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Establishing trends in design and technology teachers' approaches in Botswana

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Establishing trends in design and technology teachers' approaches in Botswana

Olefile Bethuel Molwane

Goldsmiths, University of London, UK

Abstract

Arguably design and technology, its politics and philosophy have been chronicled in a number of journals including The Journal of Design and Technology Education, IDATER Journals, International Journal of Technology Education and other similar documents. Research has also highlighted how good practice in design and technology and creativity could be fostered amongst learners in schools.

This paper explores how teachers of design and technology in Botswana junior secondary schools construct the meaning of design and technology through their classroom actions. It establishes trends in teachers' approaches, which have been constructed using trajectories. The paper primarily highlights how quantitative data was collected in qualitative situations and how it was analysed, looking not only at what teachers do in classrooms (qualitative) but for how long and how often (quantitative).

A case study approach using participant observation and ethnography strategies is used. This has been complemented by the use of qualitative interviewing. The findings of this paper emerge from a PhD research study that was undertaken in Botswana in 2000.

Keywords: broad descriptors, designing, pedagogy, proforma, project profile, trajectories

Introduction

Design and technology is increasingly recognised in many countries as an important aspect of a general education. The obvious economic benefits of having a technologically literate workforce have led to a number of countries (including Botswana and England) to make design and technology compulsory in state schools. The English approach to design and technology and its National Curriculum for the subject are often used as a basis for work in other countries. One illustration is that most English books on teaching design and technology are used in secondary schools in Botswana, Australia, South Africa and many other countries. The current design and technology course has its traces in the traditional technical subjects and crafts.

In a paper presented at 'The Innovative Technologist: Education for innovation' seminar organised by the Engineering Council in London on 27 February 2001, Kimbell and Perry (2001) considered design and technology in the knowledge economy. In this paper the authors argued

about the importance of design and technology, relating to the domain of design and technology, a distinctive pedagogy inherent in design and technology, and how it empowers learners to participate meaningfully in the world they live in. Explicit in their paper is that design and technology enables us (human beings) to understand the process of change and engage in it; and that design and technology is about the future, about what might be or should be. The authors related:

At the heart of design and technology lies a distinctive model of teaching and learning. It is project-based and involves learners taking a task from inception to completion within the constraints of time, costs and resources.' (Kimbell and Perry, 2001)

Moreover, Shirley (2001), in a foreword by the Engineering Council, outlined that design and technology has a distinctive contribution to make in the school curriculum. Shirley further commented:

... It [referring to Kimbell and Perry paper] describes the unique characteristics which makes design and technology more than just a subject. It is a learning experience which is

unbounded by fixed bodies of traditional knowledge, and transcends the academic and practical divide.' (Shirley, 2001 in Kimbell and Perry, 2001: 1)

Lawler (1999) searched for a different dimension in design and technology and explored children's learning in design and technology. He concluded that there are *Wholists* (Big pictures) and *Partists* (Small steps designers), describing the process of designing as having two distinctive features and descriptors. Describing big steps and small steps, Lawler argued that these two dimensions work in matrix form, complementing each other: without one the other will suffer. QCA/DfEE materials entered by Barlex (2000) identifies the kind of capability inherent in design and technology, and suggests that pupils learn to become autonomous, creative, problem solvers both as individuals and when working with others (QCA/DfEE, 1999).

Therefore, the politics and philosophy of design and technology cannot pass unnoticed, and, hence, are acknowledged by many governments by inclusion in the school curriculum. The subject has a distinctive pedagogy, empowering learners, contributing to economic growth and beyond, cutting across a variety of boundaries – vocational and academic – by removing the barriers between these two domains.

This paper is based on an ethnographic study conducted in Botswana in the Year 2000 and evolved from research by the author into the ways design and technology teachers in Botswana teach the three-year design and technology junior certificate programme. The research was conducted over two phases, *Phase 1* (January–April 2000) portraying the teachers' behaviours and teaching styles while *Phase 2* (September–December 2000) focused predominantly on teachers' assessment practices. The research looks at the interplay and relationship between teachers' teaching practices and teachers' assessment practices in design and technology in junior secondary schools in Botswana. And it seeks to find out how this relationship transforms/evolves during the three years of the junior secondary programme. The study explores how teachers construct the meanings of design and technology through their classroom interactions.

In an attempt to identify how teachers teach design and technology in Botswana junior secondary schools, 10 case studies based on 10 teachers in a range of schools were undertaken by the author. The author as researcher observed sev-

eral lessons of 10 teachers in different schools. These schools were located in different geographical areas; urban and peri-urban areas, some with cosmopolitan groupings of students. This paper examines how teachers teach design and technology tasks in schools, the pedagogy used, and how this pedagogy impacts on learners' understanding of design and technology. Key variables identified and analysed include the following:

- nature of interaction (teacher directing or supporting learning)
- focus of interaction (showing who the teacher is interacting with – whole class, individual pupils or groups)
- engagement (students' engagement level on tasks – stationary: denoting students being off task, not engaged in design and technology activity; poddling: denoting students working at the task but not giving it full attention or energy and/or listening to the teacher; and motoring refers to students being fully engaged and committed to the task)
- content related to teachers' teaching priorities of content areas and what students are engaged in to reflect teachers' teaching.

These variables have been combined at different levels (two variables at a time) to form trajectories. Trends in teachers' approaches were identified through the analysis of the trajectories.

Methodology

There are a variety of strategies used in conducting research. For the purpose of this research a case study approach was used, and employed qualitative and quantitative paradigms in collecting data (Denscombe, 1998; Robson, 1998; Cohen and Manion, 1994). The quantitative data was collected in qualitative situations and analysed, looking not only at what teachers do in classrooms (qualitative), but at the frequency and duration of interactions (quantitative). Through the ethnographic, grounded theory study, the researcher used techniques (Flick, 1998; May, 1998 and Oppenheim, 1992) which could be triangulated to check the validity of research and these are:

- participant observation
- ethnographic strategies
- use of qualitative interviews to complement the participant classroom observations and ethnography fieldwork notes.

In sampling teachers, predominantly cluster sampling was used to ensure representation of schools in urban and peri-urban areas. Within these clusters a list of teachers and schools, *sampling frames*, based on teacher national employment and deployment data from the Ministry of Education were used. Random sampling techniques were then used to choose the 10 teachers to be followed during the research in each of the areas. These samplings based on a combination of strategies, encompassed design and technology trained teachers, craft trained, and local and expatriate teachers. There were also variances in teachers' teaching experiences and range of subjects taught. Furthermore, gender was seriously considered and, three female teachers were included in the study.

Year 2 of the three-year programme was chosen as a focus of study as it marks a big change in philosophy in design and technology programme from 'Inward-facing – formative assessment and teacher controlled activities' in Year 1 to 'outward-facing – individualism and external assessment' in Year 3. Each year of the three-year course has a different focus but Year 1 has a distinct emphasis focusing on knowledge and skills development, giving more freedom to the teacher. The approach changes in Years 2 and 3, which have much in common such as an emphasis on designing, and encouraging learner autonomy. Year 2 focus on community service while the Year 3 focus is on product design and manufacture.

Data gathering techniques

As alluded to earlier, a range of techniques was used in data collection, participant observation, interviews, and fieldwork notes (ethnography).

Participant observation

A proforma or participant observation schedule was used to record teachers' teaching practices in design and technology and also to record their assessment practices. The proforma accounted for quantitative data collection, recording interactions between the teacher and students, and content areas. It also allowed for the capturing of qualitative data in descriptive notes of what happened in class during the interactions.

Interviews

Qualitative interviews were used to establish teachers' understanding of design and technology,

and their beliefs and understanding of assessment in design and technology. The first interview, 'Teachers' understanding of design and technology', was conducted at the beginning of the project while the second interview, 'Teachers' understanding of assessment in design and technology', was administered at the end of the project. These two interviews based on purposive sampling were restricted to only those teachers in the study. However, the interview on 'Teachers' understanding of assessment in design and technology', was also administered to three focus groups of design and technology in different geographical settings and distance apart. Teachers were selected for the focus groups from three clusters: Molepolole, Gaborone and Kanye, the three areas representing different social constructs of people and students (Rural and urban areas). In each focus group there were between 6–10 teachers with a range of different nationalities and teaching experience. Individual teacher's interviews were tape recorded and transcribed verbatim into word processor ready for analysing using Nudist software while the focus groups interviews were audio-taped and video-taped to capture the teachers' actions and debates during the interviews (Silverman, 1997 and 1998).

Ethnographic technique

The ethnographic data provided a wealth of information and rich data that could not be captured through classroom interactions. These were captured outside classroom activities, and provided rich qualitative data which was useful to inform classroom practices and could be triangulated or used to validate how teachers behave in class. For example, during interviews, not many teachers spoke about the impact of Examinations, Research and Testing Division's terminal examinations as influential to the way they taught the programme. However, outside the classrooms they freely expressed and argued that the way they teach adhered to the demands of junior certificate requirements and standards, and that, hence, professional judgements (formative assessment) were jeopardised by these external factors. Also they commented on the issue of plethora of monthly tests which force them to teach for testing.

Project profiles

A series of lessons comprising a project for every individual teacher was observed for all 10 teachers in the case study over a period of time. These

lessons enabled the researcher to capture teachers' classroom practices and were recorded on the proforma participant observation sheet to ultimately provide a project profile. Key variables included teacher directing and supporting learning (nature of interaction), teacher interaction with whole class or pupil (focus of interaction) and level of students' engagement in task (engagement). The diagram below illustrates an example of a project profile for one of the teachers demonstrating five arbitrary phases (Phase 1 to 5) or time samples of the project.

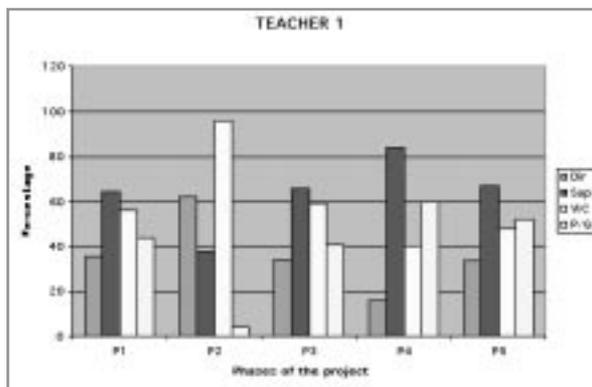


Figure 1: Teacher 1 project profile.

For this project there were six lessons observed of teacher 1 and the overall time and length was collated and divided into five equal phases enabling the author to produce a graphical idea of how the project was conducted. It also shows the start, middle and end of the project, demonstrating the pattern of classroom activities, and level of student/teacher interaction. It is always assumed that when the activities reach the middle there should generally be a pick in these activities. The level of teacher control decreasing with the passing time of the project while the students' engagement with a project rise. Therefore, in interpreting the diagram it is explicit that in Phase 2 (time sample 2) the teacher was directive towards the whole class while in Phases 3, 4 and 5 the teacher became supportive of individual pupils.

Analysing teachers' practices data

Microsoft Excel was used to analyse quantitative data from the proforma classroom instrument (recording figures) and entering fieldnotes (qualitative data). Transcribed verbatim interviews were analysed using NUD•IST software which was also used to analyse qualitative data. Within the qualitative data, the author coded the interviews, provided definitions and built the index tree.

Analysing proforma data

Initially, individual teacher templates in Excel were set for all 10 teachers. Then individual teacher's lessons captured in the computer showing the total time in minutes and number of entries, e.g. 96 minutes and 48 entries for teacher 1 in Phase 1 fieldwork. All these series of lessons were further arranged chronologically into a composite file. Then these chronological lessons in composite file for each teacher were mapped into phases or time samples and converted into datamaps file denoting that the lessons have been merged. For example teacher 1 (T1) had 50 entries lasting 100 minutes in each phase. Each entry or interval was logged-in every two minutes. At the bottom of the datamaps were the totals of time and entries, hence 500 minutes and 250 entries for teacher 1, and under each column or category were shown the datamaps total numbers of hits or entries. These series of lessons, composite files are shown in Figure 2 as an exemplar.

		Teacher Activity										Pupil Activity				
T1	L1	Nature of Interaction			Who the teacher is interacting with					Assessment		Pup #				
	Time	D	S	O	P	G	C	O	N	R	P	M	O	S	P	M
1	2.15													1		
														2		
														3		
	2.16													4		
2	2.17													1		
														2		
														3		
	2.18													4		
3	2.19													1		
														2		
														3		
	2.2													4		
4	2.21				1				1					1	1	
														2	1	
														3	1	
	2.22													4	1	
5	2.23								1					1	1	
														2	1	
														3	1	
	2.24													4	1	

Figure 2: Proforma sheet used in capturing classroom data.

Figure 2b shows individual lessons (T1.1 – T1.6 denoting that these are files for teacher 1 and the number after the decimal reflecting on the sequence of the lesson), composite file and datamaps. Thereafter, every teacher had an individual folder containing all individual lessons,

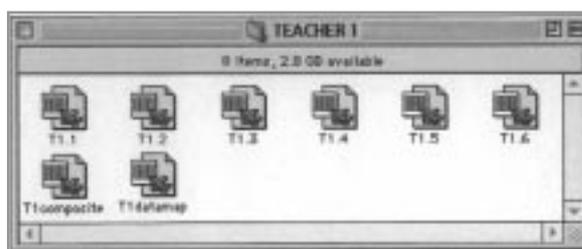


Figure 2b: Data management of Teacher 1.

composite file and datamap file contained in 'Teachers' Folder. The composite files for all teachers were also grouped into composite files folder as well as datamaps for all 10 teachers and were saved under datamaps folder (Figure 2c). The three folders Teachers, Composite files, Datamaps files and others were then all managed under a folder called *Proforma data* (Figure 2c).

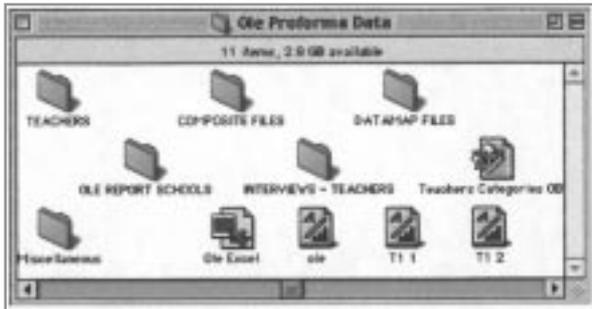


Figure 2c: How all the research data was managed and contained.

Having analysed these data showing charts, school reports contained in school reports file (shown in Figure 2c) were prepared illustrating descriptions of the project, interaction charts and interpretation of data from which broad descriptors of the project were developed and created. The descriptors highlighted what was happening under every phase of the project.

Analysing interviews

As mentioned before, the two interviews were conducted at the beginning and end of the project and analysed in NUD•IST (Gahan and Hannibal, 1998). The software allowed the author to build the tree with two main trunks. Firstly, the teachers' understanding of design and technology and, secondly, the teachers' understanding of assessment in design and technology as illustrated by Figure 3.

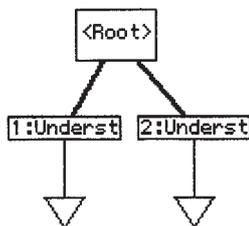


Figure 3: Index tree of the interviews.

The tree represented in Figure 3 shows the root that is the main research question, then two basic trunks, the teachers' understanding of design and technology and teachers' understanding of assessment. Under each tree trunk is a series of interview

questions enunciated as 1.1. to 9.9 implying that there were nine main questions in the interview.

The bottom arrows are representation of threads, checking details of main interview questions, that is, what the data is saying. Once the whole tree was graphically represented (Figure 5a), the author collated the notes (Figure 5b) so that meanings could be made from the research data and triangulation of information between teachers' understanding of design and technology and that of assessment. These would later be correlated to the classroom practices to see what information they revealed.

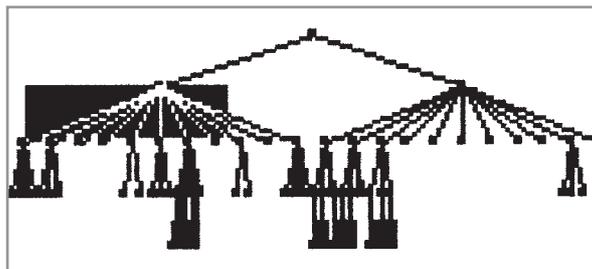


Figure 5a: Graphical representation of the research tree.

- 1 Understanding D&T
 - 1 1
 - 1 Process
 - 2 Product
 - 3 Process and Product
 - 4 Process only
 - 5 Product only
 - 2 2
 - 1 A lot
 - 2 Somewhat
 - 3 A little
 - 4 None
 - 3 3
 - 4 4
 - 5 5
 - 1 Linear
 - 2 Organic cyclical
 - 6 6
 - 1 Design solutions
 - 2 Modelling
 - 3 Making
 - -

Figure 5b: The text – list of nodes.

Establishing trends in teachers' approaches

This section provides information on how teachers' categories were created from Phase 1 data fieldwork raw data. To establish trends in teachers' approaches, trajectories were used. These are profiles produced in linear form from phase plane diagrams or quadrant analysis showing teachers' movements throughout the project from time sample (TS) 1 to the end of the project – time sample 5. The trajectories were constructed from the main variables of the study, which were combined in a sliding scale and opposite axis. For example, the trajectory of teacher 3 (Figure 6a) teaching style

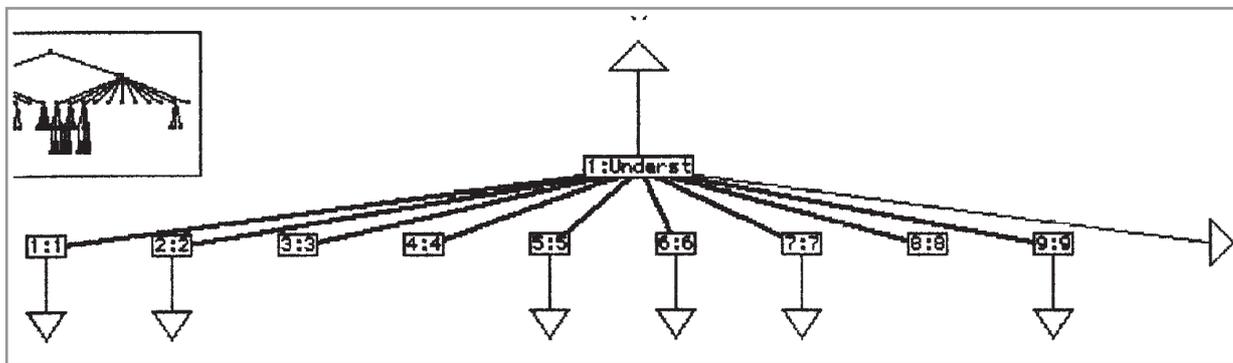


Figure 4: The series of research questions in number form.

combined the nature of interaction (directive and supportive) and focus of interaction (whole class and pupils/group). The overall pattern illustrated how the teacher interacted with students from time sample 1 to time sample 5.

In time sample 1 and 4 of teacher 3 (Figure 3), for example, the teacher was supportive of the whole class while in time samples 2, 3 and 5 the focus was on whole class teaching, with the teacher directing learning.

The exemplar demonstrates one way in which complex data could be managed and made meaningful to researchers. The trajectories could also be used together with broad descriptors of the project, not discussed in this paper, to describe what was happening at a particular time. Other sets of trajectories were produced in searching for the teachers' teaching styles. The first is demonstrated in Figure 6a. The second was produced by combining the nature of interaction variable with engagement variable (stationary, poddling and motoring). The third was the focus on interaction (whole class, pupils or groups) with engagement. The research data revealed that while the teacher was supportive towards the whole class in TS1 (Figure 6b), most students were poddling i.e. not fully engaged in any task.

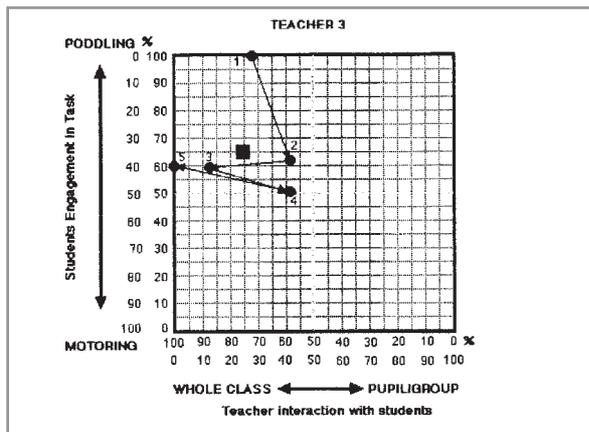


Figure 6b: The trajectory of teacher 3.

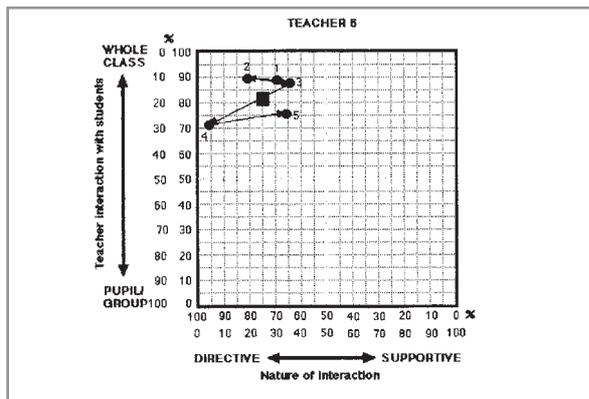


Figure 7a: Trajectory of teacher 6 with tight teacher control.

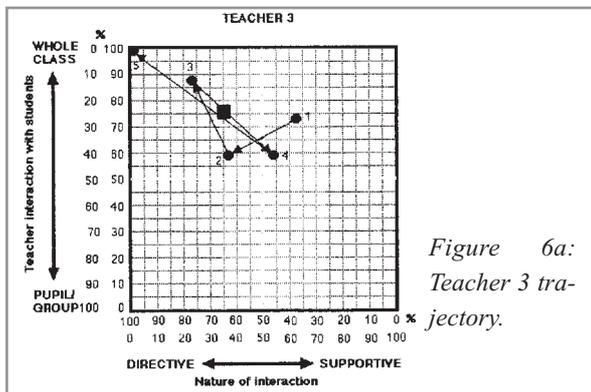


Figure 6a: Teacher 3 trajectory.

Teachers' trajectories showed a contrast in teachers' trends in teaching styles (Figures 7a and 7b

representing teacher 6 and teacher 8 respectively) as demonstrated by pedagogic trajectories.

Categorisation of teachers' teaching styles

To reiterate, the author indicated from the beginning that this paper would outline and discuss characterisation of teachers' teaching approaches in design and technology. Thorough thought was given to teachers' trajectories and groups of teachers' teaching styles were created. Three groups were created under two broad categories to classify teachers' trends in teaching approaches. The broad categories were the *pedagogic analysis* looking at the way teachers taught in the class and the second *content analysis* reflecting

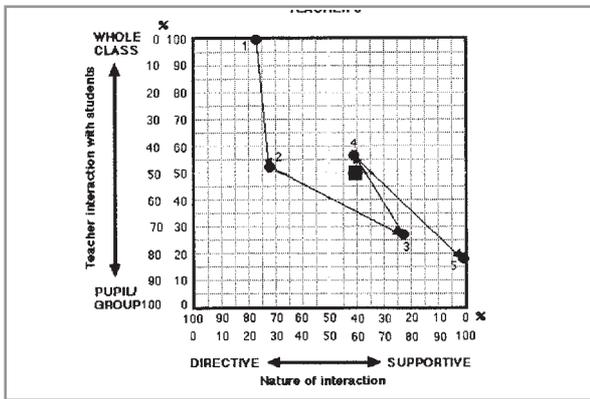


Figure 7b: Trajectory of teacher 8 showing how the teacher 'transferred' control towards the end of the project.

on teachers' teaching priorities.

Pedagogical analysis

The pedagogical analysis, as mentioned earlier, was identified from the teachers' trajectories (trends in trajectories) and was used to create three groups within which teachers in Phase 1 could be categorised. The three groups created through pedagogical analysis are:

- iterative directive and supportive axis: denoting teachers who were moving from directive control towards supportive individualism
- increasingly directive denoting whole class oriented teachers
- totally directive – teacher using teacher centred approaches and being authoritative.

Content analysis

This reflected the way teachers managed the content in their teaching, and therefore portrayed trends in teachers' approaches to content. Analysis of content charts and data provided very illuminating information about trends of teachers' approaches to content. Through the analysis of content charts, a classic phase pattern emerged which illustrated that teachers follow the steps of design process step-by-step – sequential steps or what might be called block teaching of design process and its content. Teachers would do one thing then the next thing in another phase (time sample) of the project. Exemplars are teachers 1, 2, 3, 4 and 5. However, teacher 4's approach was different, as the teaching of 'needs and opportunities' and analysis were tackled in the classroom activities at the very end of the project. The content analysis based on what students were required to do (pupils' datamaps) during the project created three categories of trends in teachers' approaches. The three groups that emerged from this analysis are:

- dominant group who covered predominantly 'Exploring and developing ideas' content area in most of the time sample of the project.
- time restricted group
- craft oriented group focusing on development of skills capabilities.

The pedagogic analysis and content analysis were used to select four teachers for the Phase 2 fieldwork, which was conducted between September and December 2000. This was done through *progressive focusing* (ethnography) based on grounded theory. As in Phase 1 of the study the sample of teachers was relatively large, portraying the kind of teaching in Botswana junior secondary schools. Phase 2 looked at the teachers' assessment practices predominantly.

Findings

Classroom practices

The findings of the study suggest that teachers are whole class practitioners with an inclination towards whole class teaching (as revealed by the chart in Figure 8). This has been elicited from teachers' interactions, content approach and classroom observations. The practice emerges from teachers spending much of their time on talking about design and technology rather than engaging students in meaningful learning. Within the cohort of teachers in the sample are those teachers who are developing understanding of design and technology conceptually, being 'talkers of the subject', and some who are developing a good practice in design and technology. Then, there is a traditional craft oriented group whose aim is on specific skills development rather than generic skills.

Interviews

The initial analysis of interviews revealed that the majority of teachers have an awareness and a fair

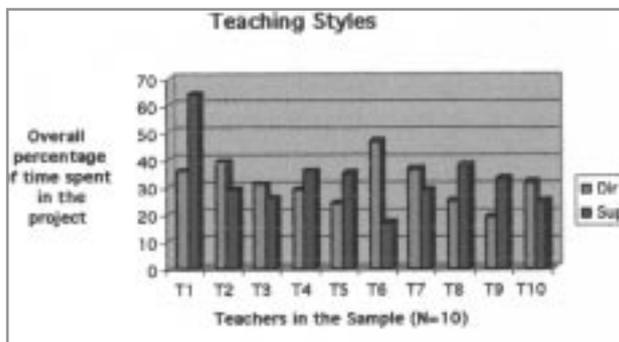


Figure 8: Summary of design and technology teachers' teaching styles.

understanding of design and technology though some still regard it as product-based. All of the teachers had a good understanding of the purposes of assessment in design and technology. The interviews analysis has been used to understand and confirm teachers' groupings (pedagogic analysis and content analysis). However, in establishing the impact that the assessment of projects and aggregation of grades (predominantly monthly tests) have on the teaching of design tasks, it was concluded that teachers are focusing on an 'itemised curriculum' (monthly tests rather than a generic skills – development process) pragmatically, without a holistic view of the tasks. What remains is to establish the relationship between teachers' beliefs and understanding of design and technology and their assessment of their everyday classroom practices. These would be further triangulated using the ethnographic field notes.

Conclusion

If teachers are whole class practitioners in their classroom operations as revealed by this research, are they teaching design and technology? Is this what design and technology is all about? This seems to contradict the essence and definitions of design and technology offered at the beginning of the paper, it being a process-driven model of technology. The findings therefore suggest and call for in-depth research on how teachers' construct design and technology, how they construct assessment as well as how good practice in design and technology could be developed. It is through this construct link and identification of the weakest link in the practices that teachers can be helped to become better teachers of design and technology. Building on the top-up construct rather than the trickle down syndrome where everything would be imposed explicitly and otherwise on teachers would be a helpful approach. Teachers' professional judgements, values and appreciation should be recognised.

The strategies used in this study illustrate one way in which research can contribute towards developing teachers' understanding of design and technology and how their classroom actions could be informed. It is not a panacea, but an alternative research approach towards enhancing capability in teaching of design and technology in schools.

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