PROMOTING AUTONOMOUS LEARNERS IN TECHNOLOGY EDUCATION

by

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Abstract

This study incorporates action research methodology and focuses on the promotion of autonomous learners in technology education. A self examination of one teacher’s attempt to involve students in the direction of their education is conducted to encourage change in student performance. This research enhances praxis knowledge, facilitating changes in pedagogical approaches through an evolving theoretical/practical base.

The study incorporates views of researchers and philosophers, and is closely aligned with research into teachers’ promotion of autonomy in institutional settings. Current literature focuses on classroom strategies, problems solving techniques, teacher influence and autonomous learner characteristics. Institutional constraints, teacher attitudes, and learners pre-existing concepts and beliefs are dealt with as limitations.

This research captures the pedagogical practices of a teacher/researcher’s work with grade nine and ten students in the context of technology education. Methods of data collection and analysis employ standards of observation, reflection and collaboration through journal writing over a fourteen month period. Collaboration with a critical colleague and an academic researcher maintain validity in recognizing changes in teacher action and student performance over time.

Through the duration of the study, students are perceived to develop self confidence, self directed and self reliant attitudes, indicative of learner autonomy. Students demonstrate greater enthusiasm, more drive and determination, and reveal growth in their ability to welcome risks and manage tasks.
The data analysis suggests three fundamental themes for developing personal skills in students and draws on a problem solving model as a practical vehicle for developing learner autonomy. Firstly, students are encouraged to gradually take charge of their learning, developing personal responsibility. Secondly, independent thinking is promoted, providing opportunities for students to learn, make decisions, and identify and solve problems on their own. Thirdly, students are encouraged to make personal connections with their work, stimulating intrinsic motivation. Finally, a problem solving model is incorporated as a vehicle for addressing these three elements of personal development. Educational priorities focus on educating students first as lifelong learners and providing subject material second as vehicles for addressing personal development.

As research specific to technology education is limited, this study attempts to stimulate further research into pedagogical practice, classroom techniques and teacher preparation for addressing learner autonomy in the classroom. Continuous examination will inform academics, researchers and teachers, establishing the development of learner autonomy as a viable pedagogy for improving student performance.
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Dedication

I dedicate my work to my son Curtis Craig Rietchel and my daughter Lauren Jae Rietchel, and strive to influence a learning environment that stimulates their inquisitive nature and love for learning.
Chapter I  Introduction

With the implementation of new curriculum in British Columbia, it is apparent that research into appropriate teaching methodologies is necessary to help educators deal with unprecedented change. In particular, many technology education teachers are searching for methods of implementing a fundamentally new curriculum, removed from a traditional industrial education philosophy. My recent classroom experience points toward some practical teaching methods that seem to coincide with these current shifts in education. Congruent with recent literature, my experiences contain strategies (i.e. elements of autonomous learning) that encourage students to become independent self directed learners. Therefore, systematic research of my classroom experience would provide an opportunity to capture and reflect on such classroom strategies, which in turn could extend our pedagogical understanding, provide a platform for further studies and enhance my own teaching methods.

Prior to this study, a variation in my approach to technology curriculum generated some interesting changes in student behavior and attitude. During a three year period, I noticed changes in students' feelings towards themselves and their ability to learn about technology. Some students seem to become very attached to their work, have lots of energy and make projects on their own. As I have tried to adopt a student oriented approach to teaching, some students appear to undertake their learning with
greater devotion. In light of these experiences, I was encouraged to investigate what is commonly referred to in the literature as autonomous learners.

Autonomous learning is described by Higgs (1988) as a process in which the learner works on a learning task or activity and is largely independent of the teacher who acts as a manager of the learning program and as a resource person for all. As Higgs describes, I find that some students in my technology education classes have a "take charge" attitude about their work. By Higgs definition, I suggest that these students have moved toward autonomous learning, in technology education at least.

Recent literature suggests that students need a wide repertoire of learning skills, and a process for meeting changing societal demands. Autonomous learners are equipped with such a process and are able to address an infinite number of situations, complicated by social pressures, environmental concerns, and personal bias. Fraser et al. (1992) agree that society needs individuals capable of finding solutions to a variety of challenges and problems. They stress that by providing opportunities for student development that elicit autonomy, we assist students in acquiring the skills needed for our changing society. The very heart of educational reform lies in developing curriculum that prepares children for the society of tomorrow. As the Ministry of Education and Ministry Responsible for Multiculturalism and Human Rights (1992) states:

The purpose of the British Columbia school system is to enable learners to develop their individual potential and to acquire the knowledge, skills, and
attitudes needed to contribute to a healthy society and a prosperous and sustainable economy (p.19).

Higgs (1988) notes that society is in desperate need of individuals capable of finding solutions to a variety of challenges. These needs have prompted many leaders to suggest that educators now implement methods of teaching that enhance the problem solving ability of their students.

The problem solving approach is recognized by several authors (Boud, 1988; Braukmann & Pedras, 1990; and Higgs, 1988) as a means of creating a stimulating learning environment for autonomous learning activities. In their research, Braukmann and Pedras (1990) argue for the inclusion of a problem solving model in technology education classrooms. They present problem solving as a viable teaching strategy and provide a step by step process for implementing the procedure. The steps involve defining a problem, establishing a criteria, arriving at solutions and producing an outcome. Fraser et al. (1992) also emphasize that the future of the technology education curriculum encompasses problem solving as an important teaching methodology. The problem solving approach is important for autonomous learning and integral to my classroom.

My change in educational focus and practice over the past four years is closely aligned with the Intermediate Program Foundations (Ministry of Education and Ministry Responsible for Multiculturalism and Human Rights, 1992) document, which stresses the importance of empowering students and turning educational experiences into student-focused objectives instead of teacher-focused objectives.
For technology educators, implications of the *Intermediate Program Foundations* (Ministry of Education et al., 1992) document and the *Technology Education Curriculum/Assessment Framework* (Fraser et al., 1992) document are resulting in a dramatic overhaul of teaching practices. No longer can educators simply use traditional teaching strategies designed to meet the needs of particular tasks in the workplace. In fact, educators need to develop confidence in, and methods for shifting the classroom focus from the teacher to the students. Many authors advocate that educational programs should provide students with opportunities to influence their own learning (Braukmann & Pedra, 1990; Fraser et al, 1992; Truxal, 1986). Truxal (1986) concludes that,

> In each of these directions, the individual interacts with a highly technological environment; education should develop capabilities for lifelong learning in all of the disciplines that contribute to that environment. (p.12)

My experience over the past few years revealed a variety of changes in the ability of students to adopt feelings of autonomy towards their work. Several students eagerly took advantage of opportunities to determine their direction in technology education and appeared motivated to produce remarkable outcomes. Others, however, continued to rely heavily on myself for motivation, and became idle without continuous direction and guidance. Such varying success raised for me a number of issues about autonomous learning.

While the literature supports educational goals and strategies discussed earlier, the reality of promoting autonomous learners in practice raises several questions. How
does one recognize an autonomous learner? What class structure is compatible with promoting student autonomy? How can one encourage continuous progress towards this goal? What manner and style of teaching encourage autonomous development in students? In what way do teacher responses affect students' development? How can one plan and implement activities to promote learner autonomy? How can one monitor students' thoughts about their work? How can one encourage student involvement in the selection and identification of problematic activities and assignments? It is apparent that these and other questions warrant formal investigation through classroom research.

This study, in particular, addresses the role of the teacher and the nature of activities that help students become autonomous learners, and is guided by the research question:

**What teacher roles and actions encourage the development of autonomous learners in technology education?**

An overall goal was to investigate the elements of what one teacher does to move students towards developing an attitude, an appreciation, and a competence level for choosing directions, identifying problems and arriving at solutions.

This study of teaching for autonomous learning is intended to provide insight into recurring questions about implementation of new curriculum and philosophy (Ministry of Education et al, 1992). Since many teachers are no longer asking questions about why or whether one should strive for educational reform but instead, are looking for answers that lead to implementation measures, classroom experience is invaluable and documentation of classroom practices are needed.
As a teacher, I know that one can feel either anxiety or tremendous elation as a result of the unforgiving nature of education. In striving towards my goal, I experience both success and failure. There are elements that seem to trigger successes and those that seem to initiate chaos. There are factors that spur enthusiasm and critical thinking, and those that stifle creative ability. A teacher/researcher is in the ideal position to understand the delicate balance between these factors and extract the positive elements, fostering learner autonomy.

Therefore, in this study, I adopt the position of teacher/researcher to observe and analyze my own classroom activity, manner, and response to students. As biases exist, methods of collegial corroboration and a reasonable balance between observation and reflection procedures add to the credibility of the study. As an insider, this researcher focuses on his teaching methods that encourage autonomous learning in the context of technology education.
Chapter II  Review of Literature

The development of autonomy as a philosophical goal has a long and distinguished history in the philosophy of education. It derives from the Greek word autonomia, meaning independence which implies freedom from influence or subjection by others. Beginning in the 1960s, there is an increasing emphasis on learning/thinking strategies in educational research which, as described in the literature, lead to an interest in autonomous or self-directed learning (Betts & Neihart, 1986; Boud (ed), 1988; Dam, 1990; Garcia et al 1991; Johnson et al, 1990; Ripley, 1984; Mulcahy, 1991; Zimmerman & Schunk, 1989). Howe and Thomson (1981) describe autonomous learning as the ability of individuals to have freedom, opportunity and capacity to make choices about what and how they learn. Wiest (1992) views autonomy as the freedom one feels in determining behavior without control, pressure, and external rewards. Being an autonomous learner means having the capacity to be initiatory, organized, and responsible for his/her own learning, a process related to both cognitive and affective growth.

Candy (1988) views autonomous students as those who accept more and more responsibility for their own learning, for setting goals and objectives, for finding resources, and for evaluating the outcomes of their learning activities. Mulcahy (1991) identifies a key feature of an autonomous learner as the independent self control of one's cognitive and affective resources. Paris and Byrnes (1989) view the self regulated
learner as a motivated person who combines positive expectations and strategies for solving problems.

For the purposes of this study, then, I define an autonomous learner as, an individual who accepts increasing responsibility for his or her learning, is intrinsically motivated, shares in decisions, identifies and solves problems, takes charge of planning and remains largely independent of the teacher.

The importance of equipping students with skills needed to become autonomous learners is well supported by the literature and is incorporated as a philosophical goal in British Columbia, in particular the technology education curriculum. Fraser et al. (1992) agree that society needs individuals capable of finding solutions to a variety of challenges and problems. By providing opportunities for student development that elicit autonomy, we assist students in acquiring the skills needed for our changing society. Dam (1990) suggests that as learners have greater influence and responsibility in planning and conducting activities, the degree of active involvement and learning increases. Barnes, (1976:81) speaks about how knowledge is acquired. He suggests that we do not possess knowledge, presented by someone else, until we begin to incorporate it into our view of the world. He suggests that to learn is to develop a relationship between one’s current understanding or knowledge and the presentation of new material (Barnes, 1976). Barnes (1976) indicates that such a process can only occur by the learner, him or herself.
Perspectives of Learner Autonomy

Research in autonomy is broken down into what Boud (1988) sees as three broad groups of interest: a philosophical view of education, a practitioner interest in promoting autonomy, and a research interest in student learning. The first group deals with philosophers who view autonomy as a fundamental goal of education. They argue that the purpose of education is to develop individuals capable of making their own choices. Dearden (1972) describes autonomous learners as those who examine alternatives, form opinions, and possess such qualities as wondering, inquiring and critical thinking. Jackins (1965) implies that autonomy refers to a responsiveness to one's environment, an ability to make creative and unique responses to situations as they arise.

The second broad group of research deals with researchers' interest in student learning and related issues. Much of the research on student learning focuses on students' response to various learning strategies, different student approaches to learning, and alternate learning environments. For example, in a study regarding motivation as part of self-directed learning, Deci and Ryan (1982) discover that intrinsic motivation is influenced by a number of factors. These factors include a contingent, responsive, and choiceful environment which enhance active student learning. In this type of environment students make their own choices and have opportunities to become competent self-directed individuals. In a number of language and reading studies (Garcia & Pintrich, 1991; Wenden, 1988) the authors view cognitive and metacognitive strategies as organized skills by which students regulate their behavior and use these
strategies as a vehicle for becoming self regulated learners. Mulcahy (1991) argues that, if the instructional approach to teaching cognitive and metacognitive strategies are regulated by students and mediated by the teacher, students are more actively involved in their learning. With the teacher acting as a mediator in the learning process, students become more aware of their own cognitive and metacognitive processes, and more critical and systematic in their learning.

This study is influenced by the first two groups of research and is aligned with the third broad group of research which is interested in teachers' promotion of autonomy in institutional settings. In recent years, much attention has been given to what Boud (1988) refers to as practical autonomy or the notion of developing learner autonomy within institutional constraints. Modern educational institutions are bound by prescribed curriculum, assessment procedures, school structures, time, and safety (Higgs, 1988). As discussed in the research literature, it seems that these limitations have resulted in a number of problems and variations to the approach practitioners take with autonomous learning strategies.

According to Betts and Neihart (1986), differing and very narrow definitions of autonomous learning causes problems in drawing conclusions from research on effectiveness and teaching characteristics. Many researchers are using very different terms to describe autonomous learning. Some terms, as Boud (1988) reveals, include descriptors like independent learning, learner controlled instruction, self directed learning, self study, self teaching and participatory learning, all of which are being used interchangeably. The problem, he states, is that many authors use the same term to
mean different things or different terms to mean the same thing. Some methods focus on teaching while others focus on learning. Some are highly structured while others are loosely structured. For example, in a study by Gibbons et al. (1980), autonomous learning is referred to as self directed education where students have responsibility for selecting and organizing their own learning experiences. In what Waterhouse (1985) calls self-study, students are involved in their own learning while teachers simply act like tutors who interact with students in small groups, one hour a week.

Regardless of the approach or terminology used to identify autonomous learning, according to Boud (1988), one commonality is that students take greater responsibility for their learning over and above instruction. Teachers act as guides and facilitators to encourage students to set goals, plan learning activities and engage in self assessment.

The remaining literature in this paper focuses on the purpose of my study, the role of the teacher in promoting student autonomy. Current literature seems to point to a variety of approaches that practitioners implement to promote autonomy in the context of an educational institution.

**Teacher Influence**

As many factors are identified through this paper as important components in promoting student autonomy, the role of the teacher is identified as crucial in assuring student interest. "Perhaps the single central quality which fosters autonomy is the quality of the relationship between teachers and learners..." (Boud 1988, p.39).
Although Higgs (1988) sees four elements interacting; the learner, the teacher, the task and the environment, she also acknowledges the relationship between the teacher and the learner as the most important factor in developing autonomous learners. The teacher acts as a guide for the learner and provides feedback as the class progresses. She equates the teacher's role to that of a manager of learning. The teacher needs skills for judging the capability of learners to adapt to independent learning, to work with other people, and to exercise leadership skills such as motivation. In managing a learning environment, the teacher structures classroom activities to encourage autonomous learning.

Tumber (1991) also argues that the role of the teacher and the teacher/learner relationship is crucially important in promoting student autonomy. She views the teacher as a facilitator of learning, whose role ranges from being a practical provider to a monitor of widely different individualized programs. Hoadley (1991), in his research on independent learning centers, finds that the role of the teacher in promoting student centered learning is also critical. He stresses that teachers should be available, committed and empathic, and be trained and experienced facilitators of learning. Teachers should be seen as resource persons or facilitators who provide education, counseling, assistance and feedback. However, Tronc (1979) cautions that the role of the teacher, in promoting autonomous learning, is much more demanding than that of a traditional classroom. Teachers have to be harder workers, greater experts, more informed facilitators, and more flexible individuals.
Not only is the role of teacher as a facilitator important in promoting autonomy but so is the teacher's personality, and attitude toward students and education in general. Deci and Ryan (1982) recognize that one key element in promoting autonomous learning are attitudes that include trust, empathy, and realness in the teacher. If students perceive their teachers to be trusting, and caring they become more active participatory learners. Johnson, Pardesi and Paine (1990) determine that appropriate teacher attitudes towards awareness, sensitivity, and confidence, are important in promoting a positive self image in students. They indicate that in order to promote autonomy in the classroom, it is important for teachers to be aware that learners are bound to make mistakes and require additional opportunities for success. In a study involving intrinsic motivation in high school students, Wiest (1992) discovered that teachers who utilized skills of empathy, problem solving and respect, influenced student ability to develop self worth, and internal motivation. When students perceived that teachers cared about them, they achieved at a higher rate and when they felt academic success, they also achieved higher standings. In short, the attitude of the teacher seems to not only affect the response of students but achievement as well.

A study completed by Karp (1989) reveals that if teachers themselves have positive attitudes toward mathematics, they tend to use instructional methods that encourage independence. They used less rule based instruction, and encourage students to explore and discover meaning rather than passively receive information. In this way, students learn self reliance and independence skills, qualities which are important in autonomous learning.
Howe and Thomson (1981) view the creation of a stimulating learning environment, the way pupils are regarded by the teacher and the way pupils regard themselves, as essential qualities for developing autonomous learning behavior. In a study of a British technology program for fourteen to sixteen years olds, Howe and Thomson find that when students are encouraged to develop critical thinking and problem solving skills, they develop self respect and admiration of their own ability. As these students are considered non-academic they are respected for their ability to solve problems and produce quality work.

Myers (1990) suggests that when teachers invite learners to participate in decisions about what is learned and how it is learned, students begin a shift towards self direction. The participatory nature creates a classroom that is purposeful, highly motivating, and conducive to learning.

Dam (1990) argues that greater influence and responsibility on the part of learners in planning and conducting learning activities will increase the potential for autonomous learning. This implies a willingness on the part of the teacher to trust learners’ conceptions and learners’ ability to be in charge of their own learning.

**Classroom Strategies**

Students becoming more independent and accepting increased responsibility for their learning, is a key thread that seems to run through virtually all of the literature dealing with the role of teachers in promoting autonomous learners. Some articles speak to shifting roles of both the teacher and the students, while others address self
direction or specific learning models. All the studies place the student in a looser structure than that of a regular classroom.

In a study of an adult ESL class, Myers (1990) examines practical ways of sharing control in four basic areas: needs assessment, formulating objectives, designing and completing learning activities, and program evaluation. In the area of needs assessment, Myers allows learners to identify and describe their needs in a variety of formal and informal ways, including group discussions and questionnaires. In the area of objectives, she develops a sample learning plan which includes a weekly goal sheet. In designing and carrying out learning activities, she finds that learners are encouraged by support for activities suggested and designed by themselves. In terms of evaluation she finds that students participate in ongoing self-evaluation through diaries and self-evaluation forms used throughout the course.

In a university study, Powell (1988) shifts from conventional lecturing and begins a series of experiments with, what he refers to as, tutorless groups. He shifts the responsibility of learning and group organization to the students, where under basic guidelines they direct the flow and content of the course. Powell finds that some students seem to enjoy the redirected nature of the course, while others feel a significant need for teacher control. As Candy (1988) suggests, it is quite likely that the past educational experience of the students has an affect on their ability to accept more responsibility and move towards autonomy.

In another study, Warner (1986) sees the development of autonomy through giving students choices in instructional approaches. On a regular basis, he replaces
weekly lectures with a series of workshops for which students have to prepare and consult with him on an individual basis. As a result, students direct their own inquiry and writing, and reveal an ability to independently solve problems.

Another program that encourages student direction is incorporated by Mulcahy (1991) who develops what is known as the SPELT Cognitive Educational Approach (Strategies Program for Effective Learning/Thinking). This approach establishes the teacher as a mediator in fostering active student involvement in their own learning. According to Mulcahy, successful mediation requires three major types of teaching strategies in the program. The first, direct instruction, involves self-regulated instruction. The second strategy emphasizes peer tutoring and dialogue about learning. The third, encourages cooperative learning and fosters group discussion and debate. Mulcahy emphasizes the importance of these three methods of instruction in fostering a student generated program versus a program imposed by the teacher.

Regardless of teaching strategies involved, both teacher and student motivation are considered critical aspects in promoting autonomous learning behavior in students. In a study by Deci and Ryan (1982) on research findings regarding motivation in elementary students, they imply that when students are intrinsically motivated they are interested in learning and becoming creative problem-solvers. In order for students to become intrinsically motivated the teachers themselves must be intrinsically motivated, excited, involved, and supportive of students’ efforts. Howe and Thomson (1981) agree that the desire to learn comes from within students themselves and that when students are provided with choices, they are much more inclined to be motivated. Tumber
(1991) agrees that motivation is an important strategy in promoting autonomy and implies that only when students are in the center of the learning process, will motivation be likely to materialize.

A theme in the above studies is that of placing the student at the center of the learning environment and actively involving them with the learning process. Students seem to gradually accept more responsibility, have greater self respect and become directors of their own education. They demonstrate a movement towards becoming autonomous learners. Ripley (1984) however, suggests, that educators provide little opportunity for the development of autonomy in adolescence due to teachers' need for control. She emphasizes that if teachers are willing to provide freedom of choice and encourage reflection through reason, then educators can encourage autonomy in classes. From the development of the student as a self directed individual, two particular teaching strategies, group work and problem solving, seem to prevail in promoting autonomous learning.

Group or team work is considered, by many authors, to be extremely important in promoting autonomous learning. Dart and Clarke (1990) emphasize the value in encouraging students to work cooperatively in small groups, as a useful strategy for enhancing their personal learning. In these groups, students actively discuss, clarify, and challenge all material they interact with. As well, members of the group teach each other about topics agreed upon by the group itself. Dart and Clarke find that when students work in groups there is a high level of activity, lots of interaction and problem solving among students, and immediate feedback at a level they understand.
Waterhouse (1990) suggests that small teacher directed groups are important for development of autonomy. He suggests that the experience is intellectually stimulating, personally and socially supportive. With such groups, encouragement, collaboration, and socially supportive environments are encouraged. Wiest (1992) stresses that when students feel the support of their peers, it leads to higher levels of self esteem and self worth.

In a comprehensive survey of British public schools, Howe and Thomson (1981) relay the importance of cooperation and working together. In a group of fourteen to sixteen year old design students, the researchers find that, if students work on a particular project or problem, it is important for them to gather ideas, information, and solve problems as a team. Generally speaking, the power of the group or team generates far more ideas and resources than do students working individually. The researchers find that individual students receive tremendous emotional and practical support from groups and that a higher degree of success is insured for each individual. Even though the use of groups facilitate a degree of control or dependence, Howe and Thomson suggest that appropriate group structures still allow for individual freedom to deviate from the group plan. The researchers encourage students to individually contract, design and construct a model while, if needed, obtaining support from the group. By allowing for individualized work, no pupil is held back by his or her peers or is led to feelings of failure. A teacher must constantly manage a delicate balance between incorporating the use of groups to provide support, and encouraging independence to think critically about solutions to problems.
**Problem Solving**

The problem solving approach to teaching is viewed by many researchers as the focal approach in promoting student autonomy (Boud, 1988; Braukmann & Pedras, 1990; Fraser et al., 1992). Problem solving is typically incorporated in conjunction with group activities and involves a series of steps. Students begin by identifying a problem and then working through various steps in order to find a solution. Higgs (1988) views the problem solving approach as a method of providing many opportunities for students. She suggests that learning experiences that involve learners in problem identification and resolution, prepare students for their role as autonomous life-long learners.

In a technology study, Braukmann and Pedras (1990) argue for the inclusion of a problem solving model in the curriculum of a technology classroom. They, as well, present problem solving as a viable teaching strategy and present a similar step by step process for implementing the procedure. The steps involve defining a problem, establishing a criteria, arriving at solutions and producing an outcome. Braukmann and Pedras suggest that motivation and interest in topics are greatly increased when students share in a group problem and involve the teacher as a facilitator. Such activities are excellent preparation for meeting the demands of a technologically changing society, one that seems to demand the capacity of individuals to master problem solving skills.

Kimbell and Wheeler (1991a; 1991b) deal with problem solving skills and focus on what Higgs (1988) recognizes as the task and extend their research to discuss the task and structure of activities. They feel that these two controls go hand in hand in assuring success in problem solving opportunities. Kimbell and Wheeler refer to the level of
cognitive reasoning required to perform an activity as the task and to the degree to which an activity is controlled within a class framework as the structure. The task may vary from one that requires simple decisions to that which demands a comprehensive incorporation of design, analysis, and production. Further, they suggest that the structure may vary from a strictly guided activity, which restrains independent thinking, to one that encourages divergent thinking, and promotes a variety of ideas and methods. They indicate that activities should be tailored to meet the needs of students according to their age, their stage of cognitive development and their past experience. Further, classroom experience shows that tight controls over task and structure are necessary when initiating learner independence to a new class of students. Once these skills are refined, a class usually responds well to the loosening of such controls. Students gradually assume more responsibility for their education and begin making decisions about design, process, and evaluation. Kimbell and Wheeler also suggest that to neglect the importance of task and structure may lead to upsetting experiences for both teacher and class. Wheeler (1990) indicates that teachers need to exercise a guiding role in structuring classroom activities otherwise total anarchy may result. Ripley (1984) agrees that the need for a sound structure is extremely important as inconsistency will leave students frustrated and confused.

Although there are a number of studies that address strategies, teaching methods and skills for developing student autonomy, such research specific to technology education is very limited (Claire, 1991; Denton, 1990; Harwood, 1991; Howe & Thomson, 1981). A possible explanation is that teachers in this field have focused
primarily on curriculum content rather than teaching methods. As technological areas of study tend to focus on practical applications of curriculum, teachers may tend to provide information that teaches students specific skills for specific tasks. As conscientious teachers strive to adopt new curriculum in technology education, perhaps their focus is toward changes in facilities and classroom activities instead of new approaches to learning about technological issues.

**Limitations in Developing Learner Autonomy**

While it is important to recognize that many strategies encourage student development there are factors at work which limit a learner's autonomy. Candy (1988) includes factors such as the learner's pre-existing concepts and belief concerning the domain studied, past educational experiences, and objectives of the educational program. Like Candy, Higgs (1988) identifies three particular points concerning student readiness to learn independently:

- the student's attitude towards performing the learning project
- the learner's experience of past independent learning activities
- the teacher's attitude toward this type of learning.

Towards the development of autonomous learning at the secondary level, Howe and Thomson (1981) identify the content of the curriculum and the way it is taught as perhaps the most inhibiting factors. They feel that because our society is still judged by academic achievement, both parents and pupils focus on examination success and identify the teacher as responsible for guiding students towards this goal. Ripley (1984)
sees teacher control as the major reason for a lack of autonomous development. Students experience extremes in classroom structure, from total control to non-control of student learning. Inconsistency in classroom structure and practice, leaves students frustrated and confused about what is expected in examination situations.

As the development of learner autonomy is encouraged, motivated teachers must recognize institutional limitations such as deadlines, curriculum constraints, external evaluation and fixed reward systems. Letter grades, for example, can create limitations to how educational programs function. Waterhouse (1990) views reasons for lack of autonomous development in students as environmental and technical conditions. The environmental reasons include examinations, large classes, rigid timetables and inadequate resources. Technical reasons include:

- the assumption that students can make an instant shift from teacher dependence to teacher independence
- the assumption that autonomy is the same thing as students working individually in isolation from other students
- a lack of teacher support in organizing independent work
- the belief that teachers have less important roles and less to do

Waterhouse explains that young students require a great deal of help in organizing and planning independent work. Teachers have to be more than available, insuring that students have direction. Furthermore, as Kimball and Wheeler (1992) suggest, teachers must maintain a balance of class structure and task according to student development.
Summary

The importance of viewing student autonomy as a goal for education is now fairly well documented in the literature. Several authors provide definitions and descriptions, and include conditions and factors necessary for promoting autonomy in classrooms.

Tronc (1979) emphasizes that to best meet the needs of autonomous development, several conditions are necessary. Emphasis should be placed on student learning, with the teacher adopting the role of a facilitator. Students need to have a voice in what they do and a wide variety of resource material at their disposal. Tronc concludes by emphasizing the value of continuous feedback and individual or self evaluation of student work.

Betts and Neihart (1986) mention that teaching approaches to autonomy must include opportunities which integrate cognitive, emotional and social areas of development. They reinforce the importance of addressing learning styles and needs of students when developing or promoting autonomy in the classroom. Like Tronc, Betts and Neihart encourage the concept of moving students from the role of student to the role of learner. They suggest that students must develop techniques for discovering what they want to study, how they want to study it, and the teacher must move towards a role of facilitator.

Boud (1988) recognizes a variety of approaches for developing autonomous learners and sees the following fundamental components as crucial to a successful program.
Promoting Autonomous Learners

- a commitment by teachers to develop learner autonomy and the confidence
  and ability of educators to introduce different approaches
- a willingness of departments or institutions to, at least minimally, accept new
courses, structures, and teaching methods
- consistency and support within the structure of courses
- reasonable student workloads and sufficient time to work independently
- opportunities for students to gain experience in dealing with all facets of a
task
- acceptance by students to assume more responsibility for their learning

Despite the conditions researchers establish for facilitating autonomy, there is
little research dealing with actual classroom strategies for promoting autonomous
learners, especially in technology education. While many authors (Boud, 1988;
Braukmann & Pedra, 1990; Howe & Thomson, 1981; Fraser et al., 1992) acknowledge
strategies such as problem solving, and group work, few studies address autonomous
teaching approaches, specific to subjects. Some studies deal with student autonomy in
technology education, but only in a general sense.

As outlined in chapter one, my intent was to examine the role of a teacher as a
facilitator of autonomous learning in technology education. This research involved
examining aspects of, one teacher's role, that have potential in developing autonomous
learning behavior in students. The promotion of autonomous learners is a very powerful
and enlightening notion for education and, although not new to the literature, it remains
absent from most public school institutions. As current curriculum development is now
addressing student autonomy as a goal, it is very exciting to imagine the empowerment such development can unleash. In light of limited literature, it seems crucial to engage in further research that extracts the key elements of a teacher's role in moving students towards becoming autonomous learners in technology education.

**Action Research**

Action research incorporates educational research methods that place the practitioner, as a teacher/researcher, in a collaborative framework for inquiring, reflecting and changing educational practice. Such methods provide a means for teachers to inquire into the nature of their pedagogy and classroom experience, and to look into pressing problems of daily educational activity (McKernan, 1988). Action research provides an opportunity to reflect on such inquiry and to search for meaning and understanding of what goes on in a classroom. Greater understanding enables teachers to contribute to an evolving process of educational reform, thus adapting pedagogy to changes in the individual, society, and environment. The principles of action research are geared not only to understanding meaning but also to affecting change in practice. These attributes are fundamental to action research and represent the foundation of my study: *promoting autonomous learners in technology education*.

**Defining Action Research**

While researchers look to qualitative methods for investigating educational practice, action research surfaces under definitions that share both commonality and diversity. Numerous authors attempt to establish guidelines for action research that
reflect a range of historical traditions and contemporary ideas. Some researchers incorporate regimented structures and compare action research to quantitative models, while others establish action research in its own right. An example of the former is a positivist perspective of action research which tends to generalize data, organize procedures into logical order, emphasize logical results, isolate variables, and formulate hypotheses, relevant to problems. Behavior is viewed as objective, testable and reducible to law-like regularities (McCutcheon & Jung 1990). An example of the latter is critical emancipatory action research which focuses on freeing practitioners to inquire into problems within the context of the classroom and to examine curriculum and pedagogy through self-reflective, cyclical processes (Carson & Sumara, 1989). Foreshadowed problems are altered and validated through collaboration by interested parties and tested within the confines of the practitioner's realm of experience (Carson, 1989; McCutcheon, 1990; Tripp, 1990). These methods are applied to a wide array of studies ranging from case studies of individual teachers and classroom practice (Hustler, 1986), to collaborative research of fundamental pedagogical principles (Elliott, 1981). Despite these differences in intentions and outcomes, some commonalities are shared in the literature.

A number of trends are emerging that reflect a goal to understand pedagogical principles and modify educational outcomes. Kemmis and McTaggart (1988) define action research as a collective, collaborative, critical, and self-reflective process of systematic inquiry, undertaken by the actual participants of a study. A view shared by McKernan (1987), stresses that action research is a process of self-reflective problem
solving, which enables practitioners to better understand and solve pressing problems in social settings. McKernan (1988) concludes that fundamental to action research is the concept of improving practice and increasing human understanding. Garcia (1992) summarizes,

Action research is an alternative way of working in the classroom. It is an approach that fine tunes what teachers intuitively strive for and supports reflective learning. i.e.: listen, adjust, watch, and respond. As a researcher, I'm encouraged to listen more acutely to the heartbeat of my classroom and to look closer for a match between my agenda and individual student needs. (p.4)

Although action research has been ruled by some as simply a technical means of implementing hypotheses, as Garcia demonstrates in the above example, action research is gaining recognition as a practical means for addressing classroom situations and as a viable means of informing both theory and practice.

As the literature reveals diversified understanding about the relationship between theory and practice, advocates of action research present some interesting views in relation to this methodology. Sprinthall and Sprinthall (1980) explain that, "Practice and theory go hand in hand. If we concentrate exclusively on either, both are diminished....Theory and practice are different sides of the same coin and reside in the real world, not the laboratory"(p 284-5). The authors clarify that we derive practice from theory and theory from careful examination of practice. They suggest that we mix our own personal understanding with public theories in order to legitimize our private
theories. Therefore teachers derive educational meaning from their evolving personal and professional theoretical base.

Other researchers agree with Sprinthall and Sprinthall (1980) and identify action research as a means of narrowing a perceived gap between theory and practice. Both Stenhouse (1975) and Elliott (1983) suggest that fundamental to action research is praxiology, a set of principles to guide teachers in translating educational aims into concrete practices. Elliott expands that praxis is the dynamic interplay of knowledge of self and knowledge of practice. He suggests that in order for praxiology to be transformed into praxis, the teacher must reflect and deliberate in the context of the teaching situation. In other words, action research facilitates the union of public and personal theoretical aims with practical and contextual experience.

**Rationale for Action Research**

Action research is an innovative methodology which constitutes a flexible and viable means for probing the essence of educational issues that other methods may obscure (McKernan, 1988). Since action research is aimed at accommodating educational reform, this method of study provides a practical solution for teachers to address issues of their classroom and initiate change. Both Ebbutt (1985), and McCutcheon and Jung (1990) see action research as the process of systematic inquiry that teachers undertake to better understand and improve their own practices.

Action research is also a powerful tool for encouraging a teaching staff to engage in dialogue and to share experiences. In his paper, Paszek (1989) explores many
possibilities of the classroom teacher for investigating, improving, and writing about what they have discovered through collaboration. He recognizes a poor exchange of information about classroom activity among teachers and reinforces the benefits of action research. Paszek suggests, student learning is directly affected by action research because it is uncomplicated by administration, free of distant theory and owned by teacher and students.

As action research constitutes flexible methodology, researchers are empowered to adapt to the complex nature of the human condition in social settings. In particular, the classroom is riddled with factors that are not easily isolated. Such influence on human behavior deems it virtually impossible to control for all possibilities. Research in a typical classroom requires a framework that enables researchers to study human behavior and consider, not disqualify, the infinite elements of an educational environment (Gauthier, 1992). The flexible nature of action research facilitates modification of procedures and research problems according to the needs of the study. As a study progresses and information is gathered, action research facilitates changes in focus and procedure, according to the needs of the practitioner (McCutcheon & Jung, 1990; Stenhouse, 1975).

Probably the most significant aspect of action research is the concept of the teacher/researcher. The practitioner remains intimately involved with the educational process and gains insight that other methods may not reveal (Elliott, 1989; Garcia, 1992; Stenhouse, 1975). According to Holly (1989), focus has gradually shifted from research on classrooms, to research with teachers and research by teachers. Holly
implies that no one is more in tune with the class ethos than the practicing teacher. It makes sense for teachers to become researchers in their classrooms.

Action research enables teacher/researchers to exercise their own critical perspectives and assume control over knowledge and curriculum (McKernan, 1987). Furthermore, action research provides a process that frees teachers to step back from the regular activities of the daily classroom to inquire into their own practice, to comprehend the reality of teaching and to solve everyday pressing problems. Garcia (1992) credits action research as providing an opportunity for teachers to step back and explore the why, the how, and the what of any teaching situation. Hence, action research is a viable choice for looking into the needs of education.

As quality education is a continuous cycle of planning, acting, reflecting and revising, the processes of action research are closely aligned with that of education and, although executed more formally, action research incorporates similar strategy. Unlike other methodologies, action research is not necessarily a study with a beginning and end (Carson, 1989). Although action research incorporates varying degrees of formality, by its nature, action research is an ongoing process of educational change. As research in general provides avenues of potential study, action research usually establishes new platforms for educators to continue an inquiry process, thus initiating new cycles of professional development (Ebbutt, 1985; Tripp, 1990).
Implementation of Action Research

Journal writing is an excellent process for implementing the basic elements of action research. Like Kemmis and McTaggart (1988), Holly (1989) advocates the use of journals to assist teacher/researchers in a process of self-inquiry. She explains that the writer retains control of a comprehensive evolving data base through case study and summative or formative evaluation. The writing provides a rich base for reconstructing experiences and constructing portraits of teachers. Holly indicates that journals are permanent records which necessitate time out for reflection on one's practice. Learning from practice can increase awareness, self knowledge and confidence.

According to Holly (1989), the very act of writing reinforces our ability to observe, direct, and understand what we do each day. She stresses that significant clarity of either a personal or professional context is obtained by a willingness to step back and examine situations from an outside view. It is important for teacher researchers to draw out experiences that lead to theories of teaching and learning.

A number of authors address curriculum development and incorporate journal writing to facilitate the concept of reflective, self inquiry. Elliott (1989) states that curriculum development should be a result of teachers' reflective capacities. Curriculum development should not be implemented as simply a technical means for transmitting curriculum to the classroom but should involve the experience of practitioners (Oberg & McCutcheon, 1987; Zeichner, 1993). Elliott fosters the development of teachers' capacity for classroom inquiry in his study, the Ford Teaching Project (Elliott & Adelman 1973). This study addresses inquiry and discovery teaching and aims at
supporting teachers in their role of self inquiry. In particular, Elliot and Adelman focus on helping teachers who keep journals about problems and implications of action research. They find that serious reflection takes support, time, self-esteem, confidence, and trust in both the environment and the people.

Progoff (1975) suggests that it is not until one begins to reflect on teaching that one is able to understand the nature of practice. He explains that one should look to understand the flow of experiences by movement, back and forth, between reflecting on experiences and writing about experiences. Such motion leads to an analysis of change and allows one to become a sensitive observer, more penetrative and focused on our roles and dialectic life (Progoff, 1975).

Holly (1989) reinforces the value of searching for understanding of one's practice through a process of reflecting upon changes in writing. She emphasizes that much more can be learned by reflecting at various points of time, ranging from weekly, monthly to annually. Such periods of time create the distance needed for critical review and observation of changes that occur over extended periods. By reflecting on teaching, one reveals the immediate effects of practice and opens a door to potential real meaning that lies below surface observations. Holly explains how deeper meaning can be found from journal writing through questions such as: what themes are drawn from the writing and what questions and concerns can one address? She insists that practitioners can improve practice by searching for insights to their teaching and by asking: has the writing changed?
Collaboration

Formal collaboration is a powerful notion of action research and integral to the on-going cycles of planning, acting, observing, reflecting and revising (McKernan 1988). To help gain understanding about the essence of practice, collaboration incorporates input by significant colleagues and researchers (Iverson, 1989; Paszek, 1989). Connelly and Ben-Peretz (1980) suggest that teams of researchers share in planning, implementing, analyzing, and reporting of research and that team members contribute unique skills and expertise in a collective process. However, as Paszek (1989) suggests, collaboration does not necessarily need to involve a team. An outside collaborator, perhaps from the school or the university, can provide an excellent sounding board for the teacher/researcher.

Collaboration provides a way of examining teaching under the teacher's direction. Discussions, by the very process, are personally meaningful and relevant to participants (Paszek, 1989; Iverson, 1989). However, collaboration is far more complex than simply a willingness to work together. Institutional roles, power relationships and perceptions of theory and practice need to be addressed in order to facilitate positive debate (Carson & Sumara, 1989). Such constraints are manageable and need not impede the important collaborative process.

Collaboration is especially important in action research because it establishes a form of triangulation by facilitating a variety of viewpoints. Winter (1989) suggests that because members of a collaborative process maintain viewpoints that reflect individual frames of experience, rather that striving for consensus, the process should be
open to divergent thinking and strive to flush out different opinions. This philosophy allows one to move analysis from a personal starting point towards a more open interpersonally connected frame of reference (Winter, 1989).

**Tension within Action Research**

As with all research methods, there are concerns which should be addressed before action research studies begin. Fundamental to the success of action research is the question of ownership. The collaborative action research continuum established by Hannay (1989) provides a way of conceptualizing the tensions involved in ownership. In some cases the teacher appears in full control of the research. In research initiated by academics, outside influences seem to prevail over the teacher. Elliott (1989) explains that successful implementation of action research is the result of involvement by teachers in the field rather than academics. Also, to eliminate potential exploitation of practitioners, the power distribution over research must be equalized between researchers and teachers. As Ladwig (1991) mentions, all too often research is done by researchers on teachers and their classrooms. The researchers gain benefit from the knowledge while the teacher learns little about innovative practice yet contributes large amounts of time and energy. Since action research is aimed at improving practice, it is crucial for participants to gain from the experience (Ebbutt, 1985).

This raises questions about the purpose of action research studies. Is the study to improve practice or is the study to generate knowledge? If action research is undertaken by practicing teachers, the progress will occur in cycles as the need arises.
Assistance from academics can provide knowledge in small supportive increments as needed, leaving the ownership with the prime researcher (Paszek, 1989). The academics' view of action research has either a beneficial or detrimental affect to the successful implementation of a study.

Academics run the risk of interpreting action research as a set of mechanical procedures and standardized techniques rather than a cluster of dynamic ideas and processes (Elliott, 1989). There is the tendency to oversimplify this methodology as a problem-solving method or technique for change. Such views neglect deeper understanding of education, gained by reflective practices (Elliott, 1989).

Since the essence of practice is obtained through collaborative self inquiry, attention is given to the power exercised within a group. Miller (1989) cautions that unequal power relationships within collaborative frameworks can lead to inequitable relationships between teacher and academics, or teachers and students. Carson and Sumara (1989) further imply that collaboration may involve discussions between theorists and practitioner, between institutions and between other areas of power. Institutional roles, power relationships and fundamental interpretations of theory and practice must be equalized in order to stimulate positive debate. Miller (1989) states that the examination of power structures and the repositioning of academics must become a part of any collaborative process for true collaborative dialogue to exist.

In this study, extensive dialog occurred on a regular basis with, as Paszek (1989) suggests, the cooperation of a academic from a university and a teacher from the education field. The discussions remained, personally meaningful, relevant to my
practice and free from institutional constraint. Such collaboration was excellent for sharing ideas, defining meaning, and modifying direction.
Chapter III  Methodology

The diverse, flexible nature of action research provides an appropriate framework for implementing my study: *promoting autonomous learning in technology education*. Action research enabled me to understand, reflect, and refine educational practice by adopting the role of a teacher/researcher. Glesne (1991) mentions that this type of research increases the ability of the teacher to contextualize and critically analyze situations or events while eliminating fast judgments and reactions. As it is crucial to approach educational change from both a theoretical and practical perspective, action research enabled me to integrate knowledge from literature, personal development, and classroom experience. In particular, this research allowed me to maintain an intimate connection to the context of the classroom. A close connection to the feelings and needs of students provided a close sense of their comprehension, self esteem and development. Collaboration with an academic and a colleague insured validity and fostered greater comprehension of factors that promote autonomous learners. This research involves two high school technology education classes and investigates one teacher’s practice in the development of autonomous learners.

*Purpose of the Research*

The purpose of this study is to examine how my role in the classroom encourages the development of autonomous learners in technology education. Specifically, this research focused on the following goals:
• inquiry into my own teaching practice to uncover my role as a teacher/facilitator and the development of concepts about particular elements of practice that encourage autonomous learning.

• collaborating, understanding and reflecting on observations, in order to establish concepts for evaluation in the classroom.

• revising my practice and continuing a pursuit of student development.

• informing practitioners and researchers about the value in developing autonomous learners and the role I play through progressive strategies.

These issues are addressed through the research question: **what teacher roles and actions encourage the development of autonomous learners in technology education?**

**Context of the Study**

As this study pertains to high school technology education programs, it is worthwhile to briefly examine the context of the facility and the background of the students. Students at the research site generally come from middle to high socio-economic homes, supported predominately by parents of professional and blue collar occupations. Parental involvement in education is a priority for many districts, which highlights a commitment by both parents and educators to quality education. A typical class reflects the school mission statement, consisting of mixed gender, ability and ethnic background. Classes include students with mental or physical handicaps,
students whose first language is other than English and students with a wide variety of backgrounds.

Technology education parallels the school philosophy, in that it strives to meet the needs of all students and ensure a wide variety of experiences. The school meets this objective with a full year timetable, allowing each class to convene for one hour, three times a week. All technology courses involve full year programs with the exception of grade eight classes, which meet for only half a year (approximately sixty hours). Classes are led by one teacher who provides experiences in several areas of the facility.

Recent renovations provide four separate facilities, two of which perform a connected function. A unique dual room facility encompasses both a clean research and design room, complete with computer and testing technology, and a multi-material development room that houses a variety of equipment for creating artifacts, systems and environments. An open classroom structure allows students to move freely from room to room according to their needs. As well, each room is decorated with numerous plants, fish, animals, murals and stimulating posters. One of my educational goals is to provide a friendly, gender sensitive environment, aimed at inspiring young people to wonder and think critically.

**Design of the Study**

This research is structured as a longitudinal study, aimed at capturing evolving teaching strategies and changes in student autonomy. I collected data from October,
1994 to June, 1995, focusing on my role with one technology education class comprised of twenty-four grade nine students. It became apparent, however, that since my efforts to develop learner autonomy also involves grade eight students, more observations were necessary. I therefore continued data collection with a new group, involving twenty-two grade eight students from September, 1995 through November, 1995. This lengthy duration enabled me to identify patterns of changes in my action and corresponding student behavior from the first class in grade eight through the end of grade nine.

As a teacher/researcher I observed interaction within my own classroom by conducting two levels of observation. I specifically observed and collected data approximately once a week but also took general notice of related elements during the other sessions with the same class. At random times within each week, I set specific classes for observation and recorded occurrences that I perceived to relate to the study. Notes on my general observation were also done at this time.

Data Collection

My data collection focused primarily on observations and reflections of my attempts to initiate student activity, participation, and personal development. Personal journal writing forms the basis of my data, wherein I documented my observations, reactions, reflections and feelings about my practice. An example of such documentation is provided in Appendix A.

My journal begins with a description of my role in initiating independent activities and student development in early stages of the program. The journal includes
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details of my teaching strategy and student ability to manage their own world, make
decisions, interact, identify problems and find solutions. Such description includes
details about the class makeup and current structure of initial lessons, assignments, and
activities. This initial description provided a good foundation for comparison to
observations which followed through the remainder of the study. It enabled me to
reflect on changes in my pedagogy, my approach with students and their ability to
master challenges and assume responsibility for their learning.

Each class was given opportunities to design, plan and make various artifacts
from a variety of materials. Grade eight students were given significant latitude for
input to the design of their work. Grade nine students were given opportunities to also
make decisions about the nature and type of artifacts. I documented the ability of
students to manage their freedom to obtain resources, develop ideas, solve problems,
plan strategies and produce viable outcomes.

As the research unfolded I documented relevant elements of dialogue between
myself and students, and detailed elements of my approach and organization that seem
to positively or negatively affect student autonomy. My strategies which appear to
affect the confidence and ability of students to independently manage situations, as well
as those which lead students to dependent behavior, were recorded. My interaction with
students and manner of responding to questions were also captured.

I identified the development of student autonomy through changes in their
approach to assignments and activities, and students' adaptation of self reliant attitudes
towards their work. Documentation of my corresponding shift in pedagogy, identifies
strategies that enhance learner autonomy and indicates the form of nurturing that students require to be successful. As students call for less structure and assistance in achieving goals I view their action as one indicator of my success in encouraging learner autonomy. Documentation and reflection on my actions, over time, helped to clarify which of my approaches were successful and which needed refinement.

My journal is formatted to include a column for observations and a column for corresponding reflections, which form a critical element of data collection. During the study, I tended to reflect continuously about my teaching methods, interactions with students and management of classroom activity. I wrote about my thoughts at regular weekly intervals, generally four or five days following my documentation of specific observations. On a monthly basis, I reviewed my notes, reflected on the results of my action, and wrote on what I learned about my practice during that period. To reach further clarification, I also documented my reflections about every three of four months, focusing on apparent changes in my practice and student performance.

In particular, I raised questions about the manner in which activities are presented and dealt with in the classroom. My reflections deal with my use of interactive activities and resulting student responses. I was interested in how my strategies, incorporating independent and group learning skills, affected student ability to enter autonomously into discourse with their peers. I raised further questions about which teaching approaches and activities stimulate the ability of students to make choices, plan action, devise solutions, and revise outcomes. My continued observation,
reflection and journal writing provided an excellent vehicle for addressing each of these issues.

**Data Analysis**

Analysis of my data involved further reflection on my journal entries, collaboration with critical colleagues and derivation of themes of pedagogical importance. These steps facilitated close examination of my data in order to recognize changes in my practice, changes in student performance and opportunities to try new strategies.

As collaboration played a critical role in maintaining validity in this study, I gained clarity in analyzing my data by regular consultation with an academic researcher and a practicing high school teacher in public education, and occasional visits from interested colleagues. Every few months I met with Dr. Anderson to analyze the details of my observations and reflection for that period. In particular we discussed the meaning of collected data in relation to my practice, student responses, and research methods. Virtually every stage of analysis including the development and examination of themes, was dealt with by viewing and collaborating over large portions of data each session. On a more regular but smaller scale, I discussed with a colleague, the details of my lessons, the direction of my activities, and the results of my interaction with students. I also had several opportunities to consult collegial educators from within my district and across the province. Their occasional observations and feedback helped me gain confidence in my direction and clarity in my reflections. Overall contact helped
me merge my practical knowledge with an academic perspective, forming a significant contribution for analyzing, clarifying and planning my research. Collaboration provided an outside objective view of my teaching practice and added to the credibility of this study.

In analyzing my data, I reflected on the study as a whole, by reviewing and recalling, episodes and reflections of my practice. The extended length of this research helped me look at data from a distance and gain an understanding from a different perspective. The process allowed me to comprehend several concepts that might not have evolved without an opportunity to step back and reflect at a different point in time.

Detailed analysis of my data occurred through a process which unfolded as I reexamined evidence spanning a full year and a half. In fact it was not until several stages of analysis occurred that I recognized patterns, different from my original organization. On first examination, I focused on themes that seem to prevail and categorized them as:

- chronology
- change
- motivation
- personal behavior
- task and structure
- success
- teacher to student responsibility
- teacher action

With the use of computer macros, I copied journal entries to the above files and italicized the same in my journal. I then incorporated a tabulated book to manage each category for easy retrieval of printed entries. A second stage of analysis involved
organizing the journal entries within each category. Entries were grouped together forming topics of importance which I have reported in chapter four.

However, difficulties arose with my attempt to deal with each category individually. Unsuccessfully, I attempted several mapping strategies which only lead to repetition and confusion. Eventually two levels of categories surfaced. The first level focuses on three elements of personal development while the second deals with a model for classroom delivery. As the process involved several stages of review, reflection and categorization, it enabled me to emphasize elements of my practice which appear to influence autonomous development in students.

**Identifying Learner Autonomy**

Although this study deals primarily with my action as a teacher, an analysis of whether or not students are engaged as autonomous learners raises questions about what characteristics can be used for such identification. For the purposes of this study, an initial definition was drawn from the literature.

an individual who accepts increasing responsibility for their learning, thrives on intrinsic motivation, shares in decisions, identifies and solves problems, takes charge of planning and remains largely independent of the teacher who acts as a facilitator of the learners program (Boud, 1988; Dam, 1990; Deci & Ryan, 1982; Gibbons et al. 1980; Higgs, 1988; Tumber, 1991; Waterhouse, 1994).

A more clear description of an autonomous learner is offered in chapter four which focuses on the student in the context of technology education.
Summary

As I endeavor to form grounded theory about the development of autonomous learners in technology education, I recognize the influence of other factors. Certainly, cultural, historical and societal issues form constraints for such programs, already entwined with institutional limitations and other similar factors. However, this research deals mainly with the practical application of teacher actions and roles in promoting autonomous learners in the classroom. One is reminded that this study is aimed at not only understanding but also initiating change in teaching practice in order to further the development of new pedagogy.

Action research has provided an efficient way for me to engage as a teacher/researcher in the study of my own practice. This study has provided an opportunity to incorporate both theoretical knowledge and practical experience in order to understand, change and promote positive teaching practices. Planning, observing, reflecting, analyzing and revising forms the basis of my study, while collaboration has brought clarity to my role in encouraging autonomous learners. The strategies of action research have facilitated self-inquiry and established new plateaus for further investigation. This research lays a new foundation for myself as a teacher and forms a basis for sharing new material with other researchers and educators alike.
Chapter IV  Data Analysis

In studying my promotion of learner autonomy in technology education, I have taken an opportunity to closely examine my action as a teacher/facilitator and student responses as self directed learners. This research has increased my understanding of suitable pedagogy and provided insight to measures that encourage such development. I have identified teacher attitudes which, in this case, facilitate learner autonomy and specific strategies which lead to student performance gains. Through the duration of this study, the roles of teacher and student change. In particular, student attitudes shift toward greater responsibility, independence and self motivation. In this chapter, I identify my view of an autonomous learner, describe changes in student behavior and document my role as a teacher/facilitator in promoting student success.

For the purpose of this research, I incorporate knowledge from both theory and practice to establish a definition of learner autonomy. The literature review in this paper discusses a variety of definitions by several authors who study this field. I have combined their understanding with my observations of a few students who, I feel resemble aspects of learner autonomy. Together this information forms a knowledge base for my interpretation of how an autonomous learner functions in the classroom.

I view an autonomous learner as one who plays a significant role in his or her education and takes advantage of opportunities to be involved in decisions about what and how learning occurs. For example, an autonomous learner is involved with
decisions about assignments, plans and strategies for reaching outcomes. Such students are usually resourceful, relying on knowledge from their past and from information outside the classroom. Many autonomous learners develop new skills as personal accomplishments, for they find the learning of such fun and exciting.

Fundamental to an autonomous learner, is the notion of personal meaning and an understanding that learning goes far beyond the activity at hand. An autonomous learner identifies problems that relate to one’s own world and society at large. In other words, the autonomous learner finds reason for accomplishing tasks that lie beyond course requirements. For autonomous learners, personal satisfaction and personal interest are the driving forces behind their efforts.

An autonomous learner is constantly moving through a cyclical process of personal achievement and self evaluation. Achievements are rewarded with personal gratification and setbacks are met with powerful determination. For the autonomous learner, the act of overcoming a difficulty simply fuels a powerful engine for even greater accomplishments. The root of what drives an autonomous learner appears to stem from the students’ sense of responsibility, independence, internal motivation, evident through displayed enthusiasm and progress toward challenges.

In my study, the ability of students to meet problem solving challenges is identified as a measuring stick for observing the level of cognitive reasoning, indicative of each activity. Continuous observation has revealed changes in student behavior towards technology education. During the course of this study, students graduated from relatively small tasks within a tightly structured learning environment to very large
tasks within a loosely structured classroom. Student motivation matured from extrinsic to intrinsic, generating personal enthusiasm, drive and determination. Students’ behavior graduated from dependent to independent attitudes, stimulating positive self-esteem and self-reliance. In short, students assumed personal responsibility for the generation of ideas, the organization of work, the creation of products, the identification of tasks and the solutions to problems. It is evident that their failure becomes an inspiration for challenge and success becomes a measure of each student’s personal autonomy.

The following analysis of my data demonstrates student progress toward learner autonomy, and reveals a number of strategies and approaches I use to encourage students in technology education. My analysis reveals three fundamental themes and a supporting classroom model that, collectively, play a fundamental role in my attempt to promote learner autonomy.

1. **Personal Responsibility** is developed as an opportunity for students to take charge of their learning and become responsible for their outcomes. Students adopt elements of responsibility, normally assumed by the teacher.

2. **Independent Thinking** reveals a number of strategies that encourage students to rely on themselves for solving problems, finding resources and producing outcomes. Students take on challenges and remain largely independent of the teacher.

3. **Intrinsic Motivation** is identified as an important factor for inspiring students to take on challenges and problem solving exercises. Students are
encouraged to find personal meaning behind each activity rather than rely on the teacher for such stimulus.

Since the acquired skills within the above themes are aspects of students' personal development, problem solving is identified as a model for classroom delivery. It facilitates a process of classroom practice that deals with the cognitive elements of knowledge, skills and attitudes, and incorporates practical components of tools, materials, and processes. In short, a problem solving model provides a tangible focus for addressing the three aspects of personal development identified above.

4. A Problem Solving Model is recognized as the basis for classroom activity and is supported by three additional factors for insuring successful implementation.

4a. The rate of development addresses how the pace of problem solving activities impact student progress.

4b. Continuous Student Success deals with the importance of successful outcomes as students engage in problem solving activities.

4c. Task and Structure organizes the degree of difficulty and the relative classroom structure for problem solving activities.

Each of the above themes and model are discussed in detail, however, it is important to note that, although each is dealt with individually, they remain interdependent. No single theme or model should be considered in isolation from the rest. For practical purposes, however, the following discussion presents the issues
related to each theme or model, my changing role as a teacher/facilitator and student development during the study.

1. Personal Responsibility

It is apparent that the very concept of being an autonomous learner implies that students become self directed and responsible for their learning. Boud (1988) suggests that a process which encourages students to form personal characteristics, indicative of learner autonomy, incorporates a level of student responsibility unlike conventional teacher driven programs. Boud indicates that most authors agree that autonomous learners assume greater responsibility for learning and remain largely independent of the teacher in addressing activities. The following example from my journal demonstrates the responsibility that students assumed regardless of my effort to rescue them from difficulty.

On several occasions, I have tried to help students through final difficulties with their work. Occasionally I have suggested simpler alternatives....students want no part of any suggestion that will diminish the impact of their work and final outcome. In fact the students seem bound and determined to see each hurdle through and accomplish their original goal. One student, for example, was not satisfied with the degree of resolution available for his animation work. Personally, I thought his results were spectacular, but according to him, the quality was simply not there. He eventually solved his dilemma and finished his work by using the computer resources of a commercial institution. He would not accept anything other than the best method of displaying his capability to produce a professional quality product.

Several authors, including Braukmann and Pedras (1990), Higgs (1988), and Howe and Thompson (1981), suggest that the role of the teacher is critical in providing
an environment that allows the learners to assume responsibility for their learning. As Higgs (1988) implies, the relationship between student and teacher is probably the single most important factor in promoting learner autonomy. The teacher must be flexible in nature, receptive to student input and excited about student directed outcomes.

The following discussion focuses on my role as a teacher in managing the learning environment, establishing relationships, and evaluating the capacity of students to assume greater responsibility for learning. Close examination of my data also reveals a developmental shift in responsibility and a fundamental change in my role as a teacher/facilitator.

**Shifting Role of the Teacher**

Probably one of the most important changes, in dealing with students, is my willingness to gradually shift my role from a teacher to a facilitator. In one case it seems that new grade eight students demand teacher direction and require continuous reinforcement for moment by moment aspects of their daily activities.

...I introduced the first assignment involving product evaluation. I instructed students to form groups of three and to sit in a particular triangular fashion at the corner of each table.

I led the discussion towards methods of enhancing photographs and focused the group on custom picture frames....

... I placed twelve learning packages...on a table and instructed one student from each group to make a selection....I assured the class that they would have an opportunity to experience all of the stations.
The responsibility for learning seems to rest solely on the teacher who establishes activities, organizes each member of the class, stimulates discussion and provides appropriate learning material. When encouraged, students gradually assume responsibility for their learning, making it necessary for me to adopt a different role. The following example suggests a shift in responsibility.

I said, 'you know, because my knowledge of the program is so limited, we really need someone who understands all aspects of the 3DS capabilities....How would you like to become the resident expert in the school?... you’ll have the responsibility of making sure the program runs properly and for helping all the other students....’ At his request I gave him the program manual.

Instead of continuing to provide instruction about various aspects of technology, I began to provide opportunities for students to engage in their own learning. As modern technology is growing exponentially, it encompasses an infinite array of topics and information, making it impossible, of course, for any one person to manage. Therefore, if given the opportunity, the potential for students to engage in areas of interest that lie beyond the scope of the teacher’s bank of knowledge is inevitable. The responsibility for such topics rests largely on the student while the instructor assists and provides links to information and resources.

... students (are) talking about numerous technological topics of personal interest that I can only provide an ear for. For example, one student has an interest in electronics and approaches me almost daily. As my knowledge of electronics is limited, I provide guidance that leads him to research. Every few days he explains how he wishes to incorporate his new knowledge with his technology activities. Of course I encourage his enthusiasm.

Gradually my grade nine students engage in activities and begin to assume responsibility for their own success. My role as an instructor becomes a guide and a
facilitator of experiences. In other words I try to ease barriers to learning and provide opportunities for students to forge ahead in their area of interest. The process demands my willingness to become a manager of the environment and a guide for learning rather than a director of instructional activities.

Encouraging student responsibility appears to demand that teachers come to grips with the concept of transferring power to students, enabling them to make decisions, determine class direction and select areas of study. The instructor is virtually transformed from a teacher to a facilitator, providing more open opportunities for students.

I said, ‘I want to include you in decisions about the direction we will take as a class....would you like to continue with the modules or change to a new activity and return to the module later?’ A few students wanted to continue but the majority clearly wanted a change.

I feel that to pursue the goal of developing autonomous learners, a teacher first has to deal with one’s personal inclinations to default to a tried and true teaching strategy. As teachers we quickly learn to adopt classroom structures that work well and reject structures that cause disruption. As a result we tend to reuse the same structure over and over, refining and honing our skills in search of an impeccably run class. Certainly it is an unnerving experience to adopt approaches that eliminate proven strategies of a smooth running classroom.

What about the activity I just spent several hours preparing.... it was clear that to pursue my goal would be met with objection and would perhaps stifle the enthusiasm I was hearing.. I must admit that the thought of leaving the tight structure I have planned is a bit scary.
The concept of loosening controls and allowing students to assume responsibility for their activities, suggests potential for student failure, deviant behavior, and perhaps class mismanagement. In fact, inadequate monitoring of students’ ability to master such power may jeopardize the success of the experience. In reality, my role includes constantly monitoring the success of students, and their ability to deal with problems and maintain productive levels.

**Monitoring and Working with Students**

It appears that the teacher must play a delicate role in fostering student involvement, monitoring student progress, adjusting activities, encouraging progress and assisting with difficulties. Higgs (1988), indicates that the teacher needs skills for judging the capacity for students to assume responsibility and manage learning experiences. The teacher therefore, encourages responsibility by involving students in decisions, tailoring activities and providing continuous reinforcement of desired behavior.

For example, one of my objectives includes demonstrating to students that they have a role in making decisions about the class. In other words, to promote personal responsibility, I strive to communicate openness with students and provide a classroom structure that encourages decision making.

You know, I certainly want your input...and you also know that I believe in providing opportunities for you to take part in decisions about the class...so, perhaps we should look at another kind of activity. What do you suggest?”
My experience suggests that providing opportunities, which incorporate student involvement in the structure of classes and nature of activities, contributes to their sense of ownership and personal contribution. I find that when opinions of students are valued, they move a step closer towards personal responsibility. Such input is valuable for not only demonstrating acceptance but also monitoring student progress.

**Monitoring Student Progress**

It appears critical for teachers to closely monitor the level of enthusiasm and degree of progress when engaging students in technology activities. Students who become apathetic or frustrated about their work are more likely to lose their sense of responsibility and willingness to pursue success. As in the following example, student performance can diminish, affecting attitudes about the program.

I am noticing a change in their performance and attitude. I notice students are starting to socialize more instead of focusing on their work. It is as though they are becoming apathetic about the course or at least their activities in the course.

Something certainly feels wrong with the atmosphere in the class. I feel as though I have been riding on a wave of success with the kids and have suddenly coasted to a grinding halt.

I decided to speak with my best students to get a sense of how they felt.

While it appears crucial to keep track of the affective domain and the mood of the class at large, it seems more important to accurately monitor the ability of students to undertake responsibility and independently attain success. As indicated, students needed specific directions according to their particular stage of personal responsibility.
The fact is, that in such an early stage of the course, I deemed it necessary to monitor the students’ work and to provide continual assistance in order to ensure development in (a progressive) direction.

Successful development of student responsibility, relies on the teacher’s ability to monitor how each student is feeling about their work and gauge the level of challenge according to his or her ability. Equally important is the willingness of the teacher to adjust activities in accordance with student feedback.

**Adjusting Activities**

My experience indicates that by changing the requirements or altering the structure of assignments, one is able to maintain challenges that stimulate responsible action. The development of student responsibility does not appear to occur in a linear fashion but seems to involve moments of both progression and regression. In fact, the unique character of each class appears to dictate the rate of developmental progression and the direction of instructional focus. Several situations occurred in my classes deeming it necessary for me to alter the activity or change it all together.

... I tend to give them activities that require relatively significant problem solving strategies. Invariably, I am forced to back up and provide much more direction than I first anticipated....to overcome the dilemma, I take students back to a position of (they) understand and provide an opportunity for them to start again.

I asked a few students about their lack of effort and interest.

"*I don't know...Ok, I'll get back to what I should be doing.*"

I asked which modules they would prefer.

"*it doesn't matter...I don't know...*"

I took two students aside and quietly asked them, “how do you think people are feeling about the modules?...Do you think people are excited?
“well, no...I think people are tired of doing them.”

In light of my students’ comments and the number of activities of this type, perhaps it is time to unleash controls and give students more responsibility for their work and greater opportunity to make decisions about assignments.

Successful encouragement of student responsibility, appears to rely on the flexible nature of teachers to alter assignment requirements. On one hand, students may be stretched beyond their capacity to deal with particular challenges, while on the other hand, students may become apathetic with the rigor of inflexible activities. Adjusting guidelines to suit the individual needs of classes, seems to foster or restore levels of enthusiasm, drive and personal responsibility in students. The following is an example of my efforts to adjust an assignment to meet the developmental stage of a class.

The class made several comments about finding out information for themselves and taking each assignment on as a personal challenge. I can feel the level of enthusiasm growing as students see my position on the matter changing.... I said, “What do you think about the idea of taking on your next assignment as a personal research project...where you are responsible for researching and finding out all of the information needed for your topic and then producing a (product?)” “Yes! Lets do it...”

Reinforcement

My experience suggests that progress towards student responsibility resulted from continuous reinforcement of desired behavior. Throughout the year, numerous instances deemed it beneficial to reinforce personal attributes such as making decisions, solving problems and acting responsibly.

...you really have learned to take charge of what you are learning.... I see you tackling problems and solving them on your own....you should all feel very proud of yourselves....
When students are successful, it appears easy to encourage self reliance and personal development, however, it is more challenging to provide reinforcement for students with difficulties. Exactly how does one provide assistance for students, who are inadvertently on an unsuccessful course of action?

Providing Assistance

It appears that students need a type of guidance which continues to encourage self direction but does not rob them of opportunities to solve their own problems. Posed questions, given at the right time, provide a vehicle for me to help students visualize their direction. A key is not to tell students what to do, but to raise issues for them to critically think about and solve.

One student, for example, showed the class a beautifully constructed box which he tried to relate to earthquake analysis. I asked, "specifically what is the box for?...how do you plan to use the box?...It sounds like you want to create a vibration inside the box...do you think the box is big enough?...how do you plan to control the level of earthquake intensity and will we be able to see the testing of various building structures?"

When students are not progressing well my role as the teacher focuses on helping students discover their problem. In some cases the problem lies in their lack of initial planning and relevant topics.

The remaining students tried to look busy but it was obvious that they were shocked with the notion of having to perform and achieve results on their own.

about five or six students seemed to have a great deal of difficulty knowing exactly where to begin. It was apparent that little thought had been put into their assignment. In each case I had to talk about the projects with the students in an attempt to help them see a direction and a
feasible outcome. In many cases the students had to revisit the design and planning stage in order to arrive at an appropriate solution to the topic they chose.

Summary

When there are repeated opportunities to make decisions, solve problems and plan strategies, students seem to develop more responsible attitudes toward their education in technology. It appears that when such exposure is linked with activities, relevant to personal interest, students thrive and become very productive. Towards the end of grade nine, most students developed tremendous enthusiasm, resourcefulness and responsibility for their learning.

...students seem to become more resourceful and obtain information from a variety of sources. They often seek assistance from their peers and sometimes arrive at class with additional information.... Students start coming in after school and at lunch in order to try out (alternate) ideas...

Watching the students negotiate a settlement among themselves was like watching them function on a higher level. They have developed an ability to fit their own desire for learning into a format that has limitations. I feel that the students in this class are developing stronger and stronger feelings of autonomy and are determined to make their sense of self direction a reality.

...one student...is constructing a plastic pipe in the form of a telescope (while another) is working very hard each period on an electronic strobe device which he researched on his own.

Several students have created clips of animation and seem eager to fulfill a personal goal..

Four students seem to be experimenting with electromagnetism for the purpose of creating electric motors and magnetic levitation tracks.

The students themselves generated a high level of excitement. It is the students who identified interesting and exciting topics. It is the students...
who organized themselves into a workable team. It is the students who identified potential problems and generated feasible solutions. And it is the students who generated the necessary energy and determination to see their own idea become a reality.

Continuous encouragement of personal responsibility seems to help form positive attitudes that drastically improve the level of energy, determination and drive within the classroom. As in the above example, students who have been exposed to self-directed opportunities are very energetic and demonstrate a "take charge attitude." It appears that students begin to function in a more professional manner and become more capable of dealing with organizational issues and set backs. But most critically, they develop a sense of ownership, pride and independence, all of which represent important factors for the promotion of autonomous learners.

2. Independent Thinking

I have identified the development of independent thinking as a critical component for encouraging autonomous learners. My notion of independence should not be confused with independent study, but should be identified as a personal skill that fosters increased responsibility for one's learning over and above instruction (Boud 1988). Since personal autonomy implies self direction and self confidence, the process of thinking critically about one's action appears to spur the development of learner autonomy. However, students' recognition of their ability to establish direction, identify problems, analyze situations, and produce solutions appears to develop through opportunities to exercise such potential. As discussed in other parts of this paper, adoption of new habits and routines require time for students to absorb different modes
of operation and reinforcement to insure continuous progress. The following discussion
briefly examines historical influence on student action, demonstrates the development
of independent behavior and describes my encouragement of continuous student
progress.

In reviewing my data at various points through the study, differences are evident
in students' ability to independently manage their learning. On one hand, examination
of student behavior indicates that an overwhelming dependency on the teacher prevails
at the beginning of grade eight.

The new grade eight students seem well grounded in the process of searching for
answers, to virtually every aspect of their day...

What time is it?...where is the pencil sharpener?...is this OK?...what do I do
now?...is this better?...may I borrow a pencil?...my pen ran out....can I start
again?...

While on the other hand, grade nine students with experience in problem solving
challenges appear very aware of their ability to independently examine, analyze and
resolve situations as they occur. Many students demonstrate personal empowerment
through engagement in their work and seem unrestricted by needs for outside approval.

form companies of four...(and) decide on ... and produce a proto-type
product...produce a TV commercial which supports the promotion of your
product

One company team devised a skit to attract and entertain their audience. They
found a unique route from boredom with their new three dimensional checker
board game. The product was complete with a TV advertisement and a
professionally designed package. Their container was beautifully designed with
a logo, product name and product highlights on the back. It included a plastic
window for clear view of internal compartments for various game pieces, and a
booklet of rules.
As demonstrated above, many students adopt very professional approaches to virtually all aspects of their work and operate independently of teacher assistance. As this example represents the fulfillment of a developmental continuum, it is important to recognize the point at which students began such personal growth.

As Candy (1988) indicates, it is critical to first recognize the historical methods of learning and practice which make up students’ understanding of their role in school. In fact, students new to the concept of independent behavior, seem unaware of their ability within the context of a school environment. Through most of their education, students have been trained to raise their hand for just about everything. It may be to answer a question, request assistance, use the pencil sharpener, or simply find something, regardless, students have had years of experience at gaining instant assistance. My reflections suggest a possible rationale for such behavior.

I recall numerous situations where students wait until all instructions have been given, only to respond with, “what do we do?” So it stands to reason that if students are placed in a new situation, where they have not been provided with a demonstration or lesson, they will default to hand raising rather than attempting to satisfy needs themselves.

Students are so accustomed to asking that they often don’t even think about trying to address simple issues themselves. Instead they simply raise their hands....When I make students aware of what they have asked, they often respond with, “Oh, I didn’t think about it.”

As all good teachers are geared towards helping students, I think we have a built-in tendency to address all student needs. It seems that both students and teachers have deeply rooted habits. My reflections suggest the type of behavior teachers may be encouraging.
In essence, we train students to rely on us for many aspects of their personal and educational needs and desires. Ironically, instead of promoting independent behavior, educators may, in fact, be encouraging dependent behavior by satisfying countless student requests.

Habits certainly can be changed, however for myself, it has been difficult to master the art of redirecting questions. As Boud (1988), Candy (1988), Higgs (1988) and many others argue for the development of independent behavior, I feel that where possible, it is more beneficial to encourage students to address their own needs through self reflection and examination of their own questions. I suggest that simply redirecting questions back to students is one step forward in the development of autonomous learning behavior.

I encourage students to look for the pencil sharpener themselves, seek the opinion of their peers, examine their own work, look for a solution to their problems themselves. I will often ask students, to indicate...what steps they have taken regarding their difficulty or problem.

Early in the study I engages new grade eight students in a variety of exercises and assignments which encourage personal development and focus on independent thinking. As a simple activity the class, in teams, was asked to provide their opinions about two products and to engage in their development of related ideas. In the beginning many students reacted with bewilderment and uneasiness towards the freedom to reply as they wish.

It became apparent that many students still were not sure just what to do. I reiterated that they were to discuss as a team and arrive at a team opinion about each characteristic of the product. Several hands began to appear with, “Mr., Rietchel, should I say what this is for....should we describe what this is...how much does this cost...what is marketability...what should we put for appearance....” I answered each question with, “what is your opinion, I want your team’s opinion about each characteristic, not mine!”
Students often seem afraid to make a move without first consulting me. As in the *product evaluation* assignment above, when asked for their opinions, students respond with, “what opinion should I give.” As indicated, students are looking for the correct answer instead of thinking independently.

Although I stress the openness of the assignment, students continue to seek my approval before generating something different or original.

...students tend to rely on others for solutions to their problems. I find that when something does not work...their usual reaction is to simply ask me to fix the problem. If they don’t understand something, rather than trying to figure it out, they rely on outside help.

The primary purpose of the *product evaluation* assignment is to, right from the first day, encourage students to value their own opinion and seek personal credibility rather than teacher acceptance.

Eventually, each student began to realize the process and focused on their team instead of me....Each team analyzed and discussed the characteristics of a triangular ruler (architect’s scale)....the analysis of the second product was more (expedient).

By redirecting questions back to students and sharing assignment objectives, students seem to gradually accept responsibility and begin generating answers.

It is apparent that generating independent behavior is, in part, simply a matter of convincing students to incorporate skills from their daily life outside the classroom.

The following discussion deals with the strategies I use to relate these skills to independent learning in technology education.
To encourage student development, I incorporate the notion of the "independent learner" as a vehicle for stimulating independent behavior. It is used to deal with the simplest question about the location of tools to more complex issues related to student projects. The following example suggests a formal approach for introducing this concept to students.

After gaining the attention of all students, I said, "what does it mean to be an independent learner?" Students replied with, "it's when you learn on your own...it's when you teach yourself something...it's when you read and learn something...etc." I said, "that's right, being an independent learner is all about teaching yourself about a topic or learning without the assistance of someone else." We discussed several examples and then I asked the class, "how many of you can program a VCR to record a TV show on another day?" Most of the class raised their hands. I then asked, "How many of you were taught by someone else?" Two or three students raised their hands. I asked, "How many of you read the manual step by step?" Two students raised their hands. Finally I asked, "how many of you just plain figured it out on your own?" The majority of the class raised their hands. I said, "you see, you are all independent learners already and that's how we are going to begin to operate in this class."

Students can be taught to use the same methods of problem solving that they employ in hobbies, sports, and other personal interests, either with or outside school. In these more personal areas of interest, students often become much more resourceful, innovative and creative. Becoming an independent learner involves a process for adapting skills learned at home to learning at school.

As students begin to accept new strategies for dealing with daily problems, continual reinforcement seems to ensure growth and diminish dependent routines. Students need new forms of assurance and daily reinforcement that promote risk taking, locating equipment, examining difficulties and finding solutions to problems. I
incorporate a variety of methods for reinforcing good habits and developing positive attitudes about learner independence.

Numerous times throughout the class, I deflected their questions and reiterated the notion of being an independent learner. Fewer and fewer questions were asked over the next three or four classes.

I concluded a lesson by asking in a loud voice, “now what kind of learners are we...? In a loud roar the students shouted, “INDEPENDENT!!”

After about fifteen minutes a girl in the class, approached me. I said, “What kind of learner are you?” She replied, “oh ya, I forgot, independent.” I asked her if she could come up with an answer to her question and she sincerely answered, “oh sure, I can just take a piece of wood and...”

Through continuous reinforcement and new daily routines, students appear to gradually function more on their own. By incorporating the notion of the independent learner, I have noticed that students do rely more on themselves and begin to see problems as challenges. Challenges become personal and seem to become a measure of each individual’s personal ability. My reflections suggest that students appear to reach deeper inside and find greater energy and determination for solving such challenges.

I have a sense that students are beginning to ask themselves questions about what to do next and what to incorporate into their designs. I also have a sense that these students are becoming accustomed with making decisions about their work. Gradually students are making fewer requests for my permission to add particular details to their designs. Instead they are suggesting ideas and showing me what they have created.

I am convinced that the quality of work can increase if students feel challenged on a daily basis. For this study I incorporated six learning modules that challenge students and develop their skills through three levels of activity. Learning modules are a set of activities which I developed for the purpose of promoting independent learning skills, problem solving skills and technological literacy. Students actually work in
teams of two, solving problems that arise and teaching themselves new skills. As Howe and Thompson (1981) suggest a partner provides a degree of mutual support by continuous and immediate feedback. Independence is generated through continuous problem solving and deviation from normal solutions. They are required to experiment with computers and other devices, plan strategies and meet challenges for each activity. These students gradually show signs of taking charge over the direction of their classroom activity.

I notice that several students are becoming quite eager to find innovative ways for dealing with the challenges involved with each module. They don’t seem satisfied to simply recreate what other students have produced. One student approached me today to inquire about going beyond the given task of a 3D studio module. He is one of several students who have been coming into the classroom at lunch and after school.

Towards the end of my grade nine portion of this study, it is clear that many students developed a sense of independence and confidence to direct and facilitate appropriate action, independent of teacher direction. In most cases, students arrived at topics on their own and developed strategies for pursuing some very complex projects and goals. Most students found resources on their own that included literature, equipment and supplies. Many students displayed an ability to make choices, and employ skills learned either at home or in other classes.

They began by explaining their goal and how they approached the problems they ran into. They explained how their first step involved teaching themselves about the 3D studio program....The students talked at length about each problem and how they solved each situation. It was obvious that they were very proud of their accomplishments....They explained their use of resources, with not once mentioning myself as their teacher. The two girls commented on their independent learning approach....
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Over and over again, the students in this class demonstrate the ability to become self directed learners. They strive to anticipate difficulties and identify problems. The students communicate with team members, establish a strategy and arrive at a schedule for working on solutions.

Many students are also incorporating skills acquired either at home or in other courses. For example, one design team chose to prepare a plastic game board by sandblasting the surface and polishing the edges. Another team is incorporating scanned images with their advertisement and are investigating the use of various sound effects.

A key to the development of learner independence is to allow students to actually operate independently (Boud, 1988). The latter portion of this study included self directed projects where students chose an area of technological study, established an appropriate outcome and made a commitment to meet a challenge. Several students were empowered to produce very high quality projects that could, in fact, be misconstrued as the results of commercial professionals.

One team produced a proto-type Fooze Ball game which includes unique rules and is played differently than existing models. The production department designed and produced all the integral parts including a board arena, control rods, handles, goal ends, and individual figures. Each part is painted, decorated and assembled, to form a colorful and inviting product. The accompanying computer generated video goes far beyond my expectations of grade nine students. The marketing department of this company produced a very dramatic TV advertisement....The music grabs you and virtually forces you to watch a close up view of a ball that drops onto the board with a thunderous beat. The music beat continues as you, the viewer, are placed on the arena floor and given a close up view of the figures as they battle for a goal. The impact on the audience is spectacular!

Continuous reinforcement, then, seems to bring students to a professional level of responsibility and encourage their involvement in challenges, as illustrated by the above example. Some students choose to work with partners while others choose to work alone. In some cases students need support while in other situations, students
unite in order to generate larger outcomes. The concept of being an independent learner encourages students to rely on themselves, and trust their own judgment and intuition when faced with technical problems. It’s a process of developing greater self reliance and self confidence. Since personal autonomy is indicative of self direction and independent thinking, the development of independent behavior in the classroom is an essential step towards learner autonomy.

3. Intrinsic Motivation

The promotion of intrinsic motivation is evident throughout this study and a major focus for virtually every technology activity. Several authors including Deci and Ryan (1992), Howe and Thomson (1981), and Tumber (1991) suggest that student motivation is critical to the development of autonomous learners and indicate that if students are intrinsically motivated, they become interested in learning and excited about creative problem solving. As Tumber implies, when students are placed at the center of the learning process, they are more likely to become motivated.

My classroom experience reinforces that of Tumber and in particular Betts and Neihart (1986) who discuss the importance of cognitive, emotional and social development as an integral component of learner autonomy. My data suggests that a student centered approach to learning helps students become emotionally attached to their work thus forming highly motivated individuals capable of significant problem solving. As Howe and Thomson (1981) imply, I find that when the desire for learning comes from within students themselves, they become more innovative, enthusiastic, energetic and determined to achieve their goals. In essence, as they become internally
motivated, goals for learning are established by the students as personal objectives. A spiraling pattern of motivation seems to emerge, as students begin to connect with their learning.

The students' affective connections to school work, seem to stimulate personal goals. Concurrently, personal goals foster a sense of drive and determination, thus creating further attachment with their work. It is a process that seems to foster cyclical development of intrinsic motivation. The following discussion elaborates on such development and illustrates the strength behind intrinsic motivation in developing autonomous learners.

Throughout my study experiences range from very extrinsic influences on motivation to significant levels of intrinsic behavior. In both the grade eight and nine classes some students demonstrated behavior indicative of highly motivated self directed individuals while others clearly displayed little motivation and relied on my influence for their success.

Early in the study, grade nine students were assigned a transportation activity and challenged to power a vehicle with a mouse trap. Many students arrived at unsatisfactory solutions and remained very inflexible about alternate methods of accomplishing the task.

In the beginning, many students did not seem very interested in the activity. They really didn’t have much to say. I continued my attempt to stimulate interest through discussion of competition, challenges, teamwork and personal satisfaction. Gradually interest grew for some students; however, I tend to think that it had more to do with a personal attachment to their work than my attempt to inspire the class.
It appears that many students do not have the natural drive, interest, motivation or will to demonstrate their individual potential.

Towards the end of the study, students portrayed high levels of energy, drive and enthusiasm, and demonstrated positive attitudes indicative of highly motivated individuals.

I am overwhelmed by the professional nature adopted by many students for meeting the challenges of this last activity. The students' positive attitudes are evident in virtually all aspects of their work. Their methods of communication with team mates, their organization of tasks, and their degree of product excellence are a testament to the students' professional level of responsibility. Most employers would be delighted with the kind of dedication and drive, displayed by these students.

It appears essential to encourage students to build positive attitudes, establish confidence, develop self esteem and make personal connections in their world. Such attributes appear to form a good foundation for intrinsic motivation and are encouraged by teaching strategies that develop self confidence.

**Self Acceptance / Self Esteem**

It is apparent, that until students recognize their answers, suggestions or solutions as viable and important input to problem solving, the development of intrinsic motivation is unlikely to occur. In this study, new grade eight students needed a tremendous amount of personal acceptance when dealing with simple design assignments.

Many requests from students are simply to gain my acceptance for their decisions or their work. Several students asked, "is this OK...what do I do now...what about...." For several days many students would not work on an
assignment for more than five or ten minutes at a time. At this point, I think it is important to fulfill their need and provide (the) reassurance (they seek).

At early stages of development, it seems more appropriate to insure self acceptance and to reassure students' decisions about their work. Students will be “testing the water” and need reassurance about their safety before venturing into more risky behavior. For the moment, such acknowledgment actually reinforces dependent behavior, however, I view the promotion of self acceptance and self esteem as more important, as it builds a solid foundation for encouraging independent behavior. Through positive reinforcement and specific learning strategies, students eventually gain confidence and comprehend their ability.

I incorporate interactive lessons as a strategy for including students in discussions, stimulating their thinking patterns, building confidence and providing acceptance for their thoughts. It provides a viable method of drawing on quiet students in order to demonstrate the value of their opinions. By simply incorporating questions that address design issues, for example, one has opportunities to confirm acceptance for “who students are” and “what they say.” It is an opportunity to help students build self confidence.

I used the lesson to pull from almost every student. It felt as though each student had to be connected with the lesson in order to gain acceptance for their idea.

...give me ideas of features found on a house....students responded with doors, windows, patio, chimney, balconies and landscaping etc....they became very excited shouting out items they wanted me to include....a house design was created from the students’ ideas. For the first time most of the students seem to have lots of energy, were highly motivated and very enthusiastic about their chance to be creative.
Once students begin to generate concrete outcomes, it appears most beneficial to focus praise on creative ideas. The act of reinforcing desired behavior is certainly a strategic maneuver, embraced by educators for years. It seems suitable to reinforce any behavior that inevitably leads to intrinsic motivation.

I like the way you solved that problem...It’s a great idea.

You’ve put a lot of energy into this...

I looked for the inventiveness in each design and pointed out details unique to each individual.

Once students begin to feel safe, comprehend their ability and obtain acceptance, they become more creative and willing to try inventive ideas. Grade eight students, for example, begin to operate more on their own, take small risks and become more creative.

Most students were working on their third design and seemed eager to place new ideas on paper. Throughout the hour, several students spoke to me about their work and demonstrated a lot of interest in trying new ideas.

The number of questions diminished and several students began helping others....the process of helping others seems to put a smile on students’ faces....the chance to assist the “normally brighter” kids is a chance to...build confidence in students who normally have a lower self esteem.

Encouraging students to help others is a tremendous strategy for building self esteem. In particular, weaker students become quite elated with opportunities to demonstrate newly discovered skills. In a few cases, normally high achievers became more humble, appreciative and accepting of students who obviously possess other skills.

As a teacher, my goal in the first few weeks of class was to build positive attitudes and to help all students accept themselves as valuable members of the class.
At a critical point in this study, the process of steering new grade eight students toward learner autonomy was a bit of a revelation for me.

*Decide on the type and design a building... the sky is the limit... add to your building frame or take away parts... add doors, windows, arches, furniture, landscaping, etc... now do everything in your power to produce an incredible design*

I now believe that I am guiding the students through a process of self acceptance. Each lesson and each activity has been geared to draw from students in order to help them realize the importance of their own personal opinions and ideas. I want students to value themselves as significant members of the class or team and to recognize their ability to think critically and be creative. I am encouraging students to see the extent of their potential and to realize the possibilities ahead... I want them to choose a direction and create for themselves, a design that demonstrates who they are. I want them to recognize their self worth and understand the value of their thoughts, ideas and decisions.

I have identified strategies for encouraging self acceptance, self esteem and positive attitudes in students, however, the element of *personal connections* stands alone as critical to the development of intrinsic motivation.

**Personal Connections**

It is apparent that for students to become intrinsically motivated, some form of personal connection with their work is necessary. Much of my time in motivating students is directed towards helping them find relevant meaning in their education and form emotional attachments to their activities. In essence, as students develop personalized feelings about success, they begin to intrinsically set goals, plan strategies, look for solutions, and test ideas. Inevitably, students become more deeply immersed as their work progresses. The role of the teacher includes helping students make these connections.
After a few minutes of discussion, each student had an opportunity to describe one special event to the class. Students talked about meeting old friends, winning hockey tournaments, going to Disney Land, traveling to Europe, and special birthday parties. The whole process, which took about ten to fifteen minutes, was very successful as a stimulating event for a new topic.

I find that when students are asked to talk or write about important elements in their life, they often become quite excited and willingly demonstrate the significance of events.

A student who is normally quite disruptive and difficult to motivate, handed in a superb description of his special event. I asked him if he would be willing to read his description to the class. The class listened intently and applauded the student’s effort. He was very sincere and obviously very proud of his experience.

As in this case when personal events are linked to school activities, the process becomes a powerful stimulator for new classroom experiences. These students planned and designed picture frames which represent pictures of important events in their lives. Personal connections seem to spur learning beyond the scope of normal assignments.

Fundamental to an autonomous learner, is the notion of personal meaning and an understanding that learning goes far beyond the activity at hand. The intrinsically motivated learner seems to find reasons for addressing tasks that go beyond course requirements and encompasses personal endeavors. For an autonomous learner, personal satisfaction and interest become the driving force behind his or her effort.

It has become obvious that the students in this class are not putting in time to simply complete an assignment, but are here to achieve the high goals they have set for themselves. It is apparent that their work is very personal for them.

The emotional attachment that students make form a powerful influence, however, significant time is often necessary in order for students to absorb the intent of
activities. In reviewing my data, it is clear that in some cases, students were not
motivated until a secondary event occurred, stimulating their interest.

It is quite interesting that most students did not really become interested until
after the test flight day. Once students saw the potential of a rocket, they
developed a renewed interest in what they were doing....once hooked by the
challenge, student enthusiasm took off and they began inventing new methods of
rocket control and devising new ways of individualizing their work.

Even my worst case scenario turned out very positive in the end. A girl in the
class who had nothing to show, even after several weeks of class time,
developed an entirely new attitude towards her work. After several
discussions...she thought about an area that truly grabbed her interest.
Photography was all it took....

In other words when students are given time to make connections they become
personally challenged and their level of enthusiasm, drive and determination rapidly
improves. It is as though students come alive and are transformed into motivated
problem solvers. Gradually they assume responsibility and become excited about the
potential of activities.

The smiles on their faces...showed how proud they were and confident (of their
work)....their success seemed to motivate them even further....The fun and
excitement generated from this (mock-cyborg demonstration) experience seemed
to motivate the whole class. It is as though I could almost feel a higher level of
energy, generated by the student’s enthusiasm towards the course material and
the tech. ed. environment.

The examples outlined, demonstrate some of the methods I use to promote
intrinsic motivation. In many cases students are stimulated by an internal source and in
some cases I play an important role in stimulating their engagement in productive
activity. My data suggests that strategies, which move students toward intrinsic
motivation, represent a major component of my pedagogy.
I concluded the lesson by saying, “this is an opportunity for all of you to become unbelievable architects... your friends and family will be amazed at what you produce.... the sky is the limit... you may add to your building frame or take away parts.... it is a wonderful opportunity for you to show everyone what you’re capable of.... now do everything in your power to produce an incredible design... go for it!!”

I probably expend more energy and put more effort into student motivation than any other type of lesson. Certainly I incorporate a variety of methods for teaching specific skills, but the time taken to adequately help students generate a reasonable level of excitement surpasses that of most other curriculum elements.

Much of this process was observed by an experienced teacher.... He was very surprised at how much time I devoted towards introducing a new topic and motivating the class.

As time devoted to motivational strategies helps students make connections, engaging in class discussions also appears to promote important motivational elements. I use a stimulating video (Heard & Mikuriya, 1991) to incorporate affective elements in a lesson and to introduce students to related topics. In reviewing my data, grade nine students were able to generate comments that appear to reflect their feelings and describe many aspects of motivation.

“It’s about drive..... It’s about determination..... it’s about hard work..... it’s about being enthusiastic...” I then asked, “so what connections do you see for our classroom?” Several students saw the connection to what they were about to undertake and commented on the importance of developing an appropriate attitude towards their work.

When I first asked the class about the video, they naturally said, “It’s about math.”

However, as I requested more, the students seemed to have significant insight to the
meaning behind the video. The process provided a terrific stepping stone to engage in
deep discussion and to relate student’s answers to their projects.

**Developmental Progression**

In analyzing my reflections, it is apparent that students became intrinsically
motivated once they made a personal connection with their work. In almost every case,
motivation played an important role, in the success of each student. Even at the
beginning of the grade eight course, students displayed some degree of internal
motivation. For example, several students chose to take design assignments home, went
beyond my expectations, and accomplished quite professional looking drawings.

Anyone looking at the very first set of drawings this class turned in, would be
truly amazed. Many students took their work home and obviously put endless
hours into their design. Many students went far beyond my expectations and
created beautiful house designs with incredible detail, showing difficult aspects
of drafting such as stairs, archways, wrought iron work and interior views.

Changes through my study, however, seem to illustrate two particular
differences related to the origin and duration of intrinsic motivation. Firstly, although
most students demonstrated a sense of internal drive, when compared to new grade eight
students, the origin of intrinsic motivation was different than for experienced grade nine
students. On one hand, grade eight students became excited about their activities after I
engaged them in a series of motivational exercises. On the other hand, many
experienced grade nine students became excited simply about the opportunity to engage
in activities.
Towards the middle of the study, grade nine students began to develop motivation for activities themselves. It was no longer necessary for me to be a role model, demonstrating high levels of motivational energy. In fact, many students initiated ideas and demonstrated significant levels of intrinsic motivation. At times I felt like I had to hold them back in order to maintain a sense of organization and order to my class.

...they were so enthusiastic that I had to go to extra effort to focus them on some of the guidelines for the activity. Before I had finished the students were trying to talk about what they could develop, who would be in their company and how they would go about producing an outcome.

Two students stopped me in the hall to announce their ideas....as I was passing through a math class, one girl said, “Mr. Rietchel, you know what we’re going to do in tech....we’re going to produce a three dimensional chess game.”

Secondly, the length of time that experienced grade nine students are able to sustain intrinsic motivation far surpassed that of grade eight students. With these latter students, I often find it necessary to reinforce motivation, insuring that a stimulating level is maintained. However, most of my grade nine students become so intrinsically motivated that I simply monitor their work and assist them with supplies and equipment. After being absent for five classes in a row, I was overwhelmed with the sense of pride, ownership and high degree of motivation generated by these students.

What is particularly impressive is the sense of pride, ownership, and teamwork evident with each group of students. No one seems to be “sloughing off.” The students have smiles on their faces and are eager to show me their work. Even students who I expected to take advantage of my absence, are progressing well and are working towards completion. Finally, many of the company members refer to their partners success in dealing with other aspects of the assignment. Students seem particularly proud of their personal involvement and coordination with other members of their company. The students seem to like their roles and play a big part in determining the direction of their product campaign.
As discussed throughout this section, the root of what drives an autonomous learner is internal motivation, evident through displayed enthusiasm and independent progress towards a personal goal. Through the duration of this study, most students made connections with their work which empowered them to initiate ideas, identify problems, create solutions and accomplish phenomenal tasks. One student in particular stands out as an example of unprecedented intrinsic motivation.

A key element of Ken's work is the level of effort and energy that goes into his product. He knows that his assignment goes far beyond the requirement for a top grade in the course. I am convinced that his efforts represent a personal objective to succeed and achieve the high standard he has set. In other words, his drive is predominately internally motivated. He wants to achieve his best. He is driven to spend whatever time it takes to reach his goal. A key to his success is that his ambitions are a reflection of his goals, not the goals of others.

As the study progressed, this student appeared to develop an increasing sense of self direction, and insight to his desire and determination towards his goals.

4. Problem Solving

Even though personal responsibility, independent behavior, and intrinsic motivation are identified as fundamental to the promotion of autonomous learners, I recognize problem solving as an essential component for delivering these three elements. In reviewing my data, it is clear that problem solving provides a vehicle for encouraging students to adopt positive approaches toward self direction, self acceptance, independent thinking, group work, personal attachment, and take charge attitudes. Howe and Thompson (1981) imply that a problem solving model which incorporates critical thinking skills, plays an important role in developing personal
admiration and self respect. Higgs (1988) suggests that activities which involve students in problem identification and resolution, increase their ability to function as life long learners.

My view of technology education is supported by Braukmann and Pedras (1990) who see a problem solving model as excellent preparation for meeting the challenges of a technologically changing society. My data also supports their argument for the inclusion of a problem solving model as a viable teaching strategy for generating interest and motivation in student work. For example, grade nine students seem to react favorably towards challenge based activities which require them to solve closed problems.

...their success seemed to motivate them even further to quickly take on the challenge of a new module....I could almost feel a higher level of energy, generated by the student’s enthusiasm toward the course material....

A problem solving model represents an underlying foundation which supports all aspects of my program and goals as an educator. It plays a role in virtually every activity and includes simple daily routines as well as major assignments. The remainder of this discussion focuses on problem solving as a vehicle for classroom delivery and three supporting elements, critical to the success of my model.

- the rate of development in undertaking problem solving challenges
- the importance of success in managing problem solving exercises
- task and structure as a means of organizing problem solving activities.

Since the success of problem solving activities are a function of many aspects of pedagogy, it is important to recognize that the above topics are interconnected and
should not be considered independent in any format. However, for clarification, the following discussion deals with each aspect separately.

**Problem Solving as a Vehicle for Classroom Delivery**

All aspects of this study involve students in a problem solving model, that places students at the center of the learning environment and actively involves them in the learning process. In many cases, students are presented with challenges which require them to independently identify and solve problems in a responsible manner.

produce an advertising poster about (your) notion of technology and arrive at an overall theme make a strong statement to attract public interest.

As the assignment represents a closed problem with loose parameters, the students will have the opportunity to make decisions about many factors involved in the project. They will arrive at a theme that has meaning for them today. They will employ their design skills to deliver an impression of how technology relates to them. They will choose what resources to use, and teach themselves how to use resources. They will plan when to apply their energy, and determine the degree to which they will employ their creativity.

As in the above example, I attempt to provide opportunities that create platforms for students to launch their work. My goal is for students to use these opportunities as starting points for more learning in order to discover the extent of their potential. Even small opportunities seem like important steps towards learner autonomy. I make every attempt to incorporate even the smallest challenge into the daily life of each student in technology education.

Students were (asked) to select the five most important characteristics, use a check system and decide on which product they felt was the best.
The last section of the worksheet requires each team to think of five features for assessing each student’s document. I said...“Imagine that you are the teacher...what would you want to look at when giving each assignment a mark?”

As in the above examples the identified challenge involves simple choices, represents minute problems and requires about five or ten minutes to resolve. Since no technological equipment is involved, other than pencil and paper, they provide a short easy method for introducing the concept of problem solving in its simplest form. My objectives focus on familiarizing students with critical thinking processes and guiding students towards more elaborate problem solving activities.

...you will form companies of four and as a team you will decide on an appropriate product....Two people will use the manufacturing facility and produce a proto-type product.... and the other two will produce a TV commercial which supports the promotion of a product....As well the company will have to decide on who will produce a professional package for the product and finally the whole company team will perform a product campaign presentation at the end of the fifteen day period.

On one hand, students are involved with major challenges such as identifying appropriate problem solving topics, gathering information, developing potential solutions and producing practical outcomes. On the other hand, students are required to independently address simple tasks that teachers would normally provide some direction and guidance to. In other words, my goal is to provide as many opportunities as possible for students to engage in decision making, problem solving and self direction. A key to achieving such goals seems to reside in the rate at which students are able to take on challenges and successfully produce practical outcomes.
The Rate of Development in Undertaking Problem Solving Challenges

It appears that a significant period of time is required in order to encourage students to exercise self direction with problem solving activities. Although teachers may visualize students as autonomous learners, in fact, such a goal is developmental in nature and is acquired through a lengthy process. As the process involves time, students appear to require time to absorb and practice aspects of critical thinking. In examining my data, it is evident that as these skills improve over time, the degree of challenge that students are able to manage also increases.

As with any significant change, one must be patient and allow for gradual implementation. I find that by being consistent, encouraging students to try again and increasing my expectations, students do adapt to a new way of thinking in technology education. They develop greater self confidence, rejoice in their success and enjoy prospects of even greater challenges. The extra patience needed for the gradual development of independent learners, is extremely rewarding and satisfying for both the students and myself.

By carefully monitoring students needs and by providing just the right degree of challenge, students are encouraged to become self directed. It seems that one must find the appropriate challenge to insure continuous progress, yet protect against over ambitious optimism about student ability. For example, it is evident that some of the activities I used in this study were beyond the capability of many students.

The goal was to apply direct energy to the wheels. Many students could not find a solution and insisted on using a type of simple slingshot which defeated the purpose of the exercise.

As I am eager to see students develop, I tend to give them activities that require relatively significant problem solving strategies. Invariably, I am forced to back up and provide much more direction than I first anticipated. In effect, I feel that I am actually promoting dependent rather than independent behavior.
By inadvertently developing dependent behavior, one may actually reverse the course of action that moves students towards learner autonomy. It seems most appropriate to take caution and move in small steps forward to provide a solid base for further student development. As in the following example, the penalty for ignoring such steps, resulted in a reversal of my attempt to encourage learner autonomy.

I found myself imposing further restrictions in order to steer students in the right direction. I was naturally very concerned about the success of the assignment. I also found it necessary to further teach students about various simple methods of energy transfer which I assumed they would be able to discover on their own.

In an attempt to break new ground and expand a repertoire of teaching strategies, one is bound to falter, gaining experience that leads to greater stability. The above episode, for example, encouraged me to find more appropriate levels of activity, thus resuming my goal.

...I know that students are capable of my higher expectations. I have decided to revert to a set of activities that will provide opportunities for students to work as independent learners and meet simple challenges with each outcome.

By incorporating an activity growth plan that gradually increases the degree of challenge, students appear to move closer towards learner autonomy. Reflections on my observation, for example, reveals a change in student behavior.

As I think back to the level of learner autonomy prior to this assignment, I am convinced that most students have grown through the work they have accomplished over the last several weeks. In each case, students selected an area of study and identified a problem. Students conducted their own research, developed plans for producing an outcome and addressed numerous difficulties throughout the process.

When students are given significant time to adjust to new ways of thinking, they appear to graduate towards self direction. It is evident through my data that students became
more resourceful, and found reasonable solutions to problems that occurred as daily experiences and long term objectives.

...their ability to deal with complicated details has substantially increased. Students seem to be less inhibited and more open to alternative ideas....Students are generally more innovative and have a greater sense of realistic solutions to problems. They are serious about their goals and determined to be successful.

The pace that challenges can be increased appears closely linked with students' willingness and ability to take charge of their learning. It is apparent that the degree of student success in problem solving exercises, played an important role in affecting the speed of student progress.

**Continuous Student Success in Managing Problem Solving**

The degree of success that students experience in problem solving activities seems important to the development of autonomous learning habits. Such success is an apparent necessary step towards critical thinking and independent behavior. In their attempt to take risks and expand ideas, students in the early stages of development must have guaranteed success. If students have not gained significant confidence, they appear to revert to dependent behavior when faced with problems. When not successful, there is significant potential for students to abandon individual effort, and revert to outside assistance for solutions. Inevitably, the teacher becomes a back-up for student failures. As described below, the role of the teacher in ensuring successful opportunities seems critically important for new grade eight students.

I view my own teaching position as one that provides opportunities for students and assures them (of) successful outcomes. If students are to develop self
direction or autonomy towards learning, I really believe that students must experience success in...decision making....

Avoiding important aspects of student development may deter the growth of learner independence and autonomy. As discussed previously, grade nine students relied heavily on my input for solutions to their mouse trap vehicles. However, opportunities that guarantee success in decision making appear to stimulate growth, foster confidence and develop learner independence. As discussed, the product evaluation assignment guarantees student success. The products are not actually produced thus any and all inventions are acceptable.

Students need to feel that their answers are acceptable and contributions are worthy. Short term exercises with guaranteed success, such as questions with no specific right or wrong answer, provide a method for building student confidence. Such questions lead to answers which are easily accepted by peers and recognized as contributions to a task.

Half the class indicated product one while others indicated product two. I said ..."is there a correct answer?" The class responded with a resounding "no." I responded, "I am not looking for the correct answers but only (your) opinions which of course are not wrong."...(students) dealt with characteristics in relation to marketability, productivity and environment, etc.

I also incorporate self evaluation as a means of providing successful outcomes for new grade eight students. In the example below, teams of students were asked to evaluate effort, quality of answers and ideas.

Finally, each team had to agree on the mark that each team member would receive, either A, B, C+ C or NOT DONE.
Emphasis is placed on recognition of each student’s contribution to a topic.

**Encouraging Success**

As students begin recognizing their ability to generate appropriate ideas and strategies, my role as teacher in ensuring student success seems to shift, focusing on providing encouragement and feedback. Over time, students appear less vulnerable to failure and more apt to take risks. In reviewing data, my role became more useful by rewarding the success of students in mastering problems and challenges.

Today I spent the first few minutes of class recapping the success that students achieved in the last project. I said, “I have to tell you folks that I am very impressed with the enthusiasm and effort of almost everyone in the class....It seems that you really tried your best to meet the challenge and I would say that most of you were very successful.”

Positive reinforcement of desired behavior seems to elicit more of the same, however, there are also situations where students take much longer to generate successful outcomes. As in the example below, some students need conventional strategies to elicit positive outcomes.

For the few students who were not ready to complete a presentation, I employed a variety of strategies to insure their success. Some were required to come each day after school. I made several phone calls to parents and involved the counselors with each student. In the end each student eventually completed their work, performed a presentation and (were perceived to feel) quite good about their, late, but complete assignment.

As students progress and develop problem solving skills, it appears valuable to involve them in the establishment of successful criteria. It seems that by encouraging students to think about “how to be successful,” they set higher goals and work harder to achieve them. In reviewing my data, criterion evaluation was used with the “individual research
assignment" to encourage students to arrive at their own parameters for success.

Students, essentially, established their own criteria for completing this assignment and obtaining a good grade.

...we conducted a discussion about the criteria for successfully choosing three suitable topics. The student provided all of the parameters....What is particularly pleasing is that the students who were difficult to deal with during the class before, were volunteering many of the criteria.

Gradually, students appear to rely less on the teacher and begin to assume responsibility for success themselves. Failure to solve problems actually appears to generate new challenges for students. As in the following example, students who have had lots of exposure to self directed problem solving, begin to view difficulties as personal challenges.

Two (grade nine) boys tried numerous alternatives to accomplish magnetic levitation. They incorporated many different materials and methods of creating magnetic fields with only minute...success, but still they persevered. The boys used every resource available to...reach a solution, but still no success. When they finally began to see positive results, it was only temporary as their magnetic system seemed to gradually erode. Rather than quit, they started again and eventually achieved success.

These students seem very much in tune with their ability, their aims and their challenges. They want results and appear determined to achieve success. The rewards for success have advanced far beyond academic recognition, and provide personal satisfaction and recognition for their innovative accomplishments. As in the following example, many students gained tremendous self satisfaction and respect for their work.

The class and myself were very impressed with the professional nature of their product. I commented to the performing team, “you know, you have come up with a product of great potential....if any of you ever have the opportunity to present the idea to a real marketing firm, it could result in a great success....I
think you really have something there....it looks so much like a realistic product with potential....be sure to let me know if it ever becomes a reality.”

The role of the teacher in providing encouragement seems to change further as students begin establishing personal success as a goal. Since these goals are intrinsic, the enthusiasm and support of the teacher is also valuable through acknowledgment and celebration of student success. The process creates a positive experience for most students, enhancing their enthusiasm towards further assignments.

I took about ten to fifteen minutes to express my thoughts about their work and to use the opportunity to celebrate their success. I looked for the inventiveness in each design and pointed out details unique to each individual...

...presentations create a sense of professionalism for students. It is a way of celebrating their success and their accomplishments, and it provides a “grand-finale” for a long term project....A great accomplishment deserves a great celebration, so the presentations provide students with a final bit of glory which enhances their success and self esteem.

Encouraging, stimulating and celebrating successful problem solving remains a key to student progress. Through repetition, students begin to see problems as challenges. Challenges become personal and therefore become a measure of each individual’s personal ability. Students seem to reach deeper inside and find greater energy and determination for solving such challenges. I am convinced that educators get more out of students if they feel challenged on a daily basis. However, the role of the teacher in assuring success seems to be guided by the task and structure of each activity.
Task and Structure as a Means of Organizing Problem Solving Activities.

Probably one of the most critical factors in encouraging successful development of learner autonomy is the task and structure of learning opportunities. As discussed in the literature portion of this study, task and structure represent, respectively, the level of cognitive reasoning and the type of guidelines involved with any problem solving activity (Kimbell & Wheeler, 1991a, 1991b). According to the stage of student development in critical thinking, the difficulty of the task and the control of the classroom structure will vary. A range of activities provide challenges for students that insure successful outcomes and reflect their ability to adapt. My analysis supports the view of Kimball and Wheeler (1991a, 1991b) who suggest that careful attention to such interacting components appear to impact the development of problem solving skills. A key for teachers is to provide appropriate challenges and to structure activities that guarantee success. The following illustrates an example of task and structure at one end of a learning continuum.

the task...requires only that students discuss and provide a team opinion.... The students were told they had only fifteen minutes to complete the first section of the work sheet.

In the example above, the amount of problem solving (task) involved with each activity is relatively low while the organizational instructions (structure) are specific and incorporate a short, predetermined amount of time for each activity. The following example, however, represents an example of the opposite end of the continuum.

Students will...be involved with the decisions about this assignment. The students will choose the company project and arrive at a theme for the class....They will determine the organization of each company, the product to be
developed, and the design for the production and marketing involved. In other words, the students will maintain a high level of self direction.

In the above example students are involved in choosing and developing their next assignment. The structure of the activity is relatively loose while the task involves a variety of problem solving opportunities. Essentially, students are required to determine what the outcome will involve, how the objective will be treated and when their efforts will be incorporated. However, moving students from an inexperienced position to a point of self direction seems to require significant management of classroom activities.

Although my experiences have been generally positive, I experienced difficulty in determining appropriate task and structure in relation to student ability. As I reflected in my journal on the poor success of the mouse trap powered vehicle challenge, the degree of structure surfaced as central to the problem.

A problem I have certainly faced before, and probably will face again, stems from the degree of problem solving or task that I give new students. All my experience and research tells me that students, who are new to critical thinking, need to begin with highly structured activities that have a small degree of problem solving tasks.

In the above case, students were not ready for the degree of challenge nor the freedom to direct their class time, team organization, or problem solving strategy. It seems that potential exists for students to choose unrealistic topics, requiring skills beyond their capability. Such students need help in a number of areas, and encouragement to stay on task and strive for reasonable productivity.

They (need) short term deadlines,... small goals...and guidance in learning to work with others. They (need) a structure that guides them through various stages of teamwork, organization and product development.
On one hand, my analysis suggests that one should move ahead in small steps to provide a solid base for further student development. On the other hand, it is important to encourage continuous development of self-directed behavior. It is important to find the right balance without focusing on one strategy that appears to be effective for a while. As in the following example, such action can generate student apathy toward their work.

...several students seem to be wandering in search of some form of excitement. I am aware that fewer students are coming in to the class on their own time after school. As well, I am having difficulty with students not handing in assignments on time.

Once again I find my role as the teacher changing. I am now becoming a bit of a slave driver as I try to encourage students to bring their projects to a close. Without pressure I feel that students would let their work carry them till the end of the year.

In a discussion with students, it became clear that the use of learning modules was stifling the students’ freedom to expand their repertoire of skills and opportunity to direct their own learning. “...I hear a lot of you saying you want to go in different directions.”

A challenge for me is to recognize a point when students are ready to accept greater responsibility, and to acknowledge the development of their personal autonomy by altering the type of guidance and structure provided. On one hand, I am drawn to activities which rely on a tight structure, guaranteeing order and success. On the other hand, I am driven by the students’ sense of self direction, and desire for freedom to choose what and how they will learn. The challenge is to loosen controls, yet see each and every student achieve success.
Task

In analyzing my data it became clear that both task and structure are two
separate, but very closely tied elements of successful problem solving. In particular,
gradually increasing the degree of task seems to generate greater cognitive ability in
students. As previously discussed, I begin new grade eight students with closed tasks
that simply require their opinions. Students then quickly gravitate toward design work
of fictitious products and building ideas. It does not take long for students to adapt to
the creative problem solving required for drafting design assignments.

Anyone looking at the very first set of drawings...would be truly amazed....Many
students went far beyond my expectations and created beautiful house designs
with incredible detail, showing difficult aspects of drafting such as stairs,
archways, wrought iron work and interior views.

As students become familiar with creative designing, their work becomes more
realistic by incorporating practical outcomes. In other words students are required to
make products that represent their designs.

Over the next few weeks the class will design and make picture frames, unique
to each student’s personal event or experience in life.

Opportunities to actually make artifacts from various materials, provide students
with feedback about the practical nature of their designs. It provides a way for students
to learn about the feasibility of their ideas and generates numerous problems for
students to solve. Although, not part of this study, the process of designing and making
provides a good foundation for a set of introductory learning modules that require grade
eight students to investigate technology and meet challenges.
The experience gained in grade eight seems to prepare grade nine students for more significant tasks, even at the beginning of the program. For example, early in the study, grade nine students were asked to address a challenge related to ethical issues.

A task for grade nine students requires them to create and produce an advertising poster that explains the pervasive nature of technology and how it affects their lives.

In this case, most students appeared capable of managing a graphical challenge and eager to address more involved tasks. Again, an opportunity to actually make a practical outcome engaged students in an entirely new level of problem solving.

The mouse trap vehicle gave students practical opportunities, however, since the involved task was too open for them, I incorporated more closed problems with specific tasks and narrower outcomes. The introduction of grade nine learning modules involves students with shorter, more straightforward problem solving exercises.

I developed learning modules to engage students in a variety of tasks that promote problem solving skills, technological literacy and independent learning skills. Students are required to experiment with devices, plan strategies and meet challenges in each activity. For students who need time to develop problem solving skills, the tasks involved are closed problems. Such opportunities seem to help students become more in tune with their capabilities.

It was a short simple assignment, but I feel that students learned great deal about aerodynamics, compressed gas, potential energy and acceleration. But most important the students learned even more about themselves and their potential.
It appears that, only after more opportunities to address closed problem exercises, were
students able to handle more open problems associated with challenges such as
compressed gas rockets.

Several students devised ingenious methods for separating the rocket at the top
of its flight path and returning a capsule with a parachute.

The launch day was a hoot....The morning was filled with flying water,
screaming rockets, kids cheering, and staff and students hanging out of windows
in order to get a glimpse of the fun.

This stage of the program appeared to represent a turning point in student
confidence and ability to manage tasks. Students became more open to potential
challenges and eager to demonstrate their ability. The remainder of the study, involved
students in open problems enabling them to derive strategies and outcomes themselves.

Individual research projects provided very open tasks that required students to
generate practical ideas, representing a form of technology that interested them. In fact
students were required to address numerous tasks relating to designing, manufacturing,
finishing, researching, and acquiring materials.

The students have developed an attitude which says “I can and I will!” These
students are driven from within and seem almost oblivious to failure. They have
come a long way over the course of the year which has resulted in significant
changes in the way activities are conducted.

The final activity required students to address an even more open problem
relating to technological, ethical, managerial, organizational, and practical problems.
The students appeared to have no limitations as to how they addressed such tasks.

If I think back to the first activity, students seemed to focus more on asking how
to simply get an assignment completed, whereas, now students are
demonstrating a sense of their own direction and confidence for meeting
challenges.
Structure

Ironically, of the two components, structure appears to have the greatest impact on student development. Structure provides a means for teachers to maintain control over problem solving activities, insuring successful outcomes for students. This perhaps sounds contradictory, but it provides a method for working with students and managing the degree of responsibility they assume. Structure represents an organized method for insuring success, keeping problem solving activities reasonable and manageable.

It seems that structure must be carefully tethered according to student success rate. As students become successful, the structure is loosened. As difficulties arise, the structure is tightened.

...the structure of the class is loosening, allowing students greater freedom to make decisions about how or what they will accomplish each hour.

It seems that students of this stage of development have difficulty with (the) activity....As a result, a tight classroom structure seems to be crucial to the success of such an assignment.

Careful administration of activity structure appears to play a critical role in the success of problem solving activities. In fact, inappropriate structure appears to represent a large reason for difficulties that arose during my observations. For example, the tight structure incorporated with learning modules began to stifle the enthusiasm, drive and energy of my grade nine students. Another example suggests that more structure may have aided student progress with the mouse trap powered vehicle activity.
What is needed here is structure...The students need a framework to work within. They need something to attach their ideas and a set of guidelines that steer them in a reasonable direction. I visualize a path of planning that provides boundaries wide enough for open opportunities, yet narrow enough to ensure success.

In hindsight, I think a tighter classroom structure may have eliminated the difficulty I had with a few students during the research project....

In particular, the planning stages of activities appear to require a tighter structure in order to assure a prompt beginning. Simply providing students with open ended problems that suggest they "go at it," appears to limit student productivity. However, guidelines that insure students head in a positive direction help them gain a clear understanding of what they want to accomplish.

One of two worksheets I propose, will facilitate the selection of three areas of study while the other will provide a structure that compels students to address particular issues with their work.

*Using my first worksheet on topic selection...read descriptions (of your ideas)...select one of your ideas and begin the planning stage...Use the second worksheet to indicate your timeline, choice of materials, and plan of action.*

It is important to recognize that students are not being told what or how to do their assignments, but are being required to demonstrate direction and determine potential difficulty. These students are required to address issues related to rationale, time-lines, expenses, and strategies. The addition of such a structure solved several classroom dilemmas and led to successful implementation of problem solving activities.

A tight structure seems to be the key to an open problem for kids of this stage of development.

In introducing the project again, I would institute more guidelines at the beginning to insure that all students are on the right track.
After the success of today's class, I am even more convinced that a tighter class structure will yield a smoother running class yet still provide students with opportunities to develop autonomous learning habits.

As the administration of structure played an important role in virtually all activities, the degree of structure was also adjusted according to student experience. My analysis suggests that a tight structure is appropriate for students, newly exposed to aspects of learner autonomy, while a looser structure is more suitable for students, experienced in self directed problem solving challenges.

...instructions (are) very direct with significant detail and specific instructions about how students are to form groups, address issues, deal with expectations and focus on particular tasks. In fact students are allotted short periods of time for each section of the assignment and told to stop before continuing.

In the above example, very specific instruction and set time periods are used to introduce grade eight students to activities. Gradually, as students develop skills for addressing problems and managing tasks the class structure is adjusted a little in order to match the students' stage of development in critical thinking.

...the level of critical thinking is more advanced than with the previous drawing assignments....students will be free to use tools and equipment as they deem appropriate and will begin to determine the timing of their own processes for completing the project.

The expectations of students shift a little toward increased student responsibility for learning. My reflections during the study suggests that by the end of grade nine, students reach a level of responsibility, independence and intrinsic motivation that warrants even more loosened parameters and classroom structure.

the structure of the activity is now relatively loose allowing students to develop their own schedule for learning, solving problems, delegating tasks and producing an outcome. Students are responsible for making judgments about
the appropriateness of their topic and making adjustments according to the results of each day's activity.

However, even for grade nine students, advanced in problem solving skills, a structure was enforced until teams were established and goals were fixed. In the following example, students actually altered their objectives and formed teams according to needs rather than friends.

_I said, "today as you form your companies, it is important to choose people who you know you can get along with and who you can count on for their part of the project....as you join a particular group, please sign one of the positions indicating your commitment to the specific task or job..."

The students quickly found ways to live within the guidelines I established. In other words, they seemed to quickly adopt an alternate method of dealing with the situation. Most students eventually looked beyond their immediate companions to find people they could work with. They changed their priorities from social concerns to pragmatic alternatives and focused on accomplishing the task at hand.

Once established, teams of students were given freedom to organize, plan, and evaluate their outcomes. In almost every case, students were successful in researching information, planning strategies, organizing tasks and achieving their goals.

Appropriate implementation of classroom structure plays a significant role in the success of students engaged in problem solving activities. Too tight a structure seems to stifle growth while too loose a structure appears to generate instability in student behavior. However, careful implementation of a structure that corresponds to student experiences appears to facilitate growth in student ability. I am convinced that as one goes through a process of relaxing the class structure, providing student involvement
and shifting power to the learners, one opens doors for those ready to accept responsibility and develop learner autonomy.
Chapter V  Conclusions and Recommendations

This chapter provides a synopsis of my findings, shares a model for classroom delivery, and provides options for further research. It deals with my action as a critical component for encouraging autonomous learners and focuses on new ways of thinking about teaching in a classroom. A number of my practices are suggested as components in promoting autonomous learning habits which appear evident through growth in student development.

Student Growth

The previous chapter details numerous accounts of students' development towards learner autonomy. This study, encompasses approximately eleven months of data collection and deals with my role in changing student behavior over a span of fourteen months, including year end activities and summer holidays. In the beginning of the grade eight year, students demonstrate predominately dependent behavior and rely on the teacher for motivation, activities and solutions to problems that arise. As the program progresses, these students take on some intrinsic motivation, and show signs of independence. Towards the middle of grade nine, students assume greater responsibility for their learning, become intrinsically motivated and operate more independently of my direction. By the end of the grade nine year, students adopt a self reliant, determined attitude that facilitates responsible students capable of determining appropriate challenges, organizing and delegating tasks, and persevering to meet
personal challenges. As a result students acquire an understanding of their ability to derive meaning from their learning, beyond normal classroom expectations. In short, these students are empowered to make connections with their learning, and determine goals, strategies and outcomes in technology education.

**Teacher Attitude**

It appears that my attitude and philosophy about education plays a critical role in encouraging autonomy in the classroom. It seems that such development requires devotion and recognition of learner autonomy as personal characteristics of student development. In other words, my priority lies in teaching students first as life long learners, and subject second as a vehicle for personal development. As a result, my prime goal involves developing personal attributes that foster critical thinking, problem solving, independent thinking, and teamwork, all elements of life long learning. Specific skills for performing specific tasks become secondary goals for helping students achieve growth in personal development.

It appears that flexibility and confidence is needed to allow students to assume responsibility, make decisions, and determine their direction. As learner autonomy implies self control and decision making, students must be allowed to operate in an environment that encourages risks, promotes independence and shares responsibility. In many cases, students endeavor to learn about topics that go beyond the realm of the teacher’s experience and knowledge. The process requires my confidence and willingness to encourage such experiences. In short, as students demonstrate an ability
to make decisions about their educational world, I must be willing to shift my role, transferring some responsibility and organization to students.

**Fundamental Themes**

*Personal responsibility, independent thinking, and intrinsic motivation* are identified in chapter four as fundamental elements for my promotion of learner autonomy. The interaction of these three factors seem to generate a learning environment, conducive to personal development and crucial to the development of positive student attitudes about their ability. From the first class in grade eight to the completion of grade nine, students are encouraged to generate personal interest, become involved in their own learning and find solutions to their own problems. Over time students appear to adopt greater responsibility for the direction of their technology experiences, operate as independent learners and become intrinsically driven towards personal accomplishments.

**Personal Responsibility**

To become an autonomous learner, implies that students are involved in decisions about their education. In particular, technology education students focus on decisions about their activities, problem solving strategies, challenges, teamwork and product outcomes. A key for myself as the teacher, is to monitor the students’ ability to take charge of their activity and allow them to assume greater responsibility accordingly. The process appears to demand flexibility and understanding on the part of the teacher in order to encourage responsible student roles in the classroom. As
students develop and become responsible, the role of the instructor shifts from a teacher towards that of a facilitator. By continually encouraging student responsibility, the teacher focuses on helping learners develop personal attributes towards learning.

**Independent Learning**

The notion of becoming an independent learner remains a key element of my technology program. My goal involves encouraging students to assume greater responsibility for their learning while remaining largely independent of myself as the teacher. Students are encouraged to adopt independence by attempting to resolve their own difficulties, acquire resources, generate ideas, and learn on their own. Through virtually all activities, students are encouraged to adopt a sense of independence in dealing with situations that arise in their work. Learning modules, for example, provide guided instruction that forces students to acquire knowledge by experimenting, testing and reporting. Instead of requesting answers from the teacher, students are encouraged to seek my advice about their own potential solutions. My role becomes that of a sounding board for students to bounce ideas and share information.

**Intrinsic Motivation**

Learner autonomy implies dedication, drive and enthusiasm towards personal goals that students establish. The connections that students make with their work appears to generate an inner driving force, empowering them to accomplish challenging tasks, riddled with problems. Such devotion enables students to master most difficulties which they seem to view, not as disabling problems but as new challenges. In other
words, problems seem to establish platforms of provocation, and draw on the students’
sense of drive, determination and ingenuity. A key for me, is to help students find
personal connections that relate to their world today. As a result, students embark on
personalized ventures in education relating to topics such as personalized picture
frames, individual research projects, and entrepreneurial endeavors. Either in teams or
individually, students work on areas of technology that portray their own interest. The
power of these connections seem to build intrinsic motivation fostering tremendous
levels of energy and enthusiasm towards goals of a personal nature.

**Teacher Action**

A problem solving model is incorporated in this research as a tangible vehicle
for addressing elements of personal development linked with autonomous learners.
Such a model involves students in a variety of opportunities to identify and solve
technological problems related to personal goals, school endeavors, and societal issues.
An apparent spin-off is the development of social skills involving teamwork, and
relationship issues. The success of such a model seems contingent upon close attention
to three critical factors.

Firstly, it is important for me to recognize that time is required for changes in
student behavior. The development of independent self directed and internally guided
students seems to involve a lengthy process for them to experience a variety of
opportunities. Each opportunity challenges students a little more, ensuring a gradual
development of skills for addressing problems. An effort is made to avoid large
increases in expectations which might frustrate students, diminish enthusiasm and cause regression.

Secondly as students, new to independent opportunities, begin to take risks, they appear to require guaranteed success in their attempt to venture forward. Positive outcomes seem to stimulate more willingness to engage in greater risks. In testing their own independence, students sometimes resort to dependent behavior if they are not successful. It is not until students adopt feelings of autonomy that they accept failure as new challenges. I therefore, try to insure, with most activities, that students are successful in their attempt to independently generate ideas and solutions to problems.

Thirdly, it seems that close attention to the task and structure of activities affects my success in promoting learner autonomy. Since the administration of activities plays a large role in this program, appropriate application of the problem solving challenges and guidelines involved seem to affect learner success. In the beginning, students are exposed to simple tasks within a tight structure. As personal skills develop, students are exposed to greater tasks where the structure of the activity is loosened. Responsible, motivated students, familiar with problem solving challenges, seem to benefit from significant tasks while functioning within a looser structure. It is also important to note however, that during the planning stage, even experienced students appear to perform better under a tighter classroom structure.

**Development of Theory**

As elaborated above and detailed in chapter IV of this paper, the study develops various concepts based on theory derived from classroom practice, academic
researchers, and personal experiences. Numerous segments of my data appear to connect theory and practice, forming a well reinforced theoretical base for other researchers to embark. Theories involving personal responsibility, self development, intrinsic motivation, teacher attitudes and problem solving are enhanced by the results of this study as critical components for promoting learner autonomy in high school settings. However, since most research into learner autonomy is examined from an academic perspective, this study pursues the development of grounded theory related to specific classroom practices.

In particular, teaching practices that promote learner autonomy in the context of high school technology education programs are developed as theories based on data collected in this study. More precisely, grounded theory is formed by drawing more specific educational practices from a level of research aimed at the essence of classroom methods. Chapter IV develops theory on teaching strategies which enhance brainstorming, teamwork, independent skills, and critical thinking. The actual methods for transferring skills from one context to another, reinforcing desired outcomes, and guaranteeing success are developed from the related data analysis. Shifts in learner autonomy reinforce the use of relevant educational connections, provide insight to student success, and emphasis critical monitoring of student development. Such theories were developed by hypotheses, and tested within the realm of my grade eight and nine technology education classroom.

As a teacher/researcher I find myself neatly situated within the context of academic theory and theory developed from classroom practice. In regards to learner
autonomy, the development of such praxis leaves me well informed yet practical in nature in terms of my classroom practice and my personal position.

As identified in the literature, the successful promotion of learner autonomy emphasizes the position of the educator as a personally autonomous individual. Both privately and professionally, I recognize my position as personally responsible, intrinsically motivated, and empowered to think independently and establish direction. For instance, my work in curriculum development at the school, district and ministry level established a framework for my input toward decisions and directions in technology education. Such opportunities and feelings of empowerment, enthusiasm, and independence are elements of learner autonomy that I am honored to pass on to students.

**Methodology Review**

The action research model chosen for this study proved to be a viable means of investigating my own practice in a high school setting. As the basis for my methodology, journal writing provided a rich data base for analyzing my labor to promote learner autonomy in technology education. My close adherence to a rigid observation and reflection schedule seemed to strengthen the data base, clarifying the results of my effort to encourage students to develop self direction. I suggest that changes in my approach and changes in student ability became apparent due to the length of the study. It seems that a full year and a half of data collection was a critical component of my success. Such intensity provided insight to a clear set of outcomes based on repetitive data.
The process of data analysis also proved to be an excellent method for highlighting strategies and methods that encourage student development. It established a clear set of themes, detailing a number of theories which both reinforce other researchers and, as discussed above, break new ground in classroom strategies. As well, the analysis of my journal writing established the presence and development of learner autonomy within the test site.

The clarity of my analysis seems to identify my close connection to the test site as a significant factor in its success. As a teacher/researcher I remained inside the research site, enabling me to virtually feel the ethos of the class culture and the results of my action. Since this likely represents the most critical benefit of action research methodology, I encourage future researchers to consider such methods for reaching the depth of understanding gained in this study.

**Recommendations**

**A Practical Model for Encouraging Learner Autonomy**

In order to pursue the promotion of autonomous learners in technology education, I have developed a problem solving program that focuses on the development of personal responsibility, independent thinking and intrinsic motivation. Such a program requires approximately one hundred to one hundred and fifty hours of instructional time spread over two grade levels.

In the beginning, activities involve short simple tasks, structured within a tightly organized learning environment. This program begins by encouraging grade eight
students to recognize the value of their opinions through decision making activities. Activities that require personal opinions and team efforts engage students through dialog about products, process, impacts and other human related issues. Design activities that follow, incorporate creativity, enabling students to experiment with architectural ideas and concepts. Such activities are short introductory assignments incorporating teamwork, independent thinking, and creativity. They appear to provide a positive introduction to aspects of personal development that lead to learner autonomy. Design activities involving building design and product development, seem to reinforce creativity and assure success since most work is hypothetical at early stages. Activities that assure success help to build self confidence, encouraging students to begin a process of thinking independently.

I establish a mode of classroom operation for engaging in a variety of technology activities by teaching students to become independent learners. Since technology encompasses such a vast potential of study, skills for independently learning, solving, researching and resourcing seem to empower students with viable processes for addressing technological problems. I address such skills by speaking directly to students about “what it means to be an independent learner.” By redirecting questions back to students and encouraging them to try a variety of ways for solving every day situations, students gradually adopt new ways of thinking about their technology class. Reinforcement of daily classroom practices that foster independence appear to prepare students for more complex activities.
As students develop, the tasks become more complex, the structure of the learning environment is loosened and students venture into more risky territory. The introduction of learning modules (six learning stations, I developed for each grade) provides a variety of learning opportunities in technology while reinforcing learning independence. In teams of two, students teach themselves about aspects of technology by experimenting, testing ideas, and reporting back via guide sheets. Each station involves short term goals, problem solving challenges, and product outcomes. Technological aspects of areo-dynamics, information processing, submersibles, robotics, electronics, and computer drafting and animation introduce students to a variety of potential topics while reinforcing teamwork and learner independence. The completion of these modules seems to prepare students for more involved study, if they so choose. Four or five lessons at each station appear to insure a high interest level while providing opportunities for students to personalize their work.

I strive for intrinsic motivation in students by involving them in product development such as material modification and technical communications. In virtually every activity, I encourage students to relate important personal experiences to areas of technology. Gradually, motivation for activities begins to come from within students themselves. For example, designing and creating a picture frame that represents an important picture, seems to stimulate a critical bond between students and their work. Such connections appear to stimulate further aspirations in students, building responsibility for grade nine activities.
Since most grade nine students are equipped with skills learned earlier, I initiate programs with more complex tasks and looser guidelines than the previous grade level. Their program commences with an examination that looks into the nature of technology, and begins with research projects and graphical outcomes. Students are encouraged to investigate an area of technology that interests them and develop technical communication skills through elaborate posters, and other forms of media. Students are given choices about the topics and risks associated with various outcomes. This activity provides me with insight to the stage of self directing skills that students possess.

As their technology teacher, I strive to carefully evaluate the students' level of interest, and ability to function independently and assume responsibility for their learning. Since the initial activity demands these skills, an analysis determines what direction the program should take. Advanced learning modules appear to reinforce learner independence, personal responsibility and intrinsic motivation, while activity content seems to build technical knowledge and practical skills. By monitoring each aspect of personal development I am able to estimate the ability of students to advance to more open problem solving tasks.

As opportunities are given for students to assume more responsibility, it becomes very evident that my role begins to shift from a teacher towards a facilitator. As students adopt a take charge attitude, I try to provide opportunities that reinforce their skills. As most students exhibit potential I give them opportunities to venture on their own. For those students who rely on others, I continue my support and encourage personal development. My role seems to involve guiding those capable of new
challenges while providing more exercises for those needing stability. I try to involve students in a discussion about their direction in technology. In other words, I provide three avenues for students: one that builds further skills through learning modules, one that advances to closed problem solving challenges and one that involves open problem solving challenges, identified and planned by the students.

Closed problem solving challenges such as compressed gas transport, provide new and exciting opportunities while remaining within tight parameters. Bottle rockets, for example, represent a fun activity that challenges students to send a passenger into “space” while returning it gently to the “earth.” Numerous other closed problem solving challenges are available through various learning resources. It is important to note, however, that while such challenges provide a variety of closed problems, I believe they typically limit students to one stage of personal development. Repetition may not necessarily advance students towards learner autonomy. Since closed problems generally include a narrow range of outcomes, they provide students with problem solving challenges only. Students receive little exposure to opportunities that encourage them to identify problems and plan strategies. I usually limit such activities to one or two only in order for students to attain related personal skills.

I use individual research projects to provide students with open problem solving challenges. The planning stage, involves tightly structured routines which are loosened significantly once the activity is underway. I believe that such projects provide opportunities for students to determine the direction of their education in technology. Students seem to build aspects of personal development by brainstorming
ideas, setting goals, determining directions, gathering information and establishing strategies for accomplishing each task. In order to encourage personal responsibility, I resist the temptation to solve student difficulties. Instead, students are encouraged to resolve their own dilemmas while seeking my acknowledgment and advice about their solutions. Students tackle areas of technology where they have a personal interest and address topics relating to: aerodynamics, solar energy, infant care, submersibles, computer animation, claymation, games, marine technology, electronics, mechanical technology, transportation, and systems technology. I encourage students to independently address their topic, provide several progress reports, and present their work as a celebration of their success.

Since independent research projects appear to swiftly increase aspects of personal development in students, projects that involve large tasks and loose classroom structures seem to reinforce personal responsibility, independent thinking and intrinsic development. The formation of companies, for example, engage students in product development and marketing, and provide similar opportunities to research projects while increasing technological awareness. Students are encouraged to form departments with separate responsibilities for developing prototypes and producing advertising campaigns. Students are encouraged to choose a direction for their company and engage in various fields of occupation that represent real businesses.

**Further Research**

Since little research involving learner autonomy is evident in technology education, I urge others to investigate various aspects of personal development that
empower students to meet challenges in this field of study. As the encouragement of learner autonomy represents a very large scope of study, researchers may choose to focus more closely on individual aspects of personal development in technology. Studies that deal with either personal responsibility, independent thinking, or intrinsic motivation will clarify and expand our knowledge of practical applications in classrooms. Further study of problem solving models that address these aspects will also contribute to our knowledge base and provide further teaching strategies for technology education.

Problem solving represents a major curriculum focus in technology education and will benefit greatly from studies that address critical thinking and practical applications. For example, one could look at the affects of various tasks by identifying the level of critical thinking involved with different levels of problem solving activities. This combined with measurements of student ability to master increasing levels of difficulty, could chart guidelines for stages of cognitive development. I believe that importance should be placed on identifying methods that maximize student ability in technology education.

As we strive to establish viable technology education programs in public schools, it may be beneficial to first identify current attitudes and philosophies associated with developing learner autonomy. Surveys that collect data about educational priorities in technology education could center on issues such as:

- student centered versus teacher centered programs
• student focus versus subject focus
• process evaluation versus product evaluation
• multi-material artifacts versus single material artifacts
• teamwork versus individual work
• student problem solving versus teacher problem solving
• loose activity control versus tight activity control

As the encouragement of autonomous learners becomes a prominent goal in education, information on the above suggestions would be valuable in determining the direction and focus for teacher inservice and further research. As these issues relate to teacher cognition, it would also be valuable to examine aspects of the daily classroom that encourage personal development in students.

The issue of role playing has surfaced as having potential influence on the development of learner autonomy. Researchers could study the affects of various positions relating to business ventures, manufacturing plants and service associations. Questions could look at how assuming a particular role builds intrinsic motivation and responsibility in students. Roles such as a design manager, marketing specialist and production supervisor may influence how students begin to think about themselves.

I think it is valuable to look at these factors in order to go beyond activities and inform readers about general factors and teaching methods that influence the personal development of students. How do teachers stimulate independent behavior or maintain teacher dependency? Such information is important to the continuous development of educational knowledge.
Further study will enlighten educators and researchers, and help establish learner autonomy as a viable strategy for empowering students in technology education. I urge other researchers to help establish learner autonomy as a viable pedagogy and expose these strategies as a dynamic aspect of education.

**Summary**

As teachers gravitate towards new curriculum in technology education they open doors for opportunities to engage in exciting and rewarding teaching strategies. Since technology education exposes students to infinite knowledge, skills, and attitudes, I urge teachers to investigate the power of learner autonomy as an empowering process for learning. It involves a shift in philosophy focusing on learning strategies as central to education while maintaining specific skills as supporting elements. As a result, independent learners engage in experiences that lie beyond the realm of the teachers' knowledge and venture towards an exciting expedition of discovery. As responsible students, they take charge of their education, while teachers are freed to create inspiring and challenging opportunities. As intrinsically motivated learners, students connect with their work and forge ahead with determination, drive, and enthusiasm. As teachers, we are revitalized with new, exciting, and rewarding approaches to educational practice.
Promoting Autonomous Learners

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Promoting Autonomous Learners


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Promoting Autonomous Learners


Appendix
Appendix A

**Sample of Journal Entries**

6/1/95

Observation:

The last six or seven classes have been devoted to the development of students' company projects. In light of my absence for several days, I am particularly pleased with the progress of all six companies in this class. In contrast, I have two or three companies in my other classes that have accomplished little and definitely need some coaching to get on track. However, in the class I am studying, each team has selected an appropriate product and organized a strategy for each member of the team.

2.23 I am impressed with the level of organization, the amount of work completed, and the professional quality of each teams' product and advertisement. Many students have developed a product theme and have arrived at practical solutions. They have not only established reasonable outcomes but have also identified their goals according to the skills each student has developed during the course of the year. Each advertising team has established goals within their reach.

This is the first time that I have not had to encourage students to make significant changes in their direction. In discussion with each company, my comments have been generally encouraging with minor suggestions for

Reflection:

I have been absent for several classes, fulfilling ministry obligations, and as a result, I have had significant reservations about the appropriateness of this assignment at this time. I have questioned the students' ability to take on their new challenges without the assistance of my typical daily encouragement. However, upon my return, I must confess that my doubts are completely unwarranted. I guess my thoughts come from my experience with students addressing a new challenge.

6.12 In initiating assignments earlier in the year, I have always had to provide encouragement to a few students by either helping them find personal direction or guiding them towards a successful path. Occasionally students reach a point of stagnation because they did not begin in a direction that has personal meaning for them. In other words, if students do not make an early personal connection to their work, they run the risk of faltering when faced with numerous stumbling blocks.

There is great potential for students to choose an unrealistic topic that requires skills well beyond their capabilities. In the past, students have needed help in a number of areas and encouragement to stay on task and to strive for reasonable productivity.
Many students are also incorporating skills acquired either at home or in other courses. For example, one design team chose to prepare a plastic game board by sandblasting the surface and polishing the edges. Another team is incorporating scanned images with their advertisement and are investigating the use of various sound effects.

What is particularly impressive is the sense of pride, ownership, and teamwork evident with each group of students. No one seems to be "sloughing off." The students have smiles on their faces and are eager to show me their work. Even students who I expected to take advantage of my absence, are progressing well and are working towards completion. Finally, many of the company members refer to their partners success in dealing with other aspects of the assignment. Students seem particularly proud of their personal involvement and coordination with other members of their company. The students seem to like their roles and play a big part in determining the direction of their product campaign.

They have needed short term deadlines and small goals to achieve success and required guidance in learning to work with others. They have needed a structure that guides them through various stages of teamwork, organization and product development.

In order to meet such challenges, students need a tremendous amount of drive, determination, energy, and enthusiasm, usually derived from personal connections. As I have discussed in other parts of this journal, intrinsic motivation and problem solving success are two key factors to the development of autonomous learners. The students in this class are internally motivated. As a teacher, I have provided an opportunity for students and a structure for the class to work within.

The students themselves generated a high level of excitement. It is the students who identified interesting and exciting topics. It is the students who organized themselves into a workable team. It is the students who identified potential problems and generated feasible solutions. And it is the students who generated the necessary energy and determination to see their own idea become a reality.