality of Learning and Teaching. Department of Basic Education (DBE). Poliah@dbe.gov.za. Pretoria: Government Printers
- De Jager, R. (2011). Latest changes in the technology education curriculum in South Africa. Paper presented PATT25: CRIPT 8 Conference in June in London
- Department of Basic Education (DBE). (2011). Curriculum and Assessment Policy Statement (CAPS) Technology Grade 7 – 9 Final Draft [Online]. Accessed on: 15 November 2011. Available at: <http://www.education.gov.za/CAPS.asp>.
- Department of Basic Education (2012) The Action Plan to 2014: Towards The Realisation of Schooling 2025. In Education Handbook. Stellenbosch: Argo.\
- Department of Education. 1996. Technology 2005: The HEDCOM Technology Education Project. Draft National Framework for Curriculum Development. Pretoria: Government Printers.
- Department of Education. 1997. Curriculum 2005 Lifelong learning for the 21st century. Pretoria: CTP Books.
- Department of Education. 2003a. Revised National Curriculum Statement Grade R-9 (schools). *Technology Government Gazette*: 443 (23406).
- Ebbutt, D. (1985). Educational action research: In R. G. Burgess (ed.) 1985. *Issues in educational research: Qualitative Methods*, 152-174. Lewes: Falmer.
- Ferrance, E. (2000). Themes in Education: Action Research. LAB: Northeast and Virgin Islands Regional Educational Laboratory. Brown University. Retrieved April 12, 2012, from http://ged578.pbworks.com/w/page/7309862/action_research_s08
- Gauteng Department of Education (GDE): Memorandum No. 202 (2003). Technology Workshops. Gauteng: Government Printers.

- Gay, L.R. 1987 (3rd Ed). Educational Research: Competencies for Analysis and Application. Columbus: Merrill.
- Grover, H.J. (2011). About Technology Education. Online: 15/05/2011, Retrieved from: [mhtml:file:///B:/TE KIT\About Technology Education.mht](file:///B:/TE%20KIT/About%20Technology%20Education.mht)
- Kufaine, N. & Nyirenda, L. (2013). *Science and Technology function literacy: case of Malawi*. In *Southern African Association for Research in Mathematics, Science and Technology Education (SAARMSTE)*. Proceeding of the 21st Annual meeting on “Making Mathematics, Science & Technology Education – socially and culturally relevant in Africa”. South Africa, University of Western Cape, Cape Province, 14 –17 January.
- Laufenberg, V (ed). (2009). About Technology Education. Online: 15/05/2011, Retrieved from: [mhtml:file:///B:/TE KIT\About Technology Education.mht](file:///B:/TE%20KIT/About%20Technology%20Education.mht)
- Mapotse, T.A. (2012a). The teaching practice of senior phase Technology Education teachers in selected schools of Limpopo Province: an Action Research study. Pretoria: Unisa.
- Mapotse, T.A. & Gumbo, M.T. (2012b). Action Research study with Technology teachers in Limpopo Province of South Africa: an Emancipation recipe for Technology teachers. In *Pupils Attitudes Towards Technology (PATT) - Technology Education in the 21st Century*. *Proceedings of the 26th Annual meeting on Science and Technology*. Sweden, Stockholm, 26-30 June 2012.
- Maree, K (Ed). & Pietersen, J. (2010). Sampling. In K. Maree (Ed.), *First Steps in Research*. Pretoria: Van Schaik.
- McMillan, J.H. & Schumacher, S. (5th ed). (2001). *Research in Education: A Conceptual Introduction*. New York: Longman
- McNamara, C. n.d. Analyzing, interpreting and reporting basic research results. Authenticity Consulting, LLC. Accessed on: 25 February 2012.
Available at: <http://managementhelp.org/businessresearch/analysis.htm>
- McNiff, J. (1988). *Action Research: Principles and Practice*. New York: Macmillan Education Ltd.
- Mouton, J. & Marrias, H.C.1990. *Basic Concept in the methodology of the Social Science*. RSA: HSRC.
- Motshekga, A. (2009). Report of the Task Team for the Review of the Implementation of the *National Curriculum Statement*. Statement by Minister of Basic Education on Curriculum Review Final Report, October 2009. Pretoria: Government Printers.
- Motshekga, A. (2010). *Curriculum News: Improving the Quality of Learning and Teaching*. Pretoria: Government Printers.
- Nieuwenhuis, J. 2010. Qualitative research designs and data gathering techniques. In K. Maree (ed), *First Steps in Research*. Pretoria: Van Schaik.
- Nampota, D. Thompson, J & Wikeley, F (2009). *The development of human capacity in Malawi: The role of ‘science and technology’*. *International Review of Education*: Vol. 55, pp 59 – 74.
- Nkatini, N.L. 2005. *Glimpses of Research: Guidelines on writing of Research Proposal, Reports, Essays, Dissertations, and Theses* Polokwane: JP Publishers.

- Ohio Department of Education. 2007. What is Technology Education? Technology Education at the Ohio State University. Accessed on: 05 May 2011. Available at: mhtml: file://B TE What is Technology Education.htm.
- Pool, J., Reitsma, G & Mentz, E. (2011). An evaluation of Technology teacher training in South Africa: shortcomings and recommendations. *International Journal of Technology and Design Education*, 10.1007/s10798-011-9198-9. Online 7 December 2011.
- Pudi, T.I. (2007). Understanding technology education form South African perspective. Pretoria: Van Schaik.
- Rausher, W. (2010). The technological knowledge used by Technology Education students in capability tasks. *International Journal of Technology and Design Education*, 21: 291-305. Netherlands: Kluwer.
- State of New South Wales, Department of Education and Training. (2010). Designing and Producing: Technology Process. Online: 21/08/2010. Retrieved from: <http://www.curriculumsupport.education.nsw.gov.au/designproduce>
- Tashakkori, A. & Teddlie, C. (2003). Handbook on mixed methods in the behavioural and social sciences. Thousand Oaks, CA: Sage.
- The South African Schools Collection. (2012). A show case of schools and tertiary education throughout South Africa. Comprehensive educational laboratory equipment, 17th ed., p31. Cape Town: Picasso Headline (Pty) Ltd.
- Whitehead, J. & McNiff, J. (2006/2009). Action Research Living Theory. London: SAGE.