An inquiry into the use of the problem solving method by technology education teachers including the barriers faced in the delivery of the curriculum to form two students of two secondary schools

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BACKGROUND:

Introduction: In 1996, the Government of the Republic of Trinidad and Tobago accepted the report of the National Task Force on Education as educational policy. Consequently, the Government, through its Ministry of Education requested assistance from the Inter- American Development Bank to implement its strategic plan to modernize and Reform the secondary education system. The Secondary Education Modernization Project (SEMP) mandate is to improve access to educational opportunities for all children in Trinidad and Tobago, and to provide a system that reflects modern approaches to teaching and learning.

During 2000, curriculum writing teams of SEMP targeted eight (8) core subject areas which included the traditional subject areas of English, Mathematics, Science, Spanish, Social Studies and the introduction of three (3) new subjects , namely Physical Education, Visual and Performing Arts and Technology Education.

Technology Education: The Technology education curriculum is an action based program for all students (without gender bias) that requires students to use resources to design, produce, use, and assess the impacts of products and services that extend human potential to improve and control the natural and human made environment (Ritz & Deal, 1992).

Technology Education Curriculum Design: The content of the curriculum is organized around four strands namely Communications, Production and Energy, Power and Transportation, and Biological Technology. **Communication technology** facilitates the sending and receiving of information locally and globally using graphic, print, digital

and/or other visual and audio forms. **Production technology** implies the use technology to prepare or modify materials by mechanical or chemical means so that they become value added, direct consumer goods or serve as standards for the production of other goods. **Energy, Power and Transportation technology** is used to move people and products across land water air or space. **Biological Technologies** may be defined as any technique that uses living organisms, their parts and products to modify other products. It also includes processes and methods to enhance agricultural production and in the process to address environmental and bio-ethical issues.

Purpose of the study: Fullan (2001) describes three possible dimensions of curriculum change or innovation that confront teachers. These include the use of a new or revised curriculum, a change in technological resources, and a change in teaching practice underpinned by the philosophical beliefs of teachers. The facilitation of the problem solving process to students by teachers, instead of a prescribed 'follow the instruction' or note-taking approach to instruction, is an example of **a change in teaching practice** in the new Technology Education Curriculum.

The purpose of this study, therefore, is to inquire whether teachers are adopting a change in practice or facilitating the problem solving process during the implementation of the Technology Education curriculum. The context of change required involved teachers adopting a new approach to delivering the new curriculum in the sense that they would no longer provide all the information to students but would guide the students in researching and selection information required to solve problems in contexts familiar to the students themselves. Once provided with the resources to do so, students brainstorm

their ideas, weighs the pros and cons of solutions, before proceeding to the design, make, and testing phases of the problem solving process. The teachers' role is that of facilitator guiding their students through the various phases of the problem solving process (Delise, 1997, p. 26-36).

Significance of the Study: The study could provide useful insights into factors affecting the implementation of the technology education curriculum in terms of a change in practice, the problem solving method, involving teacher – student and student- student classroom interactions. On a more general basis, the study would also provide an evaluation of the implementation process to curriculum developers and teacher educators about teacher concerns in the enactment of the curriculum. Information from this study can also be used by curriculum developers who are schedule to review the curriculum in August, 2006. The potential barriers to adopting the innovation that teachers could indicate in terms of administrative support, their preparedness for the subject and availability of technological resources can be fore fronted by teacher educators in their school administration and teacher training programmes.

 Statement of research questions to teachers and students: The research questions posed to teachers were based on the manner in which they facilitated the problem solving process including the barriers they faced in the implementation of this practice in the delivery of the curriculum. During an activity session, students were asked basic questions as to what problems they were working on, and to describe the processes involved in pursuing various stages of the activity in arriving at solutions to problems

encountered. The main questions and sub-questions asked will be more appropriately indicated in the methodology section.

USE OF LITERATURE

Technology Education: The Technology education curriculum is an action based program for all students (without gender bias) that requires students to use resources to design, produce, use, and assess the impacts of products and services that extend human potential to improve and control the natural and human made environment (Ritz & Deal, 1992).

Philosophical Underpinnings of Technology Education: The elements of the technology education curriculum include its philosophical underpinnings from which the goals of technology education were derived. The fulfillment of these goals are reflected in six essential learning outcomes, the achievement of which is reflected in the curriculum design, viz, its content objectives, teaching and learning strategies, and authentic methods of assessments.

The philosophical underpinnings and goals underlying the development of this curriculum are stated in the Education Policy Paper 1993 - 2003. Of particular relevance to technology education is the equality of opportunity as portrayed by the basic human right of all children, of to an education which will enhance the development of their maximum capability regardless of gender, ethnic, economic, social or religious background. The premise is that all children, even of varying ability levels are capable of developing numeracy, literacy, scientific and technological skills and to become lifelong

learners is evident in the document. The educational opportunities provided also enhance democratic living as students develop honesty, tolerance, integrity, mutual respect and respect for human reasoning. In that process, students also develop spiritually, morally, ethically, emotionally, intellectually, and personally.

These philosophical underpinnings of this curriculum have their roots in pragmatism, progressivism, humanism, and reconstructionism. From a pragmatist viewpoint, teaching the learner what to think is not as important as teaching him or her to critically think. It is with "their interaction with the social world or environment is established generalisations or tentative assertions that are subject to future research and verification"(Ornstein & Hunkins, 2004 p. 35). From a reconstructionist view, the curriculum is not afraid to address social issues such as intellectual property rights and ways to promote poverty alleviation by exposing students to small business enterprises (Ornstein & Hunkins, 2004 p. 50).

Essential Learning Outcomes: The essential learning outcomes of the curriculum is a reflection of these philosophical bases and the goals of Technology Education (Anon, 2001-3).The six essential learning outcomes include aesthetic expression, citizenship, communication, personal development, problem solving and technological competence. **Aesthetic expression** as it relates to technology education is the students, use of various art forms as a means of formulation and expressing ideas, perceptions, and feelings. **Citizenship** is the capability of students to address social, cultural, economic and environmental sustainability in the local and global context. **Communications** is actually a strand of Technology education that embodies the use of language, technology tools,

symbols, and media to demonstrate a deep understanding in the exchange of ideas and information for effective communication. As students **develop personally**, they become self-directed and self-actualising learners expanding their horizons and challenging themselves in the pursuit of a healthy and productive life.

Problem Solving refers to the ability of students to identify and solve problems individually and collaboratively in the completion of their various activities. The problem solving process encourages children to think creatively and critically about a variety of solutions and not to adopt the first new idea that comes to mind to solve a problem. Design and make problems of technology education are set out in a manner that allows for different teaching styles as well as for the variety of student learning styles encountered in the classroom (Delise, 1997 p.23).

Critical thinking encourages the child in learning how and when to question, what questions to ask, to be open minded of differing ideas of other children and to be able to make a decision based on an evaluation of evidence. In the ability to reason the children would learn sequencing, predicting, classifying, judging and understanding oneself and others (Bensen, 1999).

Technological competence envisages that all students become technological literate, be able to understand and use various technologies and understand the role of technology in contemporary life and society locally and globally. Aesthetic appreciation and communication can also be viewed through the philosophical underpinnings of reconceptualists as these often encompass communication skills, artistic meaning, dance and music (Ornstein & Hunkins, 2004 p. 52).

Teaching and Learning Strategies of Technology Education:

The Design Brief: The design brief for each proposed activity of the Technology Education curriculum involves a context, challenge, resources and materials, learning outcomes, and an evaluation process (Appendix V &VII). The **context** provides a realistic background that engages and motivates the learner to do research, usually through the internet, videos, and CD ROMs, and to apply the results to a specific area familiar to the learner's life. The **challenge** describes **the problem (Stage 1)** of the design brief that provides just enough insight to motivate the learner to progress further. Problems set out in the various activities of technology education are developmentally appropriate, curriculum based, and ill structured, the latter, providing enough information to students for them to progress to the next stage (Delise, 1997, p.22-25). In several of the modules students follow the instruction manual for example in water quality testing working through the steps of a particular process. However, it is the teacher's role to develop the challenge in a context meaningful to students.

Cooperative Learning: The problem solving process facilitated by the teacher is via cooperative problem solving. Students work in small groups, brainstorm their ideas, with the teacher facilitating the process by scaffolding small steps without revealing the actual solution unless absolutely necessary (**Stage 2**). Typically, in a production exercise, all design ideas from all participants are recognized and accepted until the **best design/solution surfaces after which students progress to the design and make (or carry out instructions) (Stage 3)** and **testing /evaluation/redesign phase** (**Stage 4**).

Scaffolding by the teacher may also take the form of redirecting the student to the instruction manual of a particular module which would reveal the stages of increasing complexity to produce a performance for example the starting of a rocket fuelled two-stroke engine.

In addition to the design brief, it is suggested that teachers formulate a **unit plan** for each activity of the various strands of technology education with general and specific learning outcomes, suggested teaching/learning strategies & resources, interrelated curriculum activities and suggested assessment method. Teaching and learning strategies are essentially student centered, based on the view that students learn best by constructing meaning within identifiable content areas (constructivism). Constructivist approaches are based on the overlapping theories of cognitivists Dewey, Piaget, and Bruner including the social interaction theory of Vgotsky. Based on these theories, the role of the teacher is to facilitate the learning process by helping students to analyse, synthesise and evaluate information, to reflect, make comparisons, draw conclusions and to apply technology to problem solving.

Technology education can utilize good education practices an example of which is the inclusion of Bloom's taxonomy in a class on a transportation activity on vehicle manufacture: From **knowledge** standpoint children discuss what they know about vehicles and what makes the wheels move. Through the use of books, CD Roms and construction kits **comprehension** of the subject is envisaged. By exploring a collection of vehicles with different wheel attachments, they then **apply** their knowledge to the process. Analysis of their previous knowledge is ensued from dissembling and reassembling different vehicles from the kits. The children then discuss the design of the

vehicle, how to make it, what materials to use by **synthesising** information. They then test and **evaluate** their final product for acceptance or redesign. This process approach to student-centered learning is in line with the new roles and practices envisaged for teachers in progressive education (Ornstein & Hunkins, 2004 p. 46).

A well functioning technology education classroom setting is one that encourages students to feel engaged and joyous about the act of learning (Warner, 2006). It is a non-controlling but directed autonomous environment that allows for "the freedom for individual exploration, creativity, expression, and **joyful involvement** in learning about many aspects of technology" (Warner, 2006, p.9).

Assessment Strategies of Technology Education: Authentic assessments in the Technology education curriculum is broad enough to capture important learning goals and processes by more directly connecting assessment with ongoing instruction. Open ended performance tasks as the one described above ensure that students reason critically, solve complex problems and to apply their knowledge to real world contexts. Assessment of this type is continuous or formative and involves a type of feedback to students that is both transparent and self-organising. Instructional goals could also include developing students metacognitive abilities, fostering important dispositions and socialising students into discourses and practices of academic disciplines. Authentic assessments in technology education include observations, reflective journals, projects, portfolios, demonstrations, collections of student works and students' self evaluations.

Cooperative or group learning, integral to each activity the technology education curriculum, is not only a means of assessing student learning, but is also a reflection of

democracy in the classroom. It fosters better development of critical thinking through discussion, clarification of ideas (recursive reflection), and evaluation of others ideas. Group diversity also adds knowledge and experiences of all members of the group. Group members go beyond statements of opinions to reasoning and reflecting upon criteria for making good judgments. Authentic assessment is in fact grounded in the instructional process within a particular context, with the teacher and learner transforming and being transformed in the process encompasses both a progressive and Post- Modernist perspective (Ornstein & Hunkins, 2004 p. 46; Doll, 1993 p.167).

Curriculum Implementation: The curriculum implementation process itself consist of two discrete stages of adoption and implementation of the innovation, with some overlapping of initiation, development, mobilization and diffusion of the innovation in the Rogers (1995) and the Fullans' (1991) models. At the adoption phase the user can decide to follow through with implementation either by adopting a fidelity perspective or one of a mutual adaptation approach. Beyond the adoption phase the innovation can either be institutionalized or rejected, declining in effectiveness through attrition.

In the research and development model which fits the fidelity perspective, the change is initiated by technical experts, who design a curriculum that is linear and rational, is theory driven and packaged for consumption for users. Teachers are expected to implement the curriculum as is and communication is a top down, one way process (Synder, Bolin, Zumwalt, 1992). This approach to curriculum seeks to measure the degree to which a particular innovation is implemented. Expressions of teacher concerns about the fidelity approach include their lack of clarity, knowledge and skills including

instructional materials to follow through with the innovation. Incompatible organizational arrangements and low staff motivation also deters implementation of the innovation (Synder et al., 1992).

Alternatively, the mutual adaptation perspective recognizes that curriculum change needs to be adapted to the contexts of individual school settings and learners for which the curriculum plans were developed. This suggests "a certain amount of negotiation and flexibility on the part of both designers and practitioners" (Synder el al., 1992).

Hall and Hord (2001) has enumerated seven stages of teachers' concerns involving their perceptions, challenges, feelings, motivations, frustrations and satisfactions as they go through the process of implementation an innovation. The seven stages (**CODES)** of the Concerns Based Adoption Model (**CBAM**) include the <u>awareness stage (**CODE CBAM1**)</u> the teacher shows little concern about the innovation. This is followed by the <u>informational stage (**CBAM2**)</u> the teachers' selfless interest deepens and is concerned about the general characteristics, effects and requirements for using the innovation. The teacher then <u>personalizes (**CBAM3**)</u> his/her concerns about personal adequacy, rewards, status, decision making, potential conflicts with existing organizational structures before making a personal commitment to the innovation. In the <u>management stage (**CBAM4**)</u> attention is focused on the processes and tasks, best practices, information and resources to effectively manage the change process. In the <u>consequences stage(**CBAM5**)</u> the teacher focuses on the relevance of the innovation for students, evaluation of student outcomes, including performances and competencies, and changes needed to increase student outcomes. In <u>the collaboration stage (**CBAM6**)</u> the focus is on collaboration and coordination with others regarding the use of the innovation. The final or <u>refocusing stage</u>

(**CBAM7**), the teachers perceives more universal benefits to the innovation and has definite ideas about alternatives to the existing form of the innovation

Rogers (1995) has defined diffusion as the process by which an innovation is communicated through certain channels, over time among the members of the social school system. As an <u>initiator</u> the school principal must have a clear vision about the school and what resources change process requires. He must have high expectations, be willing to push for change and take responsibility for decisions and be able to delegate responsibility. As the school <u>manager</u> he must provide the resources to effect the implementation of the change and have a personal interest in getting things done. As a <u>responder</u> he must also listen to the concerns of teachers, students and parents concerning the implementation of the innovation. The tasks facing change agents such as the school principal and other opinion leaders include working for a shared vision, collaborating about decision making, advocating for change, creating effective organisational structures to effect change, providing professional development for his/her staff, creating learning communities, managing conflict and communicating effectively. Communication is the process by which the principal and other opinion leaders in the change process create and share information in order to reach mutual understandings about the innovation to be adopted. The principal's leadership styles should not be power coercive, forcing teachers to adopt an innovation, but rather normative educative or empirical rational, providing both psychological and material support, a deepening understanding of the innovation and giving reasonable arguments for its adoption in the school (Benne, Bennis and Chin, 1976).

METHODOLOGY

Rationale for Selection of Participants:

Currently, the Brazil High School, Debe High School, Blanchecheusse High School and the Waterloo High School are implementing the Technology Education programme with the prescribed technological resources. Two other schools, the Penal Junior Secondary and Chaguanas Junior Secondary schools, without the stipulated 'high level' technological resources, have instead endeavoured to implement the programme using 'low level' available resources. The choice therefore, to investigate the facilitation of the problem solving process at the Waterloo High School with and the Chaguanas Junior Secondary provided a contrasting situation regarding availability of resources. Also, teachers of the Chaguanas Junior were of a Biological Technology academic background, while the teacher from the Waterloo High School was from an Industrial Arts background. The contrast of the two schools selected for the study in terms of technological resources and teacher academic background provided a "representative ness" of the real life situation of schools which make their own policy decisions in implementing various curricula.

The idea to select Form two students for the study seemed warranted because the pilot technology education programme would have been delivered for more than a year with students being basically exposed to tools and artifacts the previous year. Evaluating the programme in the second year also provided an opportunity to assess the adoption phase of the implementation process. I decided not to include form three students because they

were preparing for the National Certificate Secondary Examination (NCSE, 2006). Also, at the Form three level **standards** for portfolio assessments were only recently developed by the Ministry of Education. By contrast the form two method of portfolio assessment was less structured and allowed students more time to explore their interests in the technology laboratory. Also, direct observations and interviews with form two students at work on their various activities added richness and reliability to data collected.

Type of Study: The study is in a sense <u>a case study</u> of two particular schools of the seven schools presently required to deliver the technology education programme. It can also be regarded as phenomenological as the human reactions to unexpected change in the natural setting of the schools were being studied.

Rationale for the Qualitative Approach: The rationale for adopting the qualitative approach was to obtain a better perspective of what is happening in these particular school contexts. This approach values the subjective responses of teachers and students in terms of their perceptions, beliefs and values. The sociological framework will tend to be the interpretive paradigm of symbolic interactionism with others in a social setting. In so doing, how others and myself construct their reality or how I see others or others see me (readers included) becomes valid knowledge of the situation. Also the interpretations, meaningfulness, and appropriateness derived from a study like this could constitute a type of validity equal to or even thicker in description than that obtained from a quantitative approach (Creswell, 1998).

Data Collecting Strategies: The sites located were the Waterloo High School and Cahaguanas Senior Comprehensive School. The persons I had hoped I would be interviewing were the technology education teachers of both schools including students involved in various group activities. I gained access by speaking personally with school principals and teachers about my request to audiotape the both teacher and student interviews which they agreed to allow me to do. I purposefully wanted to interview both teachers and students (hence purposeful sampling) for the main questions I had in mind for the interviews. Their may seem to be some bias on my part for deliberately selecting these individuals but they are the main change agents at the classroom level whose views and ideological perspectives could enable a new curriculum to be adopted in their social context.

The method adopted was that of a focus semi structured interview. I previously decided to respect the teachers and students alike being interviewed, to learn from each interviewee, and not to use the opportunity to criticise or evaluate the interview's immediate thoughts or ideas. I intentionally would allow each interviewee enough time to express their views on various questions posed, not interrupting them (Creswell, 1998).The interview were carried out in the technological education laboratory at the Waterloo High School and in the staffroom for teachers at the Chaguanas Junior Comprehensive School. One particular interview of students on a problem solving hydro phonics activity was carried out in the farm area at the Chaguanas Junior secondary school.

Research Questions Posed to Teachers: Teachers were interviewed on questions pertaining to the facilitation of the problem solving process. Questions posed to teachers included the following:

How do you facilitate the stages of problem solving for an activity of Technology education (**CODES TIPS1-4**)?

CODE TIPS1-4: Teacher Interview facilitating **Stages 1 – 4 of the Problem Solving Process**

CODE TIM: Teacher Interview (Motivation/Interest/Joy)

What are the main barriers or constraints facing you as a teacher in the facilitation of this process (**TICBAM1-7**)?

CODE TICBAM1-7: Teacher Interview **Concerns-Based Adoption Model 1-7** (Stages of Concerns previously indicated)

Research Questions Posed to Students: During an activity session, students were asked basic questions on what problems they were working on, and to describe the processes involved in pursuing various problems including what solutions they arrived at in completing their activities.

Certain questions posed to students included the following:

What problems are you working on (SIPS1)?

CODE SIPS1: Student Interview Stage 1 (identification of problem/challenge of activity)

How did you arrive at solutions to problems in the various activities pursued (SIPS2-4)?

CODE SIPS 2: Student Interview Stage 2 (arriving at ideas to solve problems)

CODE SIPS 3: Student Interview (progressing to the design and make stages)

CODE SIPS 4: Student Interview Stage 4 (Process and/or Product of the testing/final stage)

What were your feelings in accomplishing the various tasks involved in completing these activities? (SIM)

CODE SIM: Student Interview (Motivation/Interest/Joy)

Criteria for Assessment of Portfolios: Sixteen student portfolios were examined for evidences of design briefs, essential learning outcomes, and the stages of the problem solving process. I read and re-read the written text of student portfolios and judged whether they portrayed aesthetic expression, citizenship, communication, personal development, and technological competence, vis a vis the essential learning outcomes, as outlined in the curriculum documents. I also read and re-read the written text of student portfolios and judged whether they portrayed evidences of a problem being defined, brainstorming for solutions, weighing the pros and cons of each solution, choosing the best solution, design and make, evaluate and present process or product. Design briefs were examined for the challenge, context, resources, learning outcomes, and evaluation.

The inclusion of student portfolios in the study provided a method of **triangulating the data** with that obtained from private teacher interviews, and interviews with students interacting with their various activities. Triangulating data is a method of reducing potential bias from articulate informants, in this case, the teachers and student group leaders and can also add to the 'representative ness' and reliability of the data (Miles and Huberman, 1994, p.262).

Data Analysis Procedure: The data obtained from audio tapings of both teachers and students was typed and interpreted by <u>forming codes</u> by reading and re-reading the data was several times (iteration). The codes formed were done so in relation to the various main questions and sub questions as outlined above. Similar codes were also developed from the criteria described for the assessment of student portfolios. Codes developed for the various research questions posed to teachers (**TIPS 1-4)** and students are stated above (**SIPS1-4 & SIM) (Table 1**). The codes used to interpret teachers' concerns, perceptions, challenges, feelings, motivations, frustrations and satisfactions as they go through the process of implementation an innovation or new practice. These were derived from the Concerns Based Adoption Model (**CBAM 1-7 & TIM**) alluded to in the literature review**.**

Table 1 Summary of Problem Solving and Barriers to Change, Codes of Interpretation

Research Question	Codes of Interpretation	Meaning of Codes
How do you facilitate the stages of problem solving?	**TI PS1**	Teacher Interview: Problem Identification
	TIPS2	Teacher Interview: Facilitation of one or more solutions to problem identified via brainstorming
	TIPS3	Teacher Interview: Facilitation of design & make or carry out

		instructions phase
	TIPS4	Teacher Interview: Testing/evaluate/redesign phase
	TIM	Teacher Interview: Motivation/Interest/Joy
What problems are you working on and how do you arrive at solutions?	**SIPS1**	Student Interview: Problem Identification
	SIPS2	Student Interview: Arriving one or more solutions to problem identified via brainstorming
	SIPS3	Student Interview: Design & make or carry out instructions phase
	SIPS4	Student Interview: Testing/evaluate/redesign phase
	SIM	Student Interview: Motivation/Interest/Joy
	SPPS1	Student Portfolio: Problem Identification

	SPPS2	Student Portfolio: Arriving one or more solutions to problem identified
	SPPS3	Student Portfolio: Design & make or carry out instructions phase
	SPPS4	Student Portfolio: Process or Product Testing/evaluate/redesign phase
What barriers to the change in practice do you face?	CBAM1	Awareness of change/innovation in practice
	CBAM2	Seeks information on change
	CBAM3	Personalizes change
	CBAM4	Manages change
	CBAM5	Consequences of change to students
	CBAM6	Collaborates use of change with others
	CBAM7	Refocuses, charts new directions on change

DATA ANALYSIS AND PRESENTATION OF FINDINGS

TECHNOLOGY EDUCATION TEACHER PROFILES:

Waterloo High School (Appendix I, p.69-75):

Mr. Sherwin Bute attended the John Donaldson Technical Institute and completed courses in general Draughtmanship, and civil engineering technician. He completed teacher training at the said institution and has also attained Diploma and advanced Diploma level in Technology Education (Mount St Vincent University (MSVU), Halifax outreach programme. Mr. Bute is also a part time lecturer in Technology Education. Mr. Bute has been teaching for the past 15 years.

Teacher Background: Mr. Bute from the Waterloo High School (WHS) was a technical vocational teacher with additional training at the diploma and advanced diploma level in technology education before he began implementing the problem solving method in the teaching of technology education in 2002. His school also had internet access and sufficient technological resources for implementing the various activities of the strands of technology education (p.69).

Teacher Interview Findings: The raw data of the interview is shown in Appendix I. Mr. Bute acting as facilitator indicated that he takes his student through the various stages of the problem solving process as they pursue their various activities. Problems are posed in a context familiar to the student for example they recently designed *'bandanas'(large coloured rags)* using the computerized sewing machine. As he remarked "the context is

related to something they are familiar with something they can associate with and like to design" (**Design Brief**). Even with that activity he was able to dispel student stereotypes (**Gender bias)** about sewing as he remarked "I could remember one group that I give *the sewing machine to, this was a group comprising two girls and one boy* and there general attitude was I don't want to be sewing, this is not actually what I come here for. But after spending some time with the computer interface and really going through the machine **it was difficult to get them off that machine** (**CODE TIM)** (p.73)", which indicated a strong motivation in his male students to pursue a production activity which they had previously stereotyped as 'female'.

He also indicated that he facilitated **the problem solving process** (**TIPS1-4**) by encouraging students to come up with more than one solution to a problem, followed by designing, make and testing of the product "Well the first aspect would be to define the problem. You must have a clear idea as what the problem is. After that would be research and brainstorming, just thinking up possible solutions. For every problem you should at least get three possible solutions. From these possible solutions you would weigh pros and cons and from this come up with a best solution, followed by either make or develop on your solution which is then followed by testing. From the testing you would know whether to make adjustments, which would mean going over the whole design solution again, or going to production" (p.69). However he has also had to occasionally model the use of technology to facilitate the problem solving process. In designing and installing a kitchen cupboard he has had to outline for his students what the frame should look like (p.70) and even the drawings supplied by his students were unintelligible at first. "They would draw sketches that they in themselves would be able to understand, but shown to

another person it was'nt there was'nt that communication in the drawing so after from **instruction** they were able to refine their drawing techniques and come up with a more understandable drawing but you must realize that it is in fact a process" (**CBAM 3)** (p.70). He therefore managed the practice via instruction, which was to facilitate the design stage of this activity.

However he had also found ways to **engender creativity** in a few students an example of which was the mouse trap car design. As he stated "One of the exercises that I did was the mouse trap car where I actually bought a made mouse trap car where students were allowed to inspect, however no instructions were given as to how to put it together so upon inspection students were able to put together their own mousetrap car, **one remarkable thing happened (TIM)** was that one student was able to put together a mouse trap car working on the principle of the mousetrap as a spring driving force but used absolutely none of the same components that was given on the model. Alright for instance there was CD wheels, this student used lawnmower wheels and gotten the same effect, the student was given a mouse trap, this student used a rat trap so this shows how she compensated for the size and the weight of the wheels by using a bigger spring"(p.71). The idea of using a benchmark mouse trap car from a previous class infers variety of teaching style on the teacher's part. This particular activity not only engendered creativity but also **strong motivation or joy** within the teacher.

Student Portfolios Waterloo High School

 General findings; I examined 16 student portfolios which reflected the various activities pursued by form two students of the Waterloo High School (Tables 2 (a) and (b)). The sixteen portfolios revealed <u>two</u> group activities on the two stroke small engine and <u>three</u> on the use of a Global Positioning Device (GHS) of the Energy, Power, and Transportation. Production type activities were more varied and included students having to design and make a box, napkin holder, test tube holder, picture frame, kitchen shelf and in one instance to embroider a shirt using the computerized sewing machine (<u>9</u> <u>activities</u>). Communication activities required students to produce business cards, barbecue tickets and bookmarks using Microsoft publisher (<u>8 activities</u>) and in one instance a power point presentation (<u>1 activity</u>). Biological Technologies activities required students to carry out measurements on water quality (<u>5 activities</u>), soil pH (<u>1</u>), hydrophonic vegetable production (<u>3</u>) and medical technology in the form of blood pressure testing (<u>1</u>).

Aesthetic Expression, Citizenship, Communication: Tables 1 (a) and (b) show the interpretation of the essential learning outcomes from the 16 student portfolios examined for these activities, based on the guidelines previously indicated and outlined in the curriculum guides (Anon, 2001-3). Interpretations of aesthetic expression, citizenship and communication are shown in Table 2 (b). There were expressions of artistic clipart inserts indicating the self applause (**self reinforcemnent)** of work well done in portfolios 9 and 10. Regarding citizenship, in six of eight group work communications activities, students displayed in their portfolios computer literacy skills in the use of Microsoft publisher,

which is a requisite for contemporary society and for their future world of work as productive citizens.

However, neither the three hydro phonic activities nor the five water testing activities from the various portfolios showed reflections of environmental sustainability, in the use of these projects, which is another aspect of citizenship as outlined in the curriculum guides (Anon, 2001-3). In ten of the 16 portfolios examined, students communicated their various activities via words, freehand and line drawings. In the remaining six portfolios students used various forms of media, such as variations of types of font, font sizes, word art and clip art to convey their communication (Table 2(b). As for aesthetic expression students of portfolios 9 and 10 communicated **their feelings of accomplishment** via clip art inserts.

Table 2(a) Evidence of Essential Learning Outcomes Aesthetic Expression, Citizenship, and Communication

Student initials M/F	Activity [1]EPT, P,C, BT	Concepts learnt	Aesthetic expression	Citizenship	Communication
1) KN/M	EPT – Global Positioning Device (GPS)	Distance, speed, time	-	-	words only
2) KL/M	P- Design & Make a box, Napkin Holder	[2]NA	-		Words measurements, poor drawings, use of crayons

	BT- Hydro phonics	Not Evident		Sustainable Development not in context	Freehand scribbled drawings, BT- use of words, drawings
	C.- Design & Make a Barbecue Ticket			Computer literacy	
3) BB/M	EPT - GPS BC- Business Card (BC)	Distance, speed, time	-	-	Same as KN for GPS BC- use of words to describe, no other media
4) NR/F	BT- Water Testing for hardness	Not evident		Sustainable development Not in context	Use of words
5) DB/M	EPT - Small engine	Not evident	-		Use of words,

	C business card			Computer literacy	business card pres
6) NR/F	P- Design & Make a Napkin Holder	NA			Use of words, drawings, measures
7) VJ/M	P- Design & Make a Kitchen Shelf C- Business Card (BC)	NA	-		Drawings, front plan, measurements, large fonts Use of word art, background but steps not described
8) IS/F	EPT - Small Engine BT-Soil testing C - BC	Not evident Concepts not defined C-NA		Computer literacy	Word ineligible drawing Business card, Use of clip art, word art, background too dark , Use of publisher not

					described
9) KB/M Jev/M/KI	EPT- Global Positioning System (GPS)	Distance, speed, time	Inserts denoting Accomplishments		Word art, clipart drawings of GPS GPS windows display line graph, numbers, units (m)
10) MB ./F	BT- Water Testing: Ph, Cl, Fe, Cu, Hardness	Concepts not defined	Inserts denoting accomplishment		Use of drawings, word art clip art of steps followed by inserts
	C - BC				Business Card, Barbecue card, bookmarks not presented, Procedure not fully described, Use of fonts, colours, clip art, word art

11) KN/M	EPT- GPS	Distance, speed, time	NA	NA	description on use of instrument Windows on GPS display line graph, numbers, units
12) KL/M KH/F & LB/F	BT-Hydro phonics	Not evident	NA	NA	Hydro. As a method of sustainable development not expressed in context
	C Business cards bookmark BT Water testing	None	NA NA	Computer literacy	

13) S/M, S/F/N/F	P Design & Make Box & Napkin Holder by individual members	Drawings/measurements	NA	NA	
	P-Design & Make a cash box	NA	NA	NA	
14) AD/F	C – Design & Make a bookmark	Not required	-	Computer literacy	Words, no format
	P- Design & Make a wooden box	NA			Words, no format, no drawings, measurements
	BT – Hydro phonics	Not evident			Words and measurements of height and width
	BT – Water testing	No concept of pH			
15)	C- Design and	Knowledge	-	Computer	Well written,

JM/M, KB/M, KA/F	Make Business card, tickets, bookmark	of tasks		literate citizen, idea of entrepreue-urship	different fonts, styles, insets of clip art,
	BT – Water testing	Concept of Ph well explained of alkaline exhaled air			Well written, use of font sizes, styles, clip art inserts
	EPT – GPS				Same as above expressed knowledge of line graphs, cardinal points, set distances 0.2m,

16) SR/F and others	C- Computer Assisted drawing (Auto Card) C – Power point Presentation	Front plan, End elevation, isometric view	-	Computer literacy Computer literacy	Drawing to scale, various shapes Oral, use of graphics
	P – Computerised Embroidery	NA	Type of embroidery	Entrepreneurs -hip	CD rom
				Entrepreneurs -hip	

	BT – Blood pressure monitoring	Related concepts to practice			
	P – Design and make a picture frame				Aesthetics of picture frame I saw the final product

[1]EPT: Energy, power & transportation, P: Production, C: Communications, BT: Biological Technologies
[2]NA- Not Applicable

Personal Development, Problem Solving, and Technological Competence: Table 2 (b) shows the activities pursued by students, the concepts learnt, and the essential learning outcomes of personal development, problem solving, and technological competence. Most student activities were done in groups which fostered personal development as students learnt to relate both inter and intra personally via **cooperative learning**. Five group work activity of professionally business cards were done and displayed a clear entrepreneurial outlook.

Students also described problems they encountered in the process of completing their activities in four of the portfolios examined. Most students' reports reflected their technical competence in the use of various tools such as Microsoft publisher, other media, their use of hand tools, and the use of light industrial equipment such as the Band saw.

Table 2b Evidence of Essential Learning Outcomes Personal Development, Problem Solving, and Technological Competence

Student initials M/F	Activity [1]EPT, P,C, BT	Concepts learnt	Personal Development	Problem Solving	Technological Competence
1) KN/M	EPT – Global Positioning Device (GPS)	Distance, speed, time	Work co-operatively Recorded distance in 0.02 m	Dem. Stages in use of tool	Located a second object
2) KL/M	P- Design & Make a box, Napkin Holder BT-	[2]NA	Singly, group	Dem. use of tools materials	Yes
	Hydro phonics	Not Evident	C-	No problems identified, no nutrients mentioned in report	Use of new technology Understood

	C.- Design & Make a Barbecue Ticket		entrepreneur-ial		use of Microsoft publisher
3) BB/M	EPT - GPS C- Business Card (BC)	Distance, speed, time	C- entrepreneur-ial	Use of micro soft publisher	
4) NR/F	BT- Water Testing for hardness	Not evident		followed steps	yes
5) DB/M	EPT - Small engine C business card	Not evident	Singly & group C- entrepreneur-ial	Followed steps	yes
6) NR/F	P- Design & Make a Napkin Holder	NA	Singly group	Used one draw. Worked through problems	Use of tools materials

7) VJ/M	P- Design & Make a Kitchen Shelf	NA		Several problems noted and solved eg evenness of edges, bracing of structure, use of band saw, sander, level, tape etc.	Product/ presentation
	C- Business Card (BC)				
8) IS/F	EPT - Small Engine BT-Soil test C - BC	Not evident Concepts not defined C-NA	Group, Entrepreneuri -al	Followed steps	Business card too dark background
9) KB/M Jev/M/KI	EPT- Global Positioning System (GPS)	Distance, speed, time	Singly peer tutoring, group	Worked out steps	Yes on use of GPS

10) MB ./F	BT- Water Testing: Ph, Cl, Fe, Cu, Hardness	Concepts not defined	Group activity	Followed steps indicated for kit	Yes
	C - BC			Different ideas	Microsoft publisher
11) KN/M	EPT- GPS	Distance, speed, time	Did not comm. Distance in m	Addressed problems in use of tool	Understanding in use of tool
12) KL/M KH/F & LB/F	BT-Hydro phonics	Not evident	Height and width measurements presented Scribble	None observed	Understands recycling of water by submersible pump

		NA	drawings by hand and lead pencil	Followed steps	Use of publisher tool
	C Business cards bookmark		Drawings by hand Same as above		
	BT Water testing			Followed steps only	Use of chemical tests
	P Design & Make Box & Napkin Holder by individual members	Drawings/ measurements	Use of words, drawings measurements , scribbled drawings, painting of boxes, career opportunity	Described steps well	Use of tools eg band saw, , router drills hammer glue gun etc
13) S/M, S/F/N/F	P-Design & Make a cash box	Drawings measurements	Measurements, scribbled drawings lengths in cm	Steps followed in design and make	Use of tools as above

			Expressed worked well in group		
14) AD/F	C – Design & Make a bookmark	Not required	Wrote Shawn and Jason did not help in the project, had done publ. in primary school	Process not described	Use of publ. tool
	P- Design & Make a wooden box	NA			
		Not evident	Expressed **no** further interest in wood craft industry	Expressed difficulty in cutting wood	Expressed sticking and glueing but not use of tool in cutting wood
	BT – Hydro phonics	No concept of nutrients No concept of pH	Expressed interest in a better way to grow vegetables, vegetables grow faster,	None observed	Did not participate in nutrient mix preparation, setting up of system

			so they were told, expressed other members non participation Again expressed that boys did not participate, but found exercise interesting	None reported	TC in steps involved
	BT – Water testing				
15) JM/M, KB/M, KA/F	C- Design and Make Business card, tickets, bookmark	Knowledge of tasks	Three tasks done as a cohesive group, expressed excitement, interest	Worked through steps in use of tool	In use of publ, laminator , secateur
					Attained technician's competence in water testing
	BT – Water testing	Concept of Ph well explained	"Part of this exercise was tiring and part	Worked through steps	

		of alkaline exhaled air	was exciting"		
	EPT – GPS			Expressed problems and solutions to sky conditions for satellites to work	TC in use of device
16) **SR/F and others**	C- Computer Assisted drawing (Auto Card) C – Power point Presentation	Front plan, End elevation, isometric view	Mastery of tool Mastery of tool	Finding coordinate - es Insertion of clip art on to a slide	Use of Auto card software Oral and multimedia presentation

	P – Computerised Embroidery	NA	Mastery of the equipment	Mechanics of treading the needle, use of different coloured treads	Use of software, mechanics of the machine Use of band saw, jigsaw, router
	P – Design and make a picture frame		Mastery of tools	Chosen pattern	
	BT – Blood pressure monitoring	Related concepts to practice	Mastery of tool	Error reading "I am not sure I am lost because the blood pressure	Use of Digital Blood Pressure Monitor

				always says error! At the moment I don't have a solution"	

[1]EPT: Energy, power & transportation, P: Production, C: Communications, BT: Biological Technologies
[2]**NA-** Not Applicable

General Findings: The sixteen portfolios revealed <u>two</u> group activities on the two stroke small engine and <u>three</u> on the use of a Global Positioning Device (GHS) of the Energy, Power, and Transportation (EPT). Production type activities were more varied and included students having to design and make a box, napkin holder, test tube holder, picture frame, kitchen shelf and in one instance to embroider a shirt using the computerized sewing machine (<u>9 activities</u>). Communication activities required students to produce business cards, barbecue tickets and bookmarks using Microsoft publisher (<u>8 activities</u>) and in one instance a power point presentation (<u>1 activity</u>). Biological Technologies (BT) activities required students to carry out measurements on water quality (<u>5 activities</u>), soil pH (<u>1</u>), hydrophonic vegetable production (<u>3</u>) and medical technology in the form of blood pressure testing (<u>1</u>) (Table 2).

Concepts and Skills Learnt: Table 3 shows the activities pursued by students, the concepts learnt, the elements of the design brief and the stages of the problem solving method. With regards to concepts and skills learnt, students' portfolios displayed an understanding of distance, speed, and time for two of the three GPS activities reported. However, neither of the two small engine reports revealed an understanding of the operation of the two stroke engine. Only one of five water and soil quality testing reports indicated an understanding of Ph and its significance to acidity, alkalinity or neutrality to liquids tested or to mineral levels or soil nutrient status. However one student clearly understood the alkaline nature of exhaled air (Table 3). Although students of the hydro phonic activity learnt measurements of length and width of lettuce over time, only one group activity wrote about the concept of recycling of nutrients and the role of the submersible pump. The student who worked on blood pressure understood the concepts of diastolic and systolic blood pressures, as these related to health issues. The students who worked on their various production design and make activities not only learnt concepts of measurements but also improved on their psychomotor skills as they used the various hand tools and operated equipment such as the band saw, scroll saw, sander, and router. The power point presentation of portfolio 16 reflected an understanding of forms of energy.

Evidence of the Design Brief and Stages of Problem Solving: Only one of the sixteen group portfolios examined projected the structure of the design brief of a challenge, in a particular context, resources and materials, learning outcomes and evaluation criteria. Two other portfolios displayed a defined problem with the resources necessary to

complete the challenges. However, the remaining portfolios implied the nature of the problem (**CODE**: **SPPS1 – Student Portfolio Problem Solving Stage 1**) especially of the nine design and make type production activities, that student worked on. Only two of these portfolios also showed several drawings in the design and make process, that indicated more than one solution to the problem at hand (**CODE: SPPS2&3**). Apparently the teacher gave verbal instructions about the problem or task at hand and expected students to produce their own design briefs.

The instructions for the steps to be followed for the six water and soil testing activities were presented in the instruction manual for the tests to be carried out. However, the **instructions were not given a meaningful environmental context** as the structure of the design brief should have entailed. Two of the four GPS portfolio reports displayed an understanding of the context of the use of the technology. Two of the eight publisher activity and the one power point activity portfolios of the communication exercises reflected a clear pattern of design and make (**CODE: SPPS1-4**) for production of business cards and the power point presentation on forms of energy.

Table 3 Evidence of Elements of the Design Brief and Problem Solving Stages

Student initials M/F	Activity [1]EPT, P,C, BT	Concepts learnt	Design brief Elements	Problem definition [3]SPPS1	Solutions One/Best [4]SPPS2	Design /follow steps [5]SPPS3	Process/ Product Evaluat - ion [6]SPPS4
1) KN/M	EPT – Global Positioning Device (GPS)	Distance, speed, time	Challenge	implied	NA	Followed steps	Steps involved or process
2) KL/M	P- Design & Make a box, Napkin Holder BT- Hydro phonics	[2]NA Not Evident	Challenge	implied	Trial and error	Followed steps	

	C.- Design & Make a Barbecue Ticket						
3) BB/M	EPT - GPS C- Business Card (BC)	Distance, speed, time	Challenge	implied		Followed steps	
4) NR/F	BT- Water Testing for hardness	Not evident	Challenge	Yes, stated	one	Followed steps	Yes tap vs distilled water
5) DB/M	EPT - Small engine C business card	Not evident	Challenge	implied	none	Followed steps	yes
6) NR/F	P- Design & Make a Napkin Holder	NA	Challenge	Yes, stated	Type of wood, pattern, shape colour	stages	Process Product
7) VJ/M	P- Design &	NA	Challenge	Yes,	Possible	Design &	Steps

	Make a Kitchen Shelf C- Business Card (BC)		, resources Challenge	stated implied	solutions, one chosen -	make Followed steps by instruction, modeling, trial and error	Process remodeled product Product business card
8) IS/F	EPT - Small Engine BT-Soil test C - BC	Not evident Concepts not defined C-NA	Challenge	Implied for BC		Followed steps	Steps Process Product too dark background
9) KB/M Jev/M/KI	EPT- Global Positioning System (GPS)	Distance, speed, time	Challenge	Implied	One only	Followed steps in proc OF GPS WT	No results shown in WT

10) MB ./F	BT- Water Testing: Ph, Cl, Fe, Cu, Hardness C - BC	Concepts not defined	Challenge	implied	Ideas on format of card	Followed steps	Business card not presented
11) KN/M	EPT- GPS	Distance, speed, time	Challenge , context (moon phases sunrise, set)	implied	One only	Followed steps	Steps Process Peer coaching & evaluation
12) KL/M KH/F & LB/F	BT-Hydro phonics	Not evident	Challenge	implied	One solution	Followed steps for BT, C, WT	Steps Process involved, measureme nts,

		NA					findings,
	C Business cards bookmark BT Water testing						
13) S/M, S/F/N/F	P Design & Make Box & Napkin Holder by individual members					Design and make for box and holder	finished box Product
	P-Design & Make a cash						

	box						
14) AD/F	C – Design & Make a bookmark	Not required	Challenge	Implied	One solution	Design and make	
		NA					
	P- Design & Make a wooden box		Oral Challenge	implied		Design and made box with parental assistance	Process & marooned finished marooned product Results of measurements of hydro phonics,
	BT – Hydro phonics					Design and make not shown for box, Stages of design of bookmark not shown,	water tests, and finished cash box
	BT – Water testing	Not evident No concept of nutrients				Steps in water	Product not shown for

		No concept of pH				testing described	bookmark, final box
							Presented results for height, width of lettuce grown, and results of water testing
15) JM/M, KB/M, KA/F	C- Design and Make Business card, tickets, bookmark	Knowledge of tasks	Challenge	Implied	One solution to each		Both process and product evaluated Performance/ Results Performance/
	BT – Water testing	Concept of	Challenge	Implied	Three	Design and make described	ce/ Correct

				Defined Problem		presentation. I learnt how to insert a digital picture into a slide"	
	P – Computerise d Embroidery			Defined Problem	Types of embroid-ery	" Our first problem was treading the needle"	Product; shirt embroidere d with a star shape pattern , names of students
				Defined problem	More than one solutions	Design and make	
	BT – Blood	Related		Defined		Error	

pressure monitoring P – Design and make a picture frame	concepts to practice		Problem		readings in the use of cuff	Process and Product or Picture Frame Process portfolio

[1]EPT: Energy, power & transportation, P: Production, C: Communications, BT: Biological Technologies

[2]NA- Not Applicable

CODES: SPPS1- student portfolio problem identification, **SPPS 2-** Student portfolio solution(s) to problem **SPPS3 –** Student portfolio Design and make, **SPPS4 –** Student portfolio Process or Product evaluation

STUDENT INTERVIEW FINDINGS AT WATERLOO HIGH SCHOOL:

The interviews carried out with Form two students at the Waterloo High School is shown in Appendix II, p. 76 -87. Students were interviewed on the problems they worked on, the stages of the process, concepts they were learning and their feelings on the activities pursued. With regards to the Biological Technologies, groups of three students were interviewed while they worked on a water testing and a hydro phonics activity. For the water testing activity, students identified that following through the steps of the process they could conclude whether the water had high or low concentrations of certain

minerals, based on its Ph. However, as observed in their portfolios, they had no idea of the concept of Ph or of the importance of determining mineral levels in a water supply to a community. In the hydro phonics activity they measured height and width of plant (p.78) growth but most portfolios did not reveal an understanding of the principles of the process such as recycling of nutrients via a submersible pump. At one of my visits there I observed signs of nutrient deficiency in the form of yellowing of leaves which was not brought to their attention by the teacher. However they saw the method of vegetable production as a different and more interesting method than growing plants in the soil (p.79).

Two students, one male and one female, were assigned to set up the Transportation activity of setting up the two stroke small engine. However, only the male student pursued the activity. Initially, he had problems starting the engine. The teacher demonstrated the starting of the engine for him and advised him "You have to try the technique, you have to get the technique all right, read up what they say about the needle valve, they go give you the settings for it and try it, you get it to reeve a lil bit" (p.79). Another male student demonstrated the procedure for him… "firstly you clamp on the engine, then you put gas you put fuel next to the needle valve, at the side you have to put fuel afterwards you have to, then you put the needle valve to shake, then you turn it three whole times, you make the battery set up, have to be completely set up; hook up the battery on top the engine, and you take the piece of wood and turn it clockwise and you will get your engine moving" (Appendix II, p.80). He eventually read the manual himself and solved the problem he experienced. I had asked what the problem was that he worked on. "OK the problem was a was am anytime the engine start I have to prime it, prime the

needle valve, so when the engine start I turn the valve to adjust it, for the fuel to go to the engine and you just do that all the time". He also expressed a good feeling after he accomplished the task …"**It felt good** because I finally get to start the engine and well" (p.81)

Another group peer taught one another on the use of the Global Positioning System to find a location (p.82). As was evident in the portfolios, student understood concepts of speed, distance, and time by using the device. One student also expressed a great interest in the technology and perceived its use in a wider global context… "I would say **it is really amazing** that nowadays we could invent this type of thing because sometimes you would be driving and you have to use a map, and that could cause accidents, but now you could probably install it (GPS) in vehicles but you have to within the sky satellites so but it depends you know as you know vehicles could come with navigational, so this is practically a hand held navigational"(p.83)

A parent of a female student assisted her in the cutting of wood for the making of a laminated box or production activity. The first problem she experienced was .. "cutting the wood. **Meh dad helped me cut the wood** …and after that I just use glue and nail it on". In the process she learnt to use basic hand tools (p.85).

Three groups of students were interviewed during their communications exercise of producing business cards, barbecue tickets and bookmarks. As was evident in the portfolios examined most students were very adept in their explanations of the design and make procedures using the Microsoft publisher software, as one group explained…"OK well first you have to get to a blank index card, go into publisher, then you go into **blank publication** and you get **an index card** then you click **create** and then well **format,** you

go into full colour full effect, you click **font** or you could resize it and so on then well if you want a **background** you go into you get a design which one you want for the background and then you pick one and then they give you a sample here, you pick a base colour and then you get your background design and then you describe what you want and then you go into format and you pick which font you want, and then you resize it and then well you get your layout"(p.86). Students also displayed an **entrepreneurial** spirit in their designs .. "the name of our business is JKK transportation, stands with Je, Keis and Kim. Our address is 12 Rustling Road Charlievile, am we included a phone number, a fax number and an email and a theme". This was also evident in five of the eight communication portfolio activities examined.

I
TECHNOLOGY EDUCATION TEACHER PROFILES:

Chaguanas Junior Secondary School (Appendix III, p.88):

(1) Ms. Patricia Maynard has had formal training from the Mausica Teachers Training college. She has also had formal training in Agricultural Science, and is also a past student of E.C.I.A.F. (Eastern Caribbean Institute of Agriculture and Forestry). She was also trained in the teaching of agriculture at A.T.E.C. (Agricultural Teacher Education Centre, E.C.I.A.F.). She is currently completing her training in Technology Education (MSVU). She has been a trained teacher for more than 20 years.

(2) Mr. Mukesh Munoo is a trained teacher of Agricultural Science teacher at A.T.E.C. He is also a U.W.I. graduate BSc Agriculture and have been teaching since 1991 at the Chaguanas Junior Secondary. He is also recently trained in Technology Education (MSVU) Graduating in Cohort 2 (2003).

Teacher Background: Ms. Maynard and Mr. Munoo of the Chaguanas of the Junior Secondary school (CJS) had only an initial two week **exposure** on the problem solving process using 12 of the 26 modules of the technology education program in the year 2000. They were told by there school principal to begin the program in September, 2000 and were promised a fully stocked technology education laboratory in the near future. Nevertheless they were told to begin the program without available resources. The program was undergoing attrition in July 2005.

Chaguanas Junior Secondary School: The teachers of the school were not formally trained until 2003-2005, so they carried out the programme without a draft document for one year and without formal training for three years (p.90). As Ms. Maynard remarked initially they did not have internet access until 2003. Even in that year the principal did not allow them access because the LAN connection was in the administrative office. Therefore, to facilitate the problem solving process a few students who had internet access at home "Initially we did not have the use of the computer lab so we had to depend on students doing there work at home and making use of libraries in order for them their research for the various projects" (p.91). The students were also accustomed to note taking and had to be trained in doing research and selecting material to solve their various problems/projects " We had to show them <u>how to do research in the first place and how</u>

to select material and how to use this now in the problem solving method and this is the challenge we had to face in getting our students accustom to that method" (**TIPS2)** (p.91). This statement reflected the teacher's facilitative role of teaching students to separate fact from opinion during the brainstorming stage 2 of the problem solving process (Delise, 1997). The teachers here were **critical of the teaching of higher order skills via problem solving** and Mr Munoo remarked that "if as we followed Consultant method where we just give the activity and then let the student go out there and come up with possible solutions at the end of the day we may not have achieved anything at all (**perceptions- CBAM 2, p. 92)** so in our school at that time we had a new shift in the education system where students were selected based on ability and were channeled to the various schools, **we got the lower end of the scale ok in terms of caliber of students and the students came with little or no skills, research skills, am students am with low ability so these higher level order of learning ok would have been inappropriate for our children our charges here so yes we did guide them accordingly"(perceived barrier CBAM 2, p.94).** Mr Mukesh has in fact personalized the innovation (practice) and has concluded how difficult it is to facilitate the problem solving process with 'lower ability students'. However, The Ministry of Education policy of placing students on the basis of ability groupings is in fact contradictory to the presuppositions of the workings of constructivist approaches like problem solving via heterogeneous ability groupings..

Teachers of both secondary schools seem to employ quite a bit of modeling in the use of equipment to facilitate the problem solving process. The school principal of the

Chaguanas Junior Secondary did not purchased basic hand tools such as hand drills, circular saws, jigsaws to facilitate the program. As the teacher remarked "Teachers in other areas would have brought in some equipment like myself, like if we were doing an activity in the woodwork area or metal work area we would have bought in some of the simple hand tools some of the simple machines like the circular saw and the drill and students would have been exposed to these first but most students would not have had hands on experience in the use of these simple tools (**CBAM 3)** am in terms of" (p.91). He had to manage the innovation by using his own resources to facilitate the make stage of an activity. He also correctly observed that the use of technology at this school was a low level for of use "I don't want to use the word **low technology as such, but were low-keyed in terms of technology use"(p.92).** In fact only 10 to 15 % of the actual program was actually implemented during the four year period.

Teacher – Student Motivation: Despite the problems experienced by teachers at the Chaguanas Junior Secondary teachers were highly motivated to carry out the programme once resources were available. As mrs Maynard remarked "Am the tech ed approach **is a wonderful approach (teacher motivation)** to teaching am with the SEMP curriculum I know that **all subjects are supposed to feed into the programme** with the necessary knowledge so that the students would be able to accomplish these tasks at hand very easily"(p.94). In the final stages of her teacher training seven of her technology education students were trained in radio and television broadcasting. The joy she experienced in her own words "**the joy**, one of the benefits that I have seen even among the problems we have had in implementing the program is a simple radio broadcasting activity that we did our students which included a visit to a radio broadcast school has resulted in seven of

our students being offered scholarships to do training in Television and Radio broadcast"

(Appendix III, p.94). In 2006, Mk. Mukesh had maintained certain aspects of the problem

solving process in the teaching of the Biological Technologies… "We have still

maintained certain aspects of the technological process, **the problem solving method**

involved in the teaching of agricultural science as you know agricultural science **is a**

problem solving, problem based, activity based and it lends itself quite easily to

actually solving problems in agricultural settings so we have had two particular projects

on the farm to date with a technological orientation, one is the **hydro phonics system**

and the second one is the growbox" (Appendix IV, p.95)**.**

STUDENTS INTERVIEW FINDINGS AT CHAGUANAS JUNIOR SECONDARY

Appendix VI, (p.99) shows the raw data of an interview carried out with students of the

Chaguanas Junior Secondary High School. Students were interviewed during a problem

solving exercise of a Biological Technology hydro phonic lettuce production exercise in

2006. During the interview students identified three problems of the design of the hydro

phonic system concerning the growth of their lettuce crop. These were a lack of oxygen,

impaired nutrient uptake, and uneven plant growth…" I am seeing that how most of the

plants are not getting enough nutrients" A female student suggested that the plants be

interchanged from the poorer growth end with the faster growth end to determine the

cause of the problem. Her actual remarks were "The plants closer to the flow of water we

could exchange these healthy ones and put them down with the unhealthy ones and bring

them closer to the flow of the water" (**SIPS2-)**. Regarding the lack of oxygen problem a

male student proposed the solution… "am we lift the height so that the flow of water can

come down slantways and it would be a equal flow of water so it would not be a flat way, some would be getting and some would not be getting, so all of the plants would be healthy" Another student perceived the entrepreneurial aspect of hydro phonic food production. He remarked "a farmer he could get crops all year round without of waiting for the reason to stop and then **that could lower his wages, his income"**

 Adaptation of the Innovation at the Chaguanas and Waterloo High Schools: The teachers of the Chaguanas has enacted about 10% of the practice of the problem solving process in the teaching of related **biological technologies** topics such as recycling, composting, grow box technology, hydro phonics, and ornamental horticulture. The technology education teacher at the Waterloo high school that because of a similar lack of materials he has included other topics in this strand such as the use of the microwave in cake making, which was not part of the draft curriculum (p.72)

Barriers to change Initially only 6 of 16 teachers of the **Chaguanas Junior Secondary School** were exposed to the training of utilizing the problem solving approach in the activities of technology education. However all 16 teachers met once per term as a group to implement the program. The older teachers decided to stay in their comfort zone and not implement the program "However **we had some of the more mature teachers (10 of the 18) who were entrenched in the tech voc areas and they were opposed to change of course" (p.90).** Also no agreed program of work was carried out by all the teachers "So **in terms of having a uniform program of work covered by all students am it was not done" (p.90).** In fact only 10 to 15% of the actual programme for technology

education forms 1 to 3 was actually implemented "we used probably about 10 to 15% of that curriculum document 10 to 25% of the actual outline curriculum document of our actual work in school". The school principal did not attend group meetings although one teacher reported to him on the "agreed upon topics for the term to be taught by the 5 or 6 of the 16 teachers."

At the Waterloo High School the Technology education teacher is perturbed by the attitude of the school principal of suggesting that students **be restricted of the use** of the technology education laboratory equipment. He has also secured the multimedia projector for other teachers use and not for the technology education classroom. As the technology education remarked "Am for instance it was said to me that you are actually bringing students into the lab what about all that equipment are they going to take the equipment and I said my answer to that was **the lab was in fact for the student and they need to interact with these equipment.** If something happens to the equipment and it breaks all that is within the service life of the equipment. It has to be used. **Also certain pieces of equipment seem to be in control by administration for what reason**" (p.73).

Attrition of the Program at Chaguanas Junior secondary: Ms. Maynard has been implemented the problem solving process in the teaching of Technology education while completing her training in Technology education in 2005. The other teachers had disbanded the program for a variety of reasons namely, the past school principal did not provide low level type of resources to sustain the program. Also the Ministry of Education had promised the school principal a fully equipped technology education laboratory to run the program, but this have never materialized to date. Also most other

teachers had realized that they were not sufficiently trained to initiate the program (p.90).However, in 2006 Mr. Mukesh still adopted a problem approach but only in the teaching of Biological technologies. Both teachers acknowledged an interest in the subject as it interrelates to other curricula including the joy or interest the students experience once resources are provided to deliver the programme.

SUMMARY, DISCUSSION AND RECOMMENDATIONS

The innovation or the use of the problem solving process to teach the various activities of technology education is by its nature inextricably bound to training requirements and the provision of technological resources (Fullan, 2001). At the **Chaguanas Junior Secondary School** the innovation or practice has been in existence for more than five years and instead of being institutionalized, it has apparently undergone attrition (Fullan, 1991; Synder, Bolin & Zumwalt, 1992). However the practice has been adapted to the biological technologies of the agricultural science using the same problem solving teaching strategy. Students at this school identified problems in a hydro phonics system and were able to propose solutions with the teacher facilitating the process.

The teachers' concerns such as a lack of resources in implementing the technology education curriculum were not addressed by the school administration and the Ministry of education. The five exposed teachers at the Chaguanas Junior Secondary School had successfully undergone the awareness and informational stages (Hall & Hord, 2001). However they personalized their concerns about conflicts of resistance by older peers, and a lack of organizational structures to support the program and decided to temporarily

disband the delivery of the curriculum, except in its adaptation to their previous subject areas. The leadership styles of the school principal seemed to be power-coercive (Benne, Bennis & Chin, 1976). Apparently the principal at the Chaguanas Junior Secondary School simply told his teachers to begin the program, did not manage the innovation and did not respond to concerns of his teachers. His method of communication was apparently a top down approach and non-distributed (Rogers, 1995). However, if I was to repeat the study I would interview him about his and the teachers' concerns about the implementation of the curriculum

The teacher at the **Waterloo High School** explained during an interview how he facilitated the stages of the problem solving method for various activities of the technology education curriculum. The more meaningful the contexts were to students, the more creative were their designs for example of *bandanas (coloured head ties/ large pocket handkerchiefs).* However, most students usually adhered to the first idea/design the came up with and very few displayed any for of creativity. The method of presenting students with a benchmark activity of the previous term, for example of a mouse trap car, for them to improve on a design type activity adds variety to teaching style (Delise, 1997). However, for the students' activities witnessed for this study and evidenced by their portfolios, the use of design briefs and the stages of the problem solving process were only evident in a few instances.

Students and the teacher at the Waterloo High School displayed a strong motivation for the subject as indicated in various expressions of enthusiasm, joy, and interest. Within the technology education classroom, students felt encouraged, engaged and joyous about the act of learning. It some activities, indicated by the teacher, the environment allowed

for "the freedom for individual exploration, creativity, expression, and **joyful involvement** in learning about many aspects of technology" (Warner, 2006, p.9).

With respect to the essential learning outcomes the students were developing numeracy, literacy, technological competence and solving problems as they pursued their various activities. They were in affect becoming lifelong learners which would benefit them in the future as productive citizens. The various activities also provided opportunities for the development for tolerance of each others weaknesses, mutual respect of one another strengths and ideas to solve problems. In the process, students were developing emotionally, intellectually, and personally.

The innovation is at the management stage of the Concerns Based Adoption Model of the implementation process at the **Waterloo High School** (Hall & Hord, 2001; Rogers & Shoemaker, 1971).The principal at the Waterloo High School apparently displayed a lack of understanding of the students having access to **all technologies** to effect the implementation of the problem solving process in activities of technology education. However, if I was to repeat the study I would interview him about his and the teachers' concerns about the implementation of the curriculum

Recommendations: The technology education curriculum should not be implemented without the necessary technological resources. Tenders have in fact gone out for 50 mobile technology education laboratories and all secondary schools will eventually deliver the curriculum. Therefore, in the interim, teachers should familiarize themselves

with the practice of delivery of the stages of the problem solving process in their related subject areas of Industrial Arts, Agricultural Science, and Home Economics.

With respect to the present programme at the Waterloo High School I would like to recommend that it is the teacher's role to produce written design briefs in contexts meaningful to his students. He should also use the opportunity to teach basic related concepts of science, and the relationship between science and technological application. He should not rely solely on his students following the instructions from a manual, otherwise there is the risk that the suggested activities for the implementation of technology education would become task and not problem oriented.

The recommendation of this study can also be used by curriculum personnel involved in the review of the curriculum due in August, 2006.

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Appendix I

Audio Tape Transcripts of Technology Education Teachers of Schools

Waterloo High School: Mr. Sherwin Bute

Interviewer: Hello Sherw I am here to interview you on your perceptions about the practice of Technology Education in the schools. First of all I want to get some formation about your profile, you as a teacher, your history as a teacher and something about your professional development.

Interviewee (Sherwin): Ok. Well I have been a teacher for the past 15 years. My educational background started with going to a secondary school which was broad based right it it also offered academic, craft and technical courses. I went to John Donaldson, did **general draught-manship**, also did a course in **civil engineering technician**, completed teacher training at Diploma and advanced Diploma level in Technology Education. (Sherw is also a part time lecturer in Technology Education – selected informant).

Interviewer: I want to get a little bit into the practice of delivery of the curriculum, this practice in Technology Education, is called **Problem Solving**. Is this a new practice to you, a recent practice to you, because of your involvement in Technology Education?

Interviewee: I would say that this is a new practice. More like a **formalized practice** because from time to time we do come up with problems and come up with our own solutions. But this is the first time that this has been in **a formal aspect where you have rules and guidelines of how to actually go about solving problems.**

Interviewer: Ok. Sherwin I want you to expand a little on **what you understand as the problem solving model as applied to any activity lets say in Technology Education?**

Interviewee: Well the first aspect would be to **define the problem**. You must have a clear idea as what the problem is. After that would be **research and brainstorming, just thinking up possible solutions**. For every problem you should at least get **three possible solutions.** From these possible solutions you would weigh pros and cons and from this come up with **a best solution**, followed by either make or develop on your solution which is then followed by **testing**. From the testing you would know whether to make adjustments, which would mean **going over the whole design solution again, or going to production**.

Interviewer: I want to take the example of which I was a non-participant observer (**during a previous informal visit)** of that shelf, that three compartment kitchen wall shelf (**production activity)** that I was present when the students were making. Could you take me through all the stages beginning up to the final product, up to the final product, which is the shelving on the wall how you took students through the problem solving process and their interpretation of how you were taking them through for example **did**

you model some of the behaviours or **did you put them to solve the problem on their own** and when they were stuck you intervened. Could you elaborate with me on this activity or for that matter any particular activity Sher.

Interviewee: Ok well looking at this activity it did require some **modeling** what we understand with students is they believe that products are made by someone else. All things that are good either **come from America or Japan and they cannot see within themselves that they have the capability to do good work (contextual irrelevance)**. So after modeling, explaining to them the concept of how the cupboard is going to be fixed to the wall and (1) what are the basic components of the cupboard they were in fact able to do some (2) sketches, come up with some measurements and (3) produce the item

Interviewer: Did you did you lets talk a little about the sketches were all the sketches good of the students. How did you accept the sketches of the students and was it modified until the final sketch, which I am seeing on the wall or the design of it reached to.

Interviewee: Now in the first draft of the sketches however the students were not technically inclined to actually producing understandable drawings(iterative process involving teacher demonstration, instructions, peer coaching – researcher observations). They would draw sketches that they in themselves would be able to understand, but shown to another person it was'nt there was'nt that communication in the drawing so after (4) from instruction they were able to refine their drawing techniques and come up with a more understandable drawing (presently, May, 2006, two OGT UWI engineering students assist students in measuring lengths, angles etc. before students proceed to using equipment such as the band saw for equipment which are presently placed on unstable tables); recommendation to install work benches) but you must realize that it is in fact a process.

Interviewer: Fine so it's a process but I am seeing a proper design on the wall. Did you have to reveal much of that along the way or did it come out of them with your guidance as you went along the process, or was it a combination of both for example?.

Interviewee: I would say it's a combination of both for instance they know they had to put up a frame and they got the concept of the frame but **I had to model to them how to actually construct the frame, the best type of joints to be used** once they had practice or they had seen one joint made they were able to make the rest of the joints to put the frame together.

Interviewer: Which is a good practice, which is really one of the techniques used in problem solving initially with students. However could just enlighten me on some other activity lets say in energy power and transportation for example how that student has to come up with a solution on its own and where you may not have to model as much, any other activity and give me an example of it (**I recently saw him demonstrate the operation of a small engine activity**).

Interviewee: OK with reference to energy power and transportation at this stage there should be some modeling One of the exercises that I did was the mouse trap car where I actually bought a made mouse trap car (benchmark) where students were allowed to inspect, however no instructions were given as to how to put it together so upon inspection students were able to put together their own mousetrap car, **one remarkable thing happened (teacher's joy/motivation)** was that one student was able to put together a mouse trap car working on the principle of the mousetrap as a spring driving force but used absolutely none of the same components that was given on the model. Alright for instance there was CD wheels, this student used lawnmower wheels and gotten the same effect, the student was given a mouse trap, this student used a rat trap **so this shows how she compensated for the size and the weight of the wheels by using a bigger spring.**

Interviewer: Tell me a little bit about the mouse trap. Is it an action and reaction t movement

Interviewee: The mouse trap uses a spring which **when wound would give potential energy this is a stored in the spring is released to kinetic energy, the spring pulls and rotate the axle, hence giving movement to the vehicle** (content).

Interviewer: This is very good Sherwin m and we try as much as possible **to get these principles** out in our activities so that the students are able **to learn these principles without really being conscious of it .they can tell you how it works (why unconsciously?)**.

Interviewer: Now in the higher order thinking you have to question students as they work in groups could you enlighten me a little bit of the type of questions you use and give some examples of questions you may use when students are working in groups to elicit the type of higher order thinking or **critical thinking**.

Interviewee: Mainly questions are asked to direct the students' progression of the various items. So one basic questions would be **how many basic solutions have you arrived at**. Students like to come up with one solution and move on and **they tend to work with a trial and error** approach where **they continuously modify that one solution until they come up with a finished product** .We try to get them to actually have <u>more than one solution</u> so that they can actually use the best solution and <u>stick to that plan</u>

Interviewer: Could you give an example where students come up with three solutions?

Interviewee: Right now I am doing a rubber band powered vehicle and where you have the basic concept of the rubber band powering this vehicle. **Students are coming up in all sorts of ways in getting this rubber band to power this vehicle**.

Interviewer: For example?

Interviewee: For example they would model on a vehicle where the rubber band would have been wound to possess energy *to turn* one am example of another solution would be stretching the rubber band in terms of a sling shot *to propel* that vehicle forward in the sling shot motion. In deliberating these solution a students would say using the slingshot method is fast, but it is not accurate, it does not have control. **So they would weigh between solutions** whether we want control or whether we want control or whether we want speed. as per se.

Interviewer: The literature says that a well defined problem has only one solution, but an ill defined problem has more than one acceptable solution, an ambiguous goal and no generally agreed upon strategy for reaching a solution. Would this be an example of an ill defined problem or could you give me some other example.

Interviewee: Well I would'nt say that there is one solution. In fact I would say although the solution carries out the function as defined there is more than one way to get to that point. If you look at **transportation** which means getting from point A to point B as the goal you could get there by bus, by car by plane which **are all in fact different solutions to the same problem**. So that I think a well defined problem should have more than one possible solution.

Interviewer: So tell me do you use the SEMP texts for Technology Education or have you **adapted** some of the activities or you have come up with some of your own activities for Technology Education along the same strands of   Technology Education?

Interviewee: Well I would say it's a combination of all what you have said. I do try as much as possible to use the SEMP curriculum. Some of it has to be modified to be more readily acceptable to the student and I have in fact created my own activities for the students. Some of the activities in the SEMP curriculum, for some reason or another for example **does not have the prescribe equipment** so we cannot go ahead with those activities.

Interviewer: Could you give me a little bit about these activities and could you give me the context on which these activities were based?

Interviewee: OK am well some of the activities I have gotten into for example on is cake making this would have been in **Biological Technologies**, one of the items we have there is a micro wave oven, this is a special microwave oven that allows you to preheat and bake items like cake so we try to make use of the equipment we don't have so we have actually made cake in this microwave oven. Another activity to design was to get students to come up with their own bandana (**production activity**). Alright this is something that is popular to students they have them in their back pocket around their shoulder all over and its very fashionable so they would take a plain piece of cloth and actually come up with a design of their own bandana. **The context is related to something they are familiar with something they can associate with and like to design**.

Interviewee: So tell me how you see their learning in these activities

Interviewee: You get rid of some stereotypes among students. I could remember one group that I give *the sewing machine(technological resource) to, this was a group comprising two girls and one boy* and there general attitude was I don't want to be sewing, this is not actually what I come here for. But after spending some time with the computer interface and really going through the machine **it was difficult to get them off that machine (student motivation).**

Interviewer: Have you been able **to teach creativity (a furtherance of problem solving)** to observe creativity in your students in doing these exercises and if so how?

Interviewee: Number one students would ask how should this look and my answer to them is **how do you want it to look** (**learner centered approach**) so for instance in the same activity in designing the bandana my answer to students was **its totally up to you how you want it to look once given that you see the creativity** come out of them that the standards that they had to work was what was in their minds

Interviewer: I want to talk a little bit about **the barriers to change** in the school system for lets ay the practice and the acceptance of Technology Education on **the implementation or the running of the program.**

Interviewee: Yea I would say that there are in fact some barriers am the barriers usually start from the top go down am administration needs to change their concept of this whole technology education. Am for instance it was said to me that you are actually bringing students into the lab what about all that equipment are they going to take the equipment and I said my answer to that was the lab was in fact for the student and they need to interact with these equipment. I f something happens to the equipment and it breaks all that is within the service life of the equipment. It has to be used. **Also certain pieces of equipment seem to be in control by administration for what reason** I am still trying to find out. The **multi media projector** is one piece of equipment which is usually locked away in the Principal and Vice principal's office where it possibly cannot be used because this piece of equipment (more than one) should be stationed in the various classes computer, Tech Ed. Lab where it could be made full use of.

Interviewer: I would to ask you a hypothetical question: Suppose you have been called **to be a change agent to monitor the implementation of Technology Education and you are face with these barriers** could you reveal to me a strategy that you can use to remove these barriers that is amenable to both administration and teachers and how this may work?

Interviewee: OK well the first barrier with rest to **changing the mind of administration concerning the loss of equipment would be to have proper storage facilities for these equipment where they can properly be accounted for**, that would be like putting up instrument boards so just by looking at that board you can see what are some of the instruments that are out am providing a lab assistant technician which would be an extra pair of eyes on the proceeding of the class and just having security cameras in the Tech

Ed Lab as we have here. All of this would alleviate the fear of loss equipment (Normative educative).

Interviewer: How can you change the beliefs of a principal for example who does not believe in Technology Education at all and you are confronted with a school to manage in which you want to see this work Are there alternative ways that this could work lets say perhaps with other opinion leaders in the system how do you think that it can effectively work lets say you want to introduce technology education to five classes in a school. Could you outline for a strategy that is possible?

Interviewee: Well basically first thing that we would have to point out is that **Technology is all around us and change is the only thing that is constant** I for one would point out some of the technologies that are being incorporated into our society and point out how quickly these technologies could be accepted, things like cell phones and computers are becoming everyday items commonplace items in homes and workplaces so to introduce these five classes and to change the mindset of the administration am would be just educating administration on the value of technology and like it or not that is the way of the future (power coercive).
Interviewer: So your approach is normative re-educative where you would teach people and you would also give reasonable arguments. If you had the authority in the system would you mandate to principals that their rolesis to do so. Is there a role for that strategy?

Interviewee: Yes I would indeed say that there is a role for that strategy?
One mindset is that an old dog cannot learn new tricks and some administrators are in fact trying to avoid learning new things because they feel that they in themselves cannot cope with the new technologies and would be shown deficient in those areas. I would say to that administrator that am we may be professionals in certain areas but in other areas we need to give our best effort in learning so to move away from that professional attitude that they have and <u>be willing to learn new things</u>.

Interviewer: OK one final question. Could you give me, now you have lectured to teachers on the technology education programme. Could you enlighten me in some of the issues teachers may face in adopting this Technology Education like yourself?

Interviewee: Well number one **Technology has to be made readily available**. Just imagine you trying to introduce a subject like technology education that deals with computers and other various technologies and you do not personally own a computer in this day and age. It would be difficult **to relate to your students**. So technology should be made available because some technologies honestly **you have to sit down at this for awhile before you get the hang of it and I can't see you sitting down between 8 and half past two and you sitting down and getting the hang of anything** (commitment/passion) (go beyond your normal teaching time to understand the technology).

Do you see some of the teachers fearing the use of technology in the program and if so how would you educate those to do better in the system?

Yes there is always that general fear of technology but I try to do is to indicate that technology is it (Passion for the subject) and there are some technologies that are readily accepted for instance am … cell phones we do in fact accept certain technologies wholeheartedly and what I would say to teachers to use that approach with all technologies. Accept the technology and accept what that technology entails so that you can move on.

Interviewer: But suppose a teacher don't want to accept it but yet is sent to teach that subject. How would you deal with that teacher?

Interviewee: Am that's a difficult question. i would suggest that the Ministry of Education (Selection process) will offer some type of VSEP program so that teacher could move on to something that could more readily suit their mindset Its no sense forcing someone to do something that they are not wiling to give a 100% in.

Interviewer: OK Sherwin. Thank you very much

Appendix II
Audio Tape Transcript of Form 2Technology Education students of Waterloo High School

Biological technology Ph Water testing activity
Interviewer: Name Please
Interviewee 1: My name is M. B. and I go to Waterloo High School.
Interviewer: Name Please
Interviewee 2: K. H.
Interviewee 3: Kris.
Interviewer: Oh right Kris., tell me what you doing here
Interviewee3: Testing water
Interviewer ok What problem you solving here
Interviewee 3 no response (first informant is unaware of problem/challenge)
Interviewee 2 realising no response from kris., interviewer presents the audio to interviewee2 K.H.
Interviewee2 **What the water has in it like chlorine, copper, iron and other stuff**

Interviewer presents audio to interviewee1 and asks how do you normally test
Interviewee1 (reliable informant MB describes the **process**): Well first you full water into a bag method saline then you put a tablet a special tablet in it to whatever testing you

want, shake the tablet until it dissolves, then it turns to a certain colour, and when it turns to the colour you check the chart, then you see what colour corresponds with what then you find out what is the result (most reliable informant describes steps of process (**SIPS1-4**)

Interviewer: What colours do you have there on the chart?

Interviewee2 You have colours sort of like, you have blue, yellow, green, pink, purple, darker purple, brown

Interviewer: What does the colour tell you?

Interviewee3: the different form of it (unclear response) (doesen't link it to the **concept of Ph or toxicity, similarly observations I made of another group who tested the hardness of water** only of its ability to lather easily, but did not relate activity to concept of forms of hardness and methods of corrections)

Interviewer: the different forms if it, what does the colour tell you, different what?

Interviewee2 the different type of like what, how much iron or what it have in the water (High or low)

Interviewer: What does the number tell you?

Interviewee 1 Well is according to different levels whatsoever the water has in it (does not relate content to practice)

Interviewer Different levels of what?

Interviewee1 OK for the different (**interviewer directs interviewee** to Ph concept)

Interviewer: What is this word here?

Interviee1 Ph

Interviewer: What is the meaning of Ph?

Interviewee1 long pause reads from instruction pamphlet Ph is the measure of how acidic or basic things are we assign numbers to things (does not make connection of colour change to Ph or levels; was not **subsequently** written in the portfolio)

Interviewer ok so you all doing chemistry, you all not doing chemistry yet, you doing science , so you all not doing Ph in science yet (concept not linked to integrated science presently taught)

Interviewees: no, no,

Interviewer: What is the importance of Ph to things around you in the environment (does not perceive environmental **context**)?

No response

Biological Technology Activity Hydro phonics

Interviewer: Alright tell me what this project is all about, please
Interviewee: Ok well like you growing plants in this system without using soil

Interviewer: OK tell me how you all set up the plants, how you all grew the plants, from the beginning, to everything to everything you understand about growing it in this system, tell me all the things you did

Interviewees: OK first of all we got the plants from our tech ed teacher Mr But, then we was acquired to wash out the soil (**peat moss)** from the plant, using water, then we fill it in a small container, a film holder, afterwards when we put the plant in there we fill some bagasse right around it, so that it would hold up the plant, and we sprinkle water on top of it and we record our observations during the term

Interviewer: These holes around here, what is the main purpose of these holes?

Interviewee: So that am the nutrients in the water that is in the system, the recycle it will water it like, the plants will use (**does not clearly relate content to practice**)

Interviewer Does'nt the roots come through here (**system** not clearly understood)

Interviewee: Yes

Interviewer: And where does the roots go now?

Interviewee: I guess the roots probably they, yeah yeah, from the pump (error in understanding the mechanics of the system)

Interviewer : So the roots will hang out into a liquid here (I was there when the teacher previously handed out plants to students; no explanations about the roots or the submersible pump or recycling of nutrients by teacher; however **students are learning to measure height and width of the plant over time**). What does that liquid contain?

Interviewee: informs students of nutrients

Interviewer How do you have nutrients running all the time to the roots

Interviewee: from the pump, the water, from the pump, from the bin; it is carried through a line to send it through the plant (**correct about that**)

Interviewer: Tell me what did you all have any challenges, any measurements to do, tell me what you all did?

Interviewee: The first day we measured the height and the width of the plant which was two and a Half inches by two and during the term we checked back the height which it grew, to six and a half by five inches (good recall of measurements)

Interviewer Did you all have any problems (previously I observed signs of nutrient deficiencies, yellowing of the leaves, and leaf miner attack **which the teacher was not aware off**)

Interviewee: no not really but it was interesting though

Interviewer: Why did you find it interesting?

Interviewee: well to see something that you don't have at your house work, something that you have never seen before, to see how it operates, you learn 'somethings' that are also interesting (**Motivation)**

Interviewer: What about growing it without soil, isn't that something interesting

Interviewee: Yes that's very interesting. The plants grow much healthier in this system than on the ground itself (**contextual relevance**)

Interviewer OK thank you

Energy, Power, and Transportation Small Engine Activity

Interviewer: Names please K B (F), N K (M) So K what you working on here

Interviewee: Small engine

Interviewer: A small engine, ok how does the small engine works, you found out how it works

Interviewee1 Am (not actually involved as yet) the activity,

Interviewer: still studying it?

Interviewee2 I am still studying it

Interviewer: So what you doing right now

Interviewee2: Trying to start it

Interviewer: ok, so what is this you using here?

Interviewee2: This is a kind of stick to turn the propeller for it to start

Interviewer: ok so you are trying to start it So the problem you working on here is to start the small engine. How long you all working on this

Interviewee 1 sir we started today

Interviewer Oh well only today, oh sorry

A peer from another group intervenes and demonstrates the process

Teacher also intervenes and demonstrates the starting of the small engine: You have to try the technique, you have to get the technique all right, read up what they say about the needle valve, they go give you the settings for it and try it, you get it to reeve a lil bit but you have to move faster on the needle valve to keep it running ok you have about, yeah you have time (teacher **redirects student to the instruction manua**l while quickly demonstrating the actual technique)

Interview with peer who is coaching student who is still at the zone of peripheral development

Peer Interviewee: firstly you clamp on the engine, then you put gas you put fuel next to the needle valve, at the side you have to put fuel afterwards you have to

Peer coaching: firstly you clamp on the engine, then you put gas you put fuel next to the needle valve, at the side you have to put fuel afterwards you have to, then you put the needle valve to shake, then you turn it three whole times, you make the battery set up, have to be completely set up; hook up the battery on top the engine, and you take the piece of wood and turn it clockwise and you will get your engine moving (**peer demonstrates and explains the process**)

Student who was peer coached reads instruction details: First it telling you to attach the propeller to the engine ay mount the engine to and then tighten the propeller screw securely, second securely mount the engine to your plane or an engine starting start, third close the needle valve clockwise till it stops, do not overtighten the needle valve, after closing open the needle valve turn clockwise three full turns using the arrow point on the needle valve as a guide, fourth fill the fuel tank, fuel will flow from the overflow near the needle valve when the tank is full.

Interviewer What are some of the problems you faced?

Interviewee Starting the engine and getting the clip from coming out of the engine (
SIPS1-4); <u>No explanations from the female student who is still uninvolved with the
activity)</u>, and that is it
Interviewer So you have to solve this problem?
Interviewee Yes

Interviewer returns after ten minutes

Male Interviewee got the engine roaring

Interviewer How did it feel to get the engine started

Interviewee: It felt good (**feeling of joy SIM**), because I finally get to start the engine and
well

Interviewer: What was the problem and how you solve it?

Interviewee: **OK the problem was** a was am anytime the engine start I have to prime it,
prime the needle valve, so when the engine start I turn the valve to adjust it, for the fuel
to go to the engine and you just do that all the time. (sense of accomplishment (**SIM**)

**Energy, Power, and Transportation activity Global positioning Satellite (GPS)
System**
Interviewee: Hi Good morning, my name is K. A. from 2.1 and the project we did is GPS
tracking. This is a hand held machine that shows you a known place that you'd like to
move to and it carries you there by looking at the navigational screens. There are several
types of navigational screens, now I choose the one that you could see where the item
you have to find is and where you are. There is **distance, speed** and how you would like
to travel (**distance**) and I choose zero point two

Interviewer: Then the speed is the speed you are walking at

Interviewee: Yes the speed that I am walking at am (could be interrelated to distance time curve in mathematics)

Interviewer: And the zero point two is what zero point two metres or what

Interviewee: No zero point two kilometers

Interviewer: That is where the location of the object is

Interviewee: No that is like how much I wish to walk like it would be showing me within zero point two kilometers that is the range (knows more than the interviewer) Am this system, am well to set locations you have to go to settings and you put a name to your location then you move towards it and then you press select. From there am you can get someone else to find it (**peer tutoring previously done**) and they choose a navigational screen and they follow to where it is. Now when you find this item the person who set it will give you a certain miles or kilometers or whatever, it depends

Interviewer Is it an item?

Interviewee No it is not an item. It could be anything. It don't have to be am something you looking for, it could be a location (**challenge**). Well my location was the school monument and the fire hydrant in front by the guard booth you just walk to it and you press select Now as I was saying when you reach a certain distance within it it will just start to beep and after that it does not show you anything. The beeping you suppose to know that you are close to it, to the item that you looking for. You could use this within major cities **(understands its use in a wider context)**, it does not have to be only a certain distance, but we did'nt learn much about major cities, just within the school compound.

Interviewer: What do you think about this type of technology?

Interviewee: I would say **it is really amazing** that nowadays we could invent this type of thing because sometimes you would be driving and you have to use a map, and that could cause accidents, but now you could probably install it (GPS) in vehicles but you have to within the sky satellites so but it depends you know as you know vehicles could come with navigational, so this is practically a hand held navigational **(enormous interest and motivation SIM)**.

Interviewer I heard you use the word satellite. Could you tell me what you mean by the satellites on the GPS?

Interviewee: There are satellites on the sky linked to the GPS so when you go out you can't go under roofs and use this. You have to use this within an open area that the sky can link with the GPS system and from there …that is where it will pick up your location and the location you selected to find

Interviewer: Did you find this an interesting problem to work with

Interviewee: It was (pleasant emphasis) Yes it was very interesting it was difficult at first but you can't let this give you problems, you have to work with this in order to find your location

Interviewer: So you have to work with the various functions on the GPS and you were able to work through ALL of them.

Interviewee No I did not go through all of them I just choose ONE that was looking pretty easy, but the reason why I choose it because it was interesting to see that instead of you having to use compass cause this is something I have never used, you seeing where you are and you seeing where this item is and you walking towards it you following these lines they are like roads and you go

Interviewer Thank you very much

Production activity Design and make a wooden box/bridge

Teacher's corrective feedback on finished product (box) at time of interview: (student (Ad) used both fine nails and wood glue to seal corners of the box and sealing of laminate)

Teacher's corrective feedback "The glue in fact if you are using wood glue you have to allow it time to dry, so it just have been a case of waiting for it to dry. Another thing you could have used to secure it, like here now you could have used a staple, alright so that you would'nt spoil the finish all these things I am telling you, using the nails are look good but this material itself have a finish so you don't want to spoil the finish with the nail (laminated finished looked spoiled to me with small nails pounded in and bent inwards). But this is a great box am everything looks uniform and neat yeah it very neat. Out of 60 how much you figure you should get for it. Well basically what we looking at we looking at 50 for how you make it and 10 marks for the aesthetics, which means how you dress it up how you make it look so out of 50 I would sat that this is well made I would give you the 50 marks for this alright. **Aesthetics** in terms of making look good I see you put some stickers on it to give it ownership. The only thing these nail holes you probably coulda try to seal it up, alright well the wood itself come with a finish, so if you notice ion the edges so we coulda plain it also so I would give you 5 in that respect so its gonna be 55 out of 60 for the box itself, and of course the other 40 marks is for your portfolio where you explain exactly how you went about to make it ok

Interview:

Interviewer: Ad, the two projects I did who worked with you Sh and Jas, they here yeah

Interviewer: Ad what was this project about?

Andrea: (whom the teacher provided corrective feedback to) Making something useful with wood (**SIPS1**)
Interviewer: Who worked on it?
Interviewee: me alone
Interviewer: you alone ok what was the project. What was the first problem
Interviewee: cutting the wood. **Meh dad helped me cut the wood** (parental assistance/ modeling)
Interviewer: you dad have equipment at home
Interviewee: well no in the business place we own a business place **I get help to cut the wood (SIPS3)** and after that I just use glue and nail it on (apparently this was mostly the student did)
Interviewer: and stuck it
Interviewee: yeah
Interviewer: did you dad show you how to cut it (parental modeling/doing the exercise)
Interviewee: yeah yeah (seems unsure)
Interviewer so how do you get that square in the wood
Interviewee I don't know the accurate name for the machine
Interviewer any type like what we have here
Interviewee yeah to the back, the **BAND SAW**. And I just measured it accurately and I cut it with the help of my father
Interviewee: ok so how you would outline this project in your portfolio
Inteviewee: what you mean by outline?
Interviewer I mean how you write it up. Tell me about the steps
Interviewee The steps I would write in the portfolio: Well first I got four pieces of wood from my dad's business place, than accurately measure the pieces of wood, then with the help of my dad to cut it, I use six pieces of wood for this stuck it with glue and then I nailed it together (steps seem to be simply steps undertaken, students largely unaware of criteria for assessment).
Interviewer Sir suggested ways to improve it what are the ways to improve on it
Interviewee Am by painting it, getting rid of the nails and I do know maybe varnish it, like when you paint it

Communications (and Production) Publisher activity: Business cards calendars etc. activities
Group 1

 Interviewer: Could you tell us exactly how you made your cards?
Interviewee: I made my business cards on the business card on the publisher. I didn't put bit on landscape I put it on portrait and we had the address, and the name of the business and well at was about it and she will continue on her ticket
Interviewer: Well what you made the ticket
Interviewee 2: OK my ticket was to sell lemonade so I get meh logos exactly according to my heading lemonade, ok I put meh name because its my lemonade and I put a catch phrase lemonade, the slogan is **"lime and refresh yourself"**
Interviewer: So you got all of that from one function of the computer or different things to get everything

Interviewee: well **clip art** to get the pictures the logos and I went on **word art** to put this one lemonade and I just step back on normal
Interviewer: So how you going to write up this project
Interviewee: Well I going to write the programme I went in publishers and I going to write exactly what I went on to get all the "gimmicks or whatever"

Communications (and Production)Publisher Activity Group 2

Interviewer; Tell me the different steps as you go along starting from scratch, pretend you never made the ticket

Interviewee1: OK well first you have to get to a blank index card, go into publisher, then you go into **blank publication** and you get **an index card** then you click **create** and then well **format,** you go into full colour full effect, you click **font** or you could resize it and so on then well if you want a **background** you go into you get a design which one you want for the background and then you pick one and then they give you a sample here, you pick a base colour and then you get your background design and then you describe what you want and then you go into format and you pick which font you want, and then you resize it and then well you get your layout (**PS1-4)**
Interviewer: OK well how you going to write up your project?
Interviewee: I going to make a portfolio and put all the things that we did into it
Interviewer: Tell me the different things that you did
Interviewee: Like the problem, to finding the
Interviewer: ok you could go through all the stages for me

Interviewee2: First thing you go into publisher, and then you go into blank publication index card, then click create, then you could resize it if you want like that and go into typing the font and then you write whatever you want to write on the card (All members of each group were independently able to explain the process in creating the product or business cards/ no real problems identified/mainly use of tools)

Communications (and Production) Publisher activity Group 3

Interviewee High God Afternoon my name is Ke Ar well our group did a business card and it included all three of us, am the name of our business is JKK transportation, stands with Je, Keis and Kim. Our address is 12 Rustling Road Charlievile, am we included a **phone number, a fax number and an email and a theme (Entrepreneurial)**
Interviewer And what was the logo, your theme
Interviewee: Well our theme was the best transportation service delivered right to your door.
Interviewer How you formed this card
Interviewee Am we went on publisher, and we choose business card, our group decided on a clip art and from there we decided what information we wanted to put on the business card
Interviewer: So you were able to get this clip art here or did you have to go on the internet for it
Interviewee: We was able to get it from Microsoft word (I saw them at work on previous visits)

Appendix III
Retrospect Interview with Two Technology Education teachers of Chaguanas Junior Secondary School who previously carried out the programme from 2000-2005 without available technology)

Interviewer: Good afternoon teachers of Chaguanas Junior Secondary School. I am here to interview you to gain some perspective of the programme that you carried out for the last five years in Technology education, the state that it was and the present state of it.
First of all I would like you to give me a profile of you as a teacher, your background, your training, your education, and anything pertaining to technology education.

Patmay: Good afternoon my name is Pa May I am a trained teacher from Mausica Teachers Training college. I have formal training in Agricultural Science, a past student of E.C.I.A.F. (Eastern Caribbean Institute of Agriculture and Forestry) and I was trained in the teaching of agriculture at A.T.E.C. (Agricultural Teacher Education Centre, E.C.I.A.F.). My present position is a Tech. Voc. Teacher at Chaguanas Junior Secondary School. I am here to teach Agricultural Science. However, in the year 2000 we underwent a training programme during the August vacation, July August in Technology education and it was my understanding and the teachers who attended the institute that we were to implement this subject based on that training when we went back out to school in September.

Interviewer: Mr Muk could you give me a little profile of yourself as a teacher and your recent connections to technology education.

Muk Moono: Good Afternoon, yea, Muk Mun I am a trained Agricultural Science teacher at A.T.E.C. . I am also a U.W.I. graduate BSc Agriculture I have been teaching since 1990 and at our school here Chaguanas Junior Sec. since 1991.I am also as trained teacher in Technology Education Graduating in Cohort 2 (2003).We started the agricultural science programme in this school since 1992 and it was a very successful programmme. With the new initiative, the SEMP curriculum we totally disregarded that agriculture programme and other technical vocational subjects and went into full fledge SEMP programme, Tech. Ed. Per se from august, 2000, through mainly an initiative that came about through through the August 2000 institute that teachers at our school underwent, just a two week programme and through the insistence of our administrator we jumped on the bandwagon and started the Tech Ed programme.

Interview: Mrs PatMay could you describe for me your perceptions at the time of that workshop, your feelings about the whole idea of introducing Technology education. What did you think about it, being exposed to the various units, the initial training coming back to the school and wanting to implement this new subject?

Mrs Pat May: my initial perceptions was that it was an interesting programme, something that we may most likely may need to introduce to our students, seeing that they would be experiencing a lot of technological changes in their adulthood and we as part of the education system needed to prepare them for it **(similar theme)**. As far as the training programme was concerned I was a bit concerned about two things one **the depth of the training, did it prepare us to initiate a new subject fully** and two the facilities at the school would not have been in place by September 2000 for us to really initiate the programme as it should have

Interviewer: Mr Muk Could you describe me some of your initial perceptions of the programme and when you came into the school how did you decide to implement this programme?

Mukesh: At first when we entered that August 2000 institute with the wonderful technology lab prepared for us (5 of the 18 tech voc teachers that is) the 12 activities that were outlined that the teachers were placed in groups to go about and carry out these activities. It was very, very nice it looked fantastic **(teacher motivation)**. As a matter of fact I was hooked on from the beginning. The subject was a new orientation in learning and teaching. **It was activity based problem solving and something that I think the kids would go for**. As a matter of fact while I took it wholeheartedly and yes I was very, what's the word, I was very enthusiastic about it in carryout that program. At am when we came to our school Mr. Mar (Principal) told us(coerced us) that we had to implement the new programme because that's on the SEMP curriculum and because of a tour visit to Halifax, both him and the director of curriculum Development had attended on Technology education.
We did start the the tech ed. programme. As being one of the five trained teachers as I said I was very enthusiastic we went out there. We tried to modify our am the Home Economics, IA (Industrial Arts) and carry out that program using the tech ed approach, problem solving.

Interviewer: OK I think we getting into the meat of the matter now I would like to know from you all how did you come together as a group of teachers. What type of planning did you do among yourselves the teachers on morning and evening shift, how did you decide you were going to implement the various strands of Technology Education? Did you come together as a committee, did you plan the curriculum did you look at the SEMP document, did you say that we can do certain things, not in this manner and so on. I would not mind if you give me one or two examples.

Mrs Maynard: Am we met as a group, all the tech voc teachers who were affected, but I say affected because we were asked to teach tech ed rather than the normal Home Economics, Agriculture and Industrial Arts. We met and we try to look at the activities that were placed before us and see **how we can use them or adapt (planning the implementation),** well we really did have to adapt because we needed one to work within the old **timetable** agriculture, home Economics, Industrial Arts and we had no equipment so most of the activities we did were am based on either things that were recycled things that am children may have to do at home. Initially we did not have the use

of the computer lab so **we had to depend on students doing there work at home** and **making use of libraries** in order for them their research for the various projects. Simple materials were used like palette sticks most of the time like Bristol board, things that were easily available (low level technological resources), a lot of recyclable materials, we did some back up teaching especially to assist the students who were not able to do research and this is how we tried to manage there were, however, a number of people who resisted the change in the sense that not all the teachers were trained **well I would not say trained were exposed to the new subject** and it was taking us out of our comfort Zone so really did have some problems in putting our heads together and getting the same set of work done. We however tried to make up **a scheme of work** after much trying, **a lot of haggling to get the curriculum document itself.** *That document seem to have been a secret in the beginning (barrier from policy makers)* and just one or two people exposed to it which was quite strange in the sense that we had to implement and we did'nt have a document. Eventually we got Form one the curriculum and we tried using some of the activities from that, based on our scheme of work.

 Interviewer: But what year did you get Form one document

Mrs Maynard: 2001

Interviewer: Mr Muk I would like your thoughts on the matter with the organizational, with the resistance, was it resistance among the 16 teachers or was it resistance form other members of staff and how were barriers death with at the tine of the initiation of the technology education programme?

Mr Mukesh: We did receive, ok as mrs Maynard was saying we had about 6-8 teachers trained "**so called train" in the August 2000, institute.** Am these teachers as I said their eyes were opened, they took the program wholeheartedly. However **we had some of the more mature teachers (10 of the 18) who were entrenched in the tech voc areas and they were opposed to change of course.** We did have **a lot of barriers** as a matter of fact these people we am these teachers that is, some of them continued with there old disciplines the Home Economics, the Industrial Arts, the Agriculture. Am those who were trained and tried to adopt it we did try in our way to some extent to modify the curriculum and with our limited resources carry on a tech ed program at our school, am as matter of fact mrs. Maynard would have also indicated we did have a problem in getting all the teachers when we had department meetings. It was tough to get all the teachers together to discuss the scheme of work, the program of work for the following term and even thought the end of the meeting we probably did suggest some topics not all of the teachers followed these things in the succeeding term. One teacher reported to the Principal on the outcome of the meetings. So **in terms of having a uniform program of work covered by all students am it was not done**. That's a problem we faced for probably 2 or 3 years within that period 2000-2005. As I said we had **a lot of opposition from more of the mature teachers** which is probably one of the reasons we discontinued the program in January this year, 2005

Interviewer: OK Mrs PatMay I want to ask you **a few questions on the problem solving approach.** Was it different for students to adopt this method? How did your students respond to this approach and could you give me a little insight on how you facilitated the problem solving approach for any one activity.

Mrs PatMy: Am it differed from the traditional method of teaching in the sense that when we taught agricultural science **the students had most of the information available to them.** There were textbooks and am we, there was a lot of reference, **however the type of activities that were set out in the tech ed curriculum required use of computers internet and touched in some areas that <u>we ourselves as teachers were not very familiar with,</u> some of it was out of our realm in the sense that we not formally trained in that it would** have touched on certain subjects like physics, informational technology, at school or informally or through programs that we may have done **to actually come and teach it is a different story** so that we too had a lot of research to do ourselves and had to sometimes help the students in getting accustom to **this problem solving method,** in the sense that they were already groomed or trained from primary school the "Morg and Job method' where the teachers give all the information and they just absorb whereas **now the teacher is NOT giving all the information and they had to go out and do some searching themselves and this was where and this is where a lot of the problems lie because the serious student would go out and they would get their work done** However this was **in the minority** in our school. In most cases we had to rely on those few students and supplement the work that was done **by providing additional information** to the class in general, **so it was not totally problem solving** you know <u>we had to adapt the method</u> to suit the student because it was something unfamiliar to them, so that if we were doing something on recycling, we could'nt just say go ahead and give them an activity in recycling, first we just had to get them to get information like what is recycling, do our own supplemental background work on it and **provide sufficient information to them,** because sometimes the type of information the children would get and bring a lot of times, **it was irrelevant**, even some of those who had the computer available to them. They might download pages and pages of information and **actually all of the information actually not relevant what they suppose to do**, so this in itself had to be <u>a learning experience for the teachers</u> themselves. We had to show them **how to do research in the first place and how to select material and how to use this now in the problem solving method** and this is the challenge we had to face in getting our students accoustom to that method.

Interviewer: Mr Muk Could you give me an example of **a problem solving design, of a design type activity where you ask the student to make and design some product which needed equipment and how did you get equipment to work seeing that the impression I am getting is that the school did not have the basic IA equipment and apart from that how did you put the idea to design and make and how did they respond and how was the entire problem solving activity facilitated for that matter?**

Mukest Muk: long pause If we use the traditional method that was taught well not the traditional but the new method that was taught art RCLRC for the August 2000 institute **we would have gotten nowhere with regards to our students in getting some product**

at the end (Adaptation) Am in the new dispensation where the teacher is no longer the sage on the stage and we have to you know am guide the student, just a guide on the side am it was a new paradigm shift for us as teachers The students initially too, if as we followed am Dr Sarg 's method where we just give the activity and then <u>let the student go out there and come up with possible solutions at the end of the day we may not have achieved anything at all so in our school</u> (contrast in engendering creativity at Waterloo) at that time we had a new shift in the education system where students were selected based on ability and were channeled to the various schools, **we got the lower end of the scale ok in terms of caliber of students and the the students came with little or no skills, research skills, am students am with low ability so these higher level order of learning ok would have been inappropriate for our children our charges here so yes we did guide them accordingly (teacher perception)** now with regards to the question Dr Mohammed pose here am yes we would have brought in our own level of equipment here. Most of the activities Mrs May. suggested were low, I don't want to use the word **low technology as such, but were low-keyed in terms of technology use** am for example lets look at a communication activity we probably did am one of those activity like you initiate a play, **you develop a play,** alright role playing drama type activity. Again **we had no computers do research** was the research level in such an activity would have been very poor students am again through what they have seen in stage alright through their own experiences would have brought into that particular activity am (1) their own feelings their own again what they have seen that's what they would bring in into the activity, (2) what they have been exposed to in their own community their own life styles etc, etc. so **most of the drama type activity we developed in production/communication activity** will be based around <u>those sort of settings (familiar context)</u> now again students were grouped, placed in groups alright, they were given research to do on the various areas ok am the teacher would have guided them accordingly ,we would have provided some basic information also and the student would have come up with their own script. We would have looked at it, vetted it make sure its appropriate for the level for I **know the language that students use what I have seen in some of these scripts were very, very inappropriate (language barrier/transcribing oral into written text in communication) and am we would have evaluate it as a matter of fact students would have done their own (3)role playing in class there would have done their drama, teachers would have been the evaluators according to set criteria, students would have been aware of these criteria for evaluation (aligning assessment to instruction), they would have performed in the classroom and they would have been marked accordingly** (Assessment). Now these things as I have said were very low keyed in terms of technology am the scripts would have been normal paper, they would not have been typed, they would have been hand written am they would have made charts, they would have made their **plack-cards** they would have made their **stage props** everything would have been done manually ok in a sense a lot of the work that was done in tech ed in our school would be low keyed technology alright. Teachers in other areas would have brought in some equipment like myself, like if we were doing an activity in the (4) woodwork area or metal work area we would have bought in some of the simple hand **tools** some of the simple machines like the **circular saw** and the **drill** and students would have been exposed to these first but most students would not have had hands on experience in the use of these simple tools so using these

tools by themselves would have been **out (teacher did not facilitate the training in the use of tools)** am in terms of.. we did a lot of work in the farm area with regards to recycling use of recycled material the compost area that was one adapted straight from agriculture, the composting activity alright, well we did a hydro phonics (biological technology). Mrs May. would have done the hydro phonics area but in a sense a question asked earlier on we used probably about 10 t0 15% of that curriculum document 10 to 25% of the actual outline curriculum document of our actual work in school.

.Intereviewer Ok I would like to finally get some of your thoughts as to why the the programme **had to be disbanded** and the practice used in your present subject area now alright or is it still going Mrs. May.

Mrs May.: **Am l am presently being trained in technology education the third cohort** that initially I would have to done activities based on the technology education syllabus but am they reason more or less decided to change back to the traditional tech voc subjects was one due to the lack of facilities to do technology education and equipment as well as the the lack of computer and internet facilities for research two would be the fact that am the children would not exposed the the agriculture, home ec IA and they would have still need these skills when they they reached form IV and V when they reached the senior comp. we have been getting feedback from the senior comp that in **these areas the children are not showing much interest** especially as they have not being exposed to it in the lower level from forms 1-3 .There were some questions raised by parents and children as to why there was'nt an exam for tec ed whereas there was still agriculture, home ec and IA exams on the 14+ or lower secondary entrance time table. Apart from that I think **general frustration on the part of the teachers** as far as support form the ministry as far as getting materials and equipment to do the tech. voc. Programme was concerned and am getting everything off the ground as it should be we never really had am **full** or total support from the entire tech voc teaching staff, and for these and a number of other reasons (archival notes available) I think because it was a new subject area as well that **most of us feel that we were not properly trained** as we were in our original areas to teach that subject and this too were some of the reasons we went back to teaching the traditional subjects.

Interviewer: Mr Muk. and Mrs May. you are both trained in technology education NOW and you are currently being trained Mrs Maynard. Should the ministry provide all an upgrade for all the facilities you need for a fully stocked million technology education lab. As I know in planning, when we meet with value engineering I know that things are on stream The Government, the Minister of Education has given us a mandate, because she was work-shoped in Technology Education, that Technology Education must be placed into every school in Trinidad and Tobago. If you have all these facilities NOW and you have all these barriers overcome, how would you as teachers respond to this subject, given all the resources and a fully stocked Technology Education lab.

Mr Muk.: I almost grabbed the system from Aphzal's hand here. Yes I really hope that would materialize in the immediate future as I said am the August 200 institute wet our appetite it was a really fantastic experience to be in that room which was two weeks yes.

We were given yes those fancy ideas that those labs would be coming to us and we did go into the subject with enthusiasm. If from all indications it is coming we would like it to be here soon. It has been a certain experience for the last 4 to 5 years teaching tech ed **without any resources whatsoever alright that were promised to us** .We have tried our best, it was an exercise in frustration for a lot of teachers alright but am we will endorse the proposal that all schools should be fully equipped with the necessary resources to facilitate the programme. Am the tech ed approach **is a wonderful approach (teacher motivation)** to teaching am with the SEMP curriculum I know that **all subjects are supposed to feed into the programme** with the necessary knowledge so that the students would be able to accomplish these tasks at hand very easily. We hope that the necessary resources will come to us and its only the students will benefit as a matter of fact. It's a wonderful idea. The subject is **a wonderful approach** there is one other thing I would like to suggest the SEMP curriculum suggest the removal of the IA Home Ec, Agriculture area art forms 1 to 3 level. Mrs May would have already suggested the detriment of these subjects at the higher level alright. We would like to suggest that tech ed runs hand in hand with these tech voc subjects in forms 1 to 3. It has to be incorporated within the regular curriculum. We cannot survive OK as a country to the detriment to these subjects. We must continue with the tech ed programme plus these subjects. Its probably just the time table would have to be modified in the various schools

Interviewer: Mrs Maynard could you share **this joy** of the students who won the **Television Broadcasting Certificates**.

Mrs May.: Alright Thank you. I would just like to say that if we were provided with all the facilities and the support from the ministry as well as authorities I would gladly welcome a technical education curriculum in the schools and I would like to agree with Mr Muk in the sense that it should be run concurrently with the traditional tech voc subjects. Now as far as Mr Mohammed stated **the joy (Teacher – Student Motivation)**, one of the benefits that I have seen even among the problems we have had in implementing the program is a simple radio broadcasting activity that we did our students which included a visit to a radio broadcast school has resulted in seven of our students being offered scholarships to do training in Television and Radio broadcast. This Saturday four of these students graduated in Television and Radio broadcasting and was an opportunity they may not have being able to get otherwise and they have been given further scholarships to pursue careers and training in Television and Radio broadcasting (**communication activity**). **It just goes to show how Technology Education can be successful and it can be of benefit to the student if the Technology Education programme is really being implemented so that students can be provided with the tools to assist them in meeting their challenges.**

Appendix IV: Interview 2 with Mr Mukesh Munoo of Chaguanas Junior Secondary, June, 2006

Interviewer: Morning Mr. Mukesh, I am here to interview you on the biological technologies aspect of the technology education programme, if you have maintained any aspect of this part of the technology education programme in your endeavour now as you have gone separately industrial arts, home economics and agriculture

Interviewee Good morning Doc, for your information yes, we have stopped the programme since September, 2005, and we have gone into the agricultural science programme fulfledge. Even though the form two's had a background in technology education, because of the absence of labs and other key facilities the tech ed programme, we saw it fit to give the student some background at least in agricultural production. We have still maintained certain aspects of the technological process, **the problem solving method involved in the teaching of agricultural science as you** know agricultural science **is a problem solving, problem based, activity based** and it lends itself quite easily to actually solving problems in agricultural settings so we have had two particular projects on the farm to date with a technological orientation, one is the **hydro phonics system and the second one is the growbox.** Now students initially were involved, are we had these projects prior to the agricultural programme being disenfranchised. in the year 2000. These projects were left at the side and tech ed were put in place. However **we revamped these projects in September, 2005**.
Now the students themselves have been able to assist us in setting up these systems. The grow box system: right now we have two crops one of lettuce, one of pacthoi. The students were able to assist together with the farm attendants and the other teachers to prepare the soil mixture which is a three to one ratio of bagasse and sharp sand, they were able to assist in filling the boxes, they were also able to assist in the actual planting in certain instances of the pacthoi and lettuce and they also were involved in some aspects of the fertilizer applications. Now in the hydro phonics area the crop that is being cultivated right now is lettuce. Its approximately 3 weeks old. Again the students were involved very much in the actual setting up of the system. **They were here when the system was being designed**. They made inputs into **the actual design of the system** Previous gone by where **it was inconvenient to get between the plants** and again inputs from them we were able to put the system in a particular way where easy access was facilitate. Even in the actual sump (concrete catchment containing submersible pump with recyclable nutrients); the students were the actual ones involved in the actual work of digging the sump and getting it organize to collect the run off from the actual system. Now students were involved in basically the physically structure. They did some research of the actual solutions for the hydro phonics system but that was all in terms of student participation because of examinations, so they were not able to see the actual growth of the crop in the system.

Interviewer: So Muk. so I know systems like these you and the students would face problems to establish and maintain the system, did you as a teacher facilitate the problem

solving approach, by adopting a stance well here we are we have certain day to day problems in the system and her we are we need to solve these problems

Interviewee: Yes students **are fully aware of the day to day problems (TIPS1)** the field conditions we face in establishing crops in their plots as a matter fact it is because of those problems encountered such because of the seasonality, extreme dry and rainy conditions that prevent year round cultivation in the field, and also the lack of control of pests and disease, and other things such as lack of soil nutrients, the students are very much aware that those prevailing conditions hinders successful growth of their crops year round in the field, so in the design of these systems the grow box and the hydro phonics, they were fully aware of these pitfalls in field conditions, so they really took to these the grow box and hydro phonics systems and they looked at it yes **as areas they can control the conditions so that successful growth of `crops can take place so actual problem solving,** actual awareness of the pitfalls of the growth of `crops in field conditions that can probably be remedied or controlled in the actual hydro phonics and grow box can be satisfied, so students were fully aware of the problem solving method and they utilized this as much as possible in the setting up of the system.

Teacher facilitates problem solving activity in the hydrophonic system
Interviewer addresses both students and teacher in the student teacher interaction:

Appendix V

BIOLOGICAL TECHNOLOGY

Context: Suitably designed Hydrophonic and Grow box production systems are can lessen the problems in growing food crops associated with soil and climatic conditions. However, the designed of such a system may not counteract all the problems associated the growth of lettuce.

Challenge: Your group is required the present to identify the problems of growth of lettuce in the present hydrophonic system and to make inputs into the redesign of the system.

Materials & Resources: PVC pipes (2"", 3 & ¼ ") with assorted fittings, PVC glue, portable drill, submersible water pump, net pots, lettuce seedlings, promix, inorganic fertilizers, internet, Hydrophonic food production, Resh, 1990

Learning outcomes:

1) Identify problems in the system
2) Suggest solutions to problems
3) Work cooperatively
4) Record growth of lettuce

Evaluation:
1) Cooperative learning
2) Student portfolios
3) System redesign

Appendix VI

Interviewer: Addresses the first student: Just tell me one problem only you are seeing in the system Students were previously informed to look for problems in the system.

Student1: Lack of oxygen (**SIPS1**)
Interviewer addresses another student: Tell me another problem you are seeing here
Student 2: I am seeing that how most of the plants are not getting enough nutrients (**SIPS1**)
Interviewer: Are you seeing any further problems
Student 2 Yes am some of the plants are bigger than some because the flow of the water with the oxygen

Interviewer addresses female student 3 : Are you seeing any problems in the system?
Student 3: No I am not besides the oxygen, the lack of oxygen to the plant
Interviewer: So we have identified some problems in the system now we want to get at some solutions to these problems. I heard sir … speaking to you all a while ago and giving you some ideas how to come up with solutions to these problems. What are the problems and what solutions you see in the system?

Student 1 (**suggests a unique solution**): The plants closer to the flow of water we could exchange these healthy ones and put them down with the unhealthy ones and bring them closer to the flow of the water (**SIPS2-3**).
Interviewer: Addresses student2; Why should he do that?
Student 2: To see if the plants are getting enough oxygen which means that we can switch them and come back next week and see if anything is being adequate here (**SIPS4**)
Interviewer: What about the level of the system. What is happening to the flow of the water in terms of how level the system is. Should it be like this or could we improve on it?
Student2 Yes because the water is being blocked by most of the plants and when it reach further down those plants are not getting enough water
Student3 Yes we could improve on it **(She makes a new observation) A next thing ah do understand how some getting bigger and smaller further down to the end too.**

Interviewer Addresses teacher: Sir could you explain that to us

Teacher explanations: its possibly variability in the seedlings from the beginning that's one, also in terms of the oxygen level, some plants possibly, yes are receiving more than others, and if there was variability in the seedlings from the actual propagation system, they will be able to grow faster than others, so it could be explained by the variability of the actual seedlings (**TI PS1-3)** alright, one thing the students did not mention there in terms of the gradient of the tubing, right now the tubing is pretty horizontal, pretty flat and the flow is insufficient really for fast flow of water so at the top we need to increase the height of the pipe so that we can get an increase flow so that the increase flow could be maximized one and secondly the water will be more oxygenated (**TI 1-3).**

Interviewer addresses Student: Could you explain us what sir has just said

Female Student: OK he was speaking about the extra flow of water we could increase to get a bigger, better growth
Interviewer: OK What can you do to increase the flow of water
Female student: By raising, lifting the height (**SIPS3**)
Interviewer to student1 Any more thoughts on that
Student1 Yes she basically correct, am we lift the height so that the flow of water can come down slantways and it would be a equal flow of water so it would not be a flat way, some would be getting and some would not be getting, so all of the plants would be healthy (**SIPS3**).

Interviewer: So I want to know about your feelings about this way of growing crops by hydro phonics?

Student1: My feelings towards it right is that it grows towards an advantage of it and one advantage of it is am grows crops all year round for example the tomatoes which does not grow too well in the rainy season and for this now according to whatever crop you have you can grow crops all year round and alright fore instance like a farmer he could get crops all year round without of waiting for the reason to stop and then **that could lower his wages, his income, I think it have a lot** (personal development - **entrepreneurial**)

Interviewer: What are your feelings on it

Student2 Yes we have an interest because in it was kinda new to us instead of growing plants without soil just having them in water, and **it look good (outlier SIM).**

Appendix VII

FIELD/COMPONENT: BIOLOGICAL TECHNOLOGY

TOPIC   Agricultural technology

SUB TOPIC: Monitoring water quality of ornamental fishes using different
                       filtering systems

FORM:

CONTEXT: In Trinidad and Tobago many small producers are exporting
                       goldfishes, angels and other tropical fishes to Miami. Ryan is
                       currently rearing 'Oranda' Gold fishes for sale at the local pet shop
                       and hopes to export his fishes in the future. Recently he has
                       noticed that although he uses a charcoal filtering system to clean
                       the aquarium water that his fishes have started to die suddenly.

CHALLENGE: You**r** group is required to set up three aquariums with different
                       filtering systems for monitoring water quality and growth of
                       'Orandas' or 'Angels' over a six week period.

RESOURCES/MATERIALS: Internet access, tropical fish handbook, 3 x 6 Oranda (or
                       Angels) gold fishes or other types, three 30" x 12" x 12"
                       aquariums, Ph testing kit, Water conditioner, rock salt, Bio-filter,
                       sponge type filter, purely charcoal filter.

LEARNING OUTCOMES:

Students will be able to:

- Work cooperatively in groups
- Set up and establish three different filtering systems
- Read and follow manufacturers instructions
- Make daily observations of the fish swimming habits.
- Observe fish for signs of disease.
- Test for water quality
- Do partial water changes weekly.
- Clean Filters weekly