CHAPTER 2

LITERATURE REVIEW

The aim of this literature survey is to give an overview of the literature in the field of the integration of computer-assisted education. A synthesis of the literature is done to develop a model against which the integration of computer-assisted education at Pinelands High School can be measured.

1 Integration of computer-assisted education

1.1 Introduction

When computers are used in education they are more than just another medium of teaching, such as a chalkboard. The integration of computers changes the whole ecology of a school, for example, funding, teaching methodology, evaluation, curricula and timetables (Lippert, 1993, p.5). The integration of computer-assisted education is a development which influences all the stakeholders in education (Anderson, 1996; McKinsey, 1996). As computers are introduced, certain supporting factors contribute to specific outcomes which impact on other sustaining factors. The integration of computer-assisted education will produce an effect on all the stakeholders at different phases of the process of integration.

1.2 Defining the integration of computer-assisted education

Integrating the computer in education means using the power and ability of the computer to aid learning in every subject area within the school (Dudley, 1980, quoted in IFIP, p.14). The integration of computer-assisted education means using the computer as a tool to teach subject matter, and to promote problem-solving and higher-order thinking skills (IFIP, 1993, p.14). The power of the computer is applied to facilitate decision-making, to amplify concepts and to support synthesizing of information (IFIP, 1993, p.14).

The integration of computer-assisted education is neither computer literacy nor computer awareness. It means using the computer where it is the best medium to support the learning goal (Anderson, 1996; Apple Computer, Inc., 1992, p.3). It involves changes in a school. The entire school community of students, parents, teachers and administrators has to accept that computers are a part of everyday school life (Kearsley, 1992, p.iii).

Integrating computer-assisted education implies a move towards a different kind of teaching, a whole-school awareness which looks at the following (IFIP, 1993, p.15):

- aims of general secondary education
- meeting new demands of society in students skills
- reforming the curricula
- training teachers in new skills
- internal school organisation
- hardware provision and maintenance
- stabilizing of funding policies
- support by technical staff
- equity of access for all students
- software development and provision
- development and provision of complementary materials
- copyright policies for software

Thus, if one accepts that integration represents the means to combine the above-mentioned factors into a whole and to make it part of a larger unit, then it implies that there has to be consensus between the stakeholders. All the stakeholders in education have to reach basic consensus regarding the organisation and setting of goals. In order to reach this consensus, the criteria for integration and organisation have to be agreed upon and followed by the stakeholders. In order to integrate technology, schools have to exploit that technology for the betterment of themselves and their students (Mecklenburger, 1989, p.6) and computers form a part of that technology.

Successful integration takes place when technology becomes invisible or transparent and both the teacher and students can concentrate on the content of the course, thus making it possible for students to use computers in the natural flow of classroom activities (Brunner, 1990, p.12; Partee, 1996, p.79; Rieber, 1994, p.17; Smith, 1995, p.8). The impact that computers make in the classroom depends on their availability and upon the ways in which they are used (Morrison, 1989, p.4). In other words, the impact of the computer depends on the developmental level of the school in respect of computers.

2 Models of the integration of computer-assisted education

2.1 Introduction

Any model for integrating computer-assisted education at school level must take cognisance of the form of education of the school, for example: the method of teaching being group work or lecture; exam orientated or continuous assessment; goals and remuneration.

The author uses three developmental models of integrating computer-assisted education to develop a single standard from which to discuss the integration of computer-assisted education and the resulting changes at Pinelands High School. These three models describe the different phases of the introduction of computer-assisted education. The outcome and the support factors which contribute to development differ in each phase of the models.

The models differ because they have different goals:

- In the **Apple Classrooms of Tomorrow (ACOT) Model** the goal is to provide insights into how technology would affect teaching and learning (Fisher, 1996, p.2).
- In the **CAMI Mathematics Model** the goal is to introduce computers gradually into the school, taking cognisance of the educational task to be performed and

the teachers' capabilities at each stage, matching the hardware with the software deployed at each stage (Vorster, 1996).

- In the **Make It Happen! (MIH) Model** the goal is to integrate technology into the curriculum to meet the needs of all students.

2.2 Apple Classrooms of Tomorrow Model

A widely noted model (Dwyer, 1991, p.49; Kearsley, 1992, p.150) is the **Apple Classrooms of Tomorrow (ACOT)** project illustrated in Table 2.1. This project involved thirty-two teachers and 650 students working in technology-rich **ACOT** K-12 (from grade school to matriculation) classrooms in the United States of America. The project documented the course of instructional change in those classrooms from 1985 to 1990 when it began publishing its findings. An aim of the project was to document how learning and teaching change in technology-rich environments, what factors inhibit the changes and what support is needed to effect fundamental and sustainable change (Apple Computer, Inc., 1992, p.4).

The **ACOT Model** was selected as it is a model for which there is a large data collection. It follows the changes which take place when the students and staff have constant access to the relevant technology. There does not appear to have been any deliberate direction except to provide technology and to note what happens in the class.

The **ACOT Model** involved parents, students, teachers, administrators and volunteers. This project has produced an evolutionary model of the integration of technology-intensive classrooms divided into five phases, i.e. Entry, Adoption, Adaptation, Appropriation and Invention (Dwyer, 1991, p.49) illustrated in Table 2.1.

The first phase in the **ACOT Model** is the Entry Phase where computers are installed and teachers start using the technology. The staff are initially unsure of the technology and, when they have confidence, mainly use the computers for text-based work. The method of teaching remains what it was in a traditional school, mainly lecture, recitation and seatwork instruction.

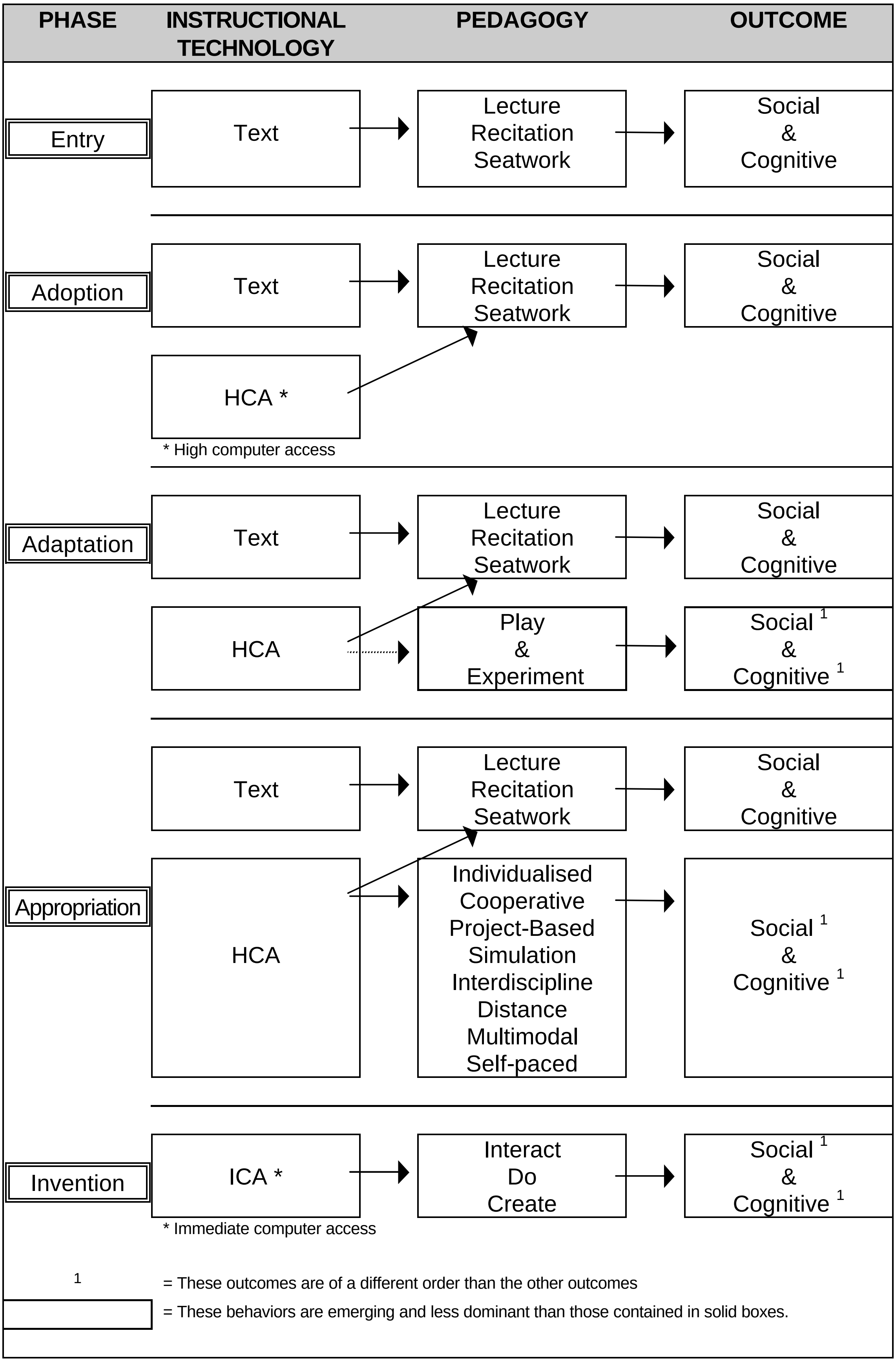
During Phase 2 of the **ACOT Model**, Adoption, the computer is used to support traditional text-based instruction using drill-and-practice or word processing applications. There is high computer access but the students receive whole group instruction via lectures, recitation and seatwork.

In Phase 3, Adaptation, the computer has been integrated into classroom teaching. There is high computer access in the form of word processor, database, spreadsheet and graphics applications. Classroom teaching is still in the form of lecture, recitation and seatwork instruction. There has been a change in the social and cognitive outcome of classroom instruction. Students use the computer for play and experimentation. This phase continues the lecture, recitation and seatwork mode of instruction. The computer is used to support classroom instruction but the students are encouraged to be creative.

The Appropriation or Phase 4 of the **ACOT Model** is a continuation of the previous three phases. The changes hinge on the teachers' mastery of the computer technology. High computer access supports lecture, recitation and seatwork instruction but the teachers' computer experience facilitates creative activities in collaborative work. Cooperative interdisciplinary projects are created, as well as multimodal, self-paced and individualised work. The school timetable is changed to accommodate enthusiastic teachers. Social interaction changes from that of the first phase.

In the final Phase 5, Invention, of the **ACOT** instructional evolutionary model the students have intensive computer access. Learning is something the students create or do. There is much interaction between the students and teachers who collaborate in the construction of knowledge. The type of learning has totally changed from that in the first Entry Phase.

Table 2. 1 ACOT instructional evolution in technology-intensive classrooms (from Dwyer, 1991, p.49)



PHASE	INSTRUCTIONAL TECHNOLOGY	PEDAGOGY	OUTCOME
Entry	Text	Lecture Recitation Seatwork	Social & Cognitive
Adoption	Text	Lecture Recitation Seatwork	Social & Cognitive
	HCA *		
Adaptation	Text	Lecture Recitation Seatwork	Social & Cognitive
	HCA	Play & Experiment	Social [1] & Cognitive [1]
Appropriation	Text	Lecture Recitation Seatwork	Social & Cognitive
	HCA	Individualised Cooperative Project-Based Simulation Interdiscipline Distance Multimodal Self-paced	Social [1] & Cognitive [1]
Invention	ICA *	Interact Do Create	Social [1] & Cognitive [1]

* High computer access

* Immediate computer access

[1] = These outcomes are of a different order than the other outcomes

▭ = These behaviors are emerging and less dominant than those contained in solid boxes.

2.3 CAMI Mathematics Model

Vorster (1995) of **CAMI Mathematics** has a different developmental model. The model is divided into three phases: Knowledge Retention, Knowledge Processing and Knowledge Expansion, illustrated in Table 2.1. This model was based on the running of a commercial computerised mathematics school since 1984 and the implementation of software and methodology in more than 200 schools by 1996 (Vorster, 1996).

This model was selected as it is South African where the educational emphasis has been the retention of information. The focus of this model is not on technology as in the **ACOT Model**, but on teachers, hardware, software and examination results. In this model there is individualised seat-based learning in the initial phase with the emphasis on improving the retention of knowledge, as is found in most South African schools.

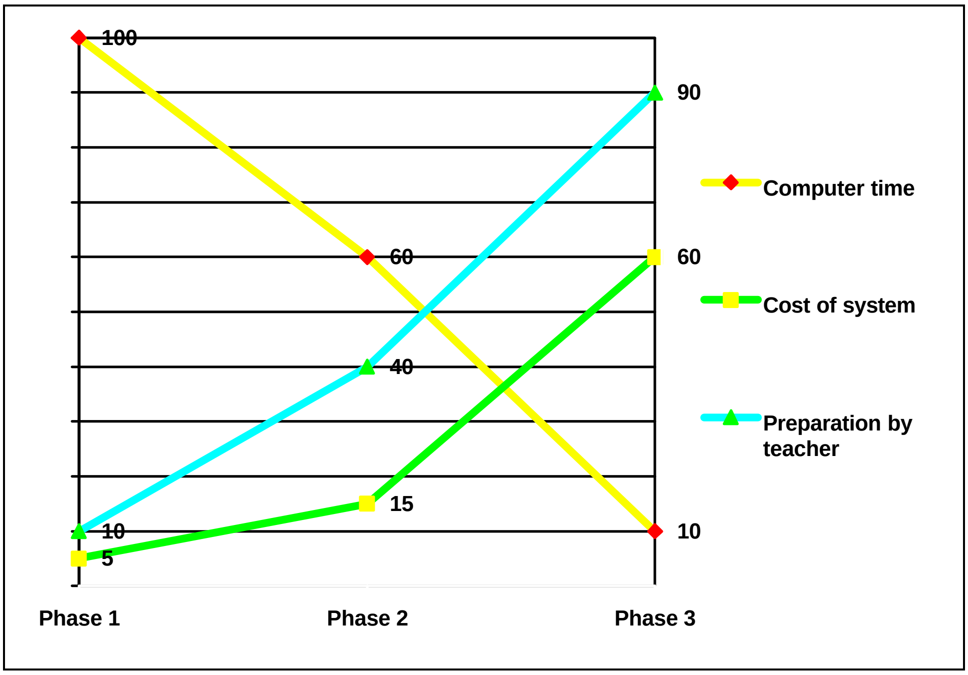
According to Vorster (1996) all three phases of the **CAMI Mathematics Model** must be covered before you have a fully computerised school. Phase 1 is concerned with Knowledge Retention and does not require sophisticated hardware or software. The work done is mainly of a drill-and-practice nature which does not require much computer knowledge on the part of the teacher. Phase 2, concerned with Knowledge Processing, requires hardware sufficient to run a number of packages such as word processors, spreadsheets and databases. That hardware could be of the level used in the preceding phase. Planning as well as preparation would be required from the teacher. Computer application knowledge would be essential, although it could be of a basic level. Phase 3, Knowledge Expansion, would require more technology, hardware and software, and greater teacher computer skills than the previous two phases. The teacher would also require greater planning, organisational, technical and application knowledge.

Table 2. 2 CAMI Mathematics Model of the integration of computer-assisted education

PHASE	USE MADE OF COMPUTER	TYPE OF HARDWARE AND SOFTWARE	ROLE OF TEACHER
1. Knowledge Retention	Cements recently taught subject matter using • drill-and-practice	Needs • mono screen monitor • 1 MB of RAM • one dot-matrix printer • networked system • drill-and-practice program, for example *CAMI Mathematics*	Needs little • involvement • supervision • computer knowledge
2. Knowledge Processing	Takes existing knowledge and reprocesses it using • word processor • databases • spreadsheets	Same as above with addition of • ink-jet printer • suite such as *MSWorks for DOS* • DOS based desktop publisher • testing program such as *Study Aid*	Needs • planning • preparation • teaching tasks using existing applications • computer application knowledge
3. Knowledge Expansion	Exposes students to new and unknown topics using • CD-ROM • multimedia • new technologies	As above plus • at least one multimedia computer with CD-ROM in each computer room	Needs • lesson preparation • planning and organisational skills for cooperative learning groups • technical computer knowledge • computer application knowledge

As a school is always getting new students and new teachers the first phase must continue simultaneously alongside phases two and three,. The first phase of Knowledge Retention must *also* simultaneously be used for drill-and-practice and assisting students to retain information (Vorster, 1996). There must be sufficient venues and computers for all three phases to take place simultaneously. The three phases have different hardware, software, time and usage requirements as illustrated in Figure 2.1

Figure 2. 1 Graph to depict access time of the student, the effort required by the teacher in preparation of course material and overall cost of the system through the three phases of computerisation (from Vorster, 1996)



The **CAMI Mathematics Model** as seen in Table 2.2 focuses mainly on the teacher's capabilities, hardware and software requirements for each phase of the model and providing effective time for a large number of students on the computers (Vorster, 1996). Figure 2.1 depicts the relationship between computer time, the cost of the computer system and the preparation by the teacher in the different phases of the integration of computer-assisted education using the **CAMI Mathematics Model**. In the **CAMI Mathematics Model** the development of integrating computer-assisted education can be halted by not purchasing the hardware and software necessary for the next phase.

2.4 Make It Happen! Model

The **Make It Happen! (MIH) Model** focuses on the curriculum and the integration of technology to promote school change by developing a positive attitude towards learning; and by implementing a curriculum which supports inquiry-based learning.

According to the model the school aims to move forward to collaborative planning and teaching that fosters higher-order thinking in adolescents. The goals set in the model (Zorfass, 1991, p.69) are for

- interdisciplinary teams of teachers to design, implement and evaluate a curriculum that uses computers to support inquiry-based learning;
- adolescents to expand their critical thinking abilities, cooperative learning behaviours and positive attitudes towards learning by engaging in the curriculum which would have been developed above; and
- principals and school-based management teams to create a supportive context that facilitates computer integration.

The **Make It Happen! Model** was selected as technology is deliberately integrated into the curriculum. This has happened in selected subject departments at Pinelands High School.

Table 2. 3 Make It Happen! Model of the integration of technology into the curriculum

Step 1 (1st Year)	**Theme: Build a strong foundation for innovation** **Curriculum component** Teachers and administrators • evaluate school's curriculum goals • begin a process of curriculum revision • select topics which could be studied in an interdisciplinary inquiry based unit which integrates computers • begin to form a shared vision of successful technology integration **Teacher development component** Teachers • learn about software that can enhance inquiry-based learning • evaluate software • receive training with applications suitable for potential use **School-based facilitation component** Principal • identifies participants for the MIH team
Step 2 (1st and 2nd Year)	**Theme: Initiate with a small group of pioneer teachers** • work continues as in 1st Year • MIH team meets regularly to discuss problems, plan and make decisions
Step 3 (2nd Year)	**Theme: Expand to whole school** • pioneer team continues to design, implement and evaluate curriculum units • more teams of teachers follow pioneer group's example • pioneer teachers mentor members of expansion teams • MIH team changes composition to give representation to expansion team

The model has three components - the curriculum, the teacher development and the school-based facilitation components. The model is implemented over a two year period in three steps, starting with a small group of teachers who pioneer the innovation in their school and draw in other teams, as illustrated in Table 2.3.

In Step 1 teachers and administrators evaluate the school's curriculum goals and begin a process of curriculum revision. They select topics which could be studied in an interdisciplinary inquiry-based unit which integrates computers and begin to form a shared vision of successful technology integration. Teachers learn about software that can enhance inquiry-based learning, evaluate software and receive training to become fluent with applications suitable for potential use. The principal identifies participants for the **Make It Happen!** team.

In Step 2 of the **Make It Happen! Model** the work initiated with a small group of pioneer teachers in the first year continues with the pioneer team meeting regularly to discuss problems, plan and make decisions.

In Step 3 of the **Make It Happen! Model** the pioneer team continues to design, implement and evaluate curriculum units; more teams of teachers follow the pioneer group's example and the pioneer teachers mentor members of expansion teams. The **Make It Happen!** team changes its composition to give representation to an expanded team.

3 Models synthesized

The three models selected have different features which are of relevance to the investigation of computer-assisted education at Pinelands High School.

Reasons for selection as a model:

- The **ACOT Model** was selected for the investigation as Pinelands High School seemed to have all the software and hardware it needed. Unlike the teachers in South Africa, the **ACOT** teachers appeared to have freedom of teaching material and methodology. The most compelling reason for selecting this model was that technology was not forced on the **ACOT** schools nor was it forced on the

Pinelands High School staff. The integration of computer-assisted education *evolved* in both situations.

- The **CAMI Mathematics Model** was selected as it emphasises results as do many South Africa schools. In addition to the results-focus the model *slowly* integrates computer technology as improved hardware and software are obtained and teachers develop expertise. It was thought that that was what was happening at Pinelands High School.
- The **Make It Happen! Model** was selected for the investigation as in this model teams expand, bringing in other departments/teams as the original team gains confidence. This appeared to be happening at Pinelands High School.

3.1 Synthesis of the three models into one integrated model, the Evolutionary Model

The author has synthesized the three models into one new **Evolutionary Model** to facilitate the examination of computer-assisted education at Pinelands High School. All three models were selected as each has aspects which are valid for an investigation into the integration of computer-assisted education at the school. They have been synthesized as each has a dominant feature common to the situation at Pinelands High School.

3.2 Prerequisite infrastructure of the Evolutionary Model

The support infrastructure below forms the foundation of the new **Evolutionary Model** of the integration of computer-assisted education and contributes to its success (Apple Computer, Inc., 1990-1992; Becker, 1993, p.7; Brunner, 1990, p.14; Dyrli, 1994; Kearsley, 1992; Stager, 1995, pp.80, 81; Vorster, 1995; Zorfass, 1991, 1993; correspondents from the mailing list *Kidsphere* and the newsgroup *za.school*). They do not fit into any particular part of the **Evolutionary Model** but underpin the whole development.

The staff should be

- able to practise using the computer out of class;

- enabled to use the computer as a personal tool;
- given time in school for training and research;
- involved and play an active role from the design and planning stage to the evaluation stage (Anderson, 1996; Carl, 1995, p.244);
- financially assisted to purchase their own computers to use at home;
- financially assisted to purchase the same software as that being used at school;
- provided with access to program-expertise when necessary;
- provided with loaned computers for home usage; and
- encouraged to share enthusiasm and celebrate initiative.

The school should

- allocate resources prudently - it should initially focus on a few successful classrooms, teachers or subjects (Lippert, 1993, p.5);
- eliminate technical obstacles with technical staffing and enough financial planning;
- involve the principal, school management team and support staff as well as teachers (De Klerk, 1995);
- practice what it preaches with regard to learning theory, i.e. train the staff in the method/theory being used in the classroom;
- make technology and computers part of their overall planning to increase student learning (Morrison, 1996);
- introduce a system of ‘buddies’ where enthusiastic staff are partnered with those who are reluctant to use technology (Frers, 1996);
- provide adequate resources for the desired outcomes;
- take cognisance of the school’s dominant teaching/learning style, for example, whether it uses the traditional ‘factory’ approach or cooperative group work (De Klerk, 1995);
- provide time for joint decision-making and planning (Carl, 1995, p.244);
- select software with broad usage; and
- share the vision and goals of computer-assisted education (O’Neil, 1995b, p.11).

Community involvement and private sector support can be a useful help factor (De Klerk, 1995) which can be gained

- by means of communicating success and problems; and by

- offering training sessions using the school's facilities (Carter, 1996, p.29) on current market applications.

The **Evolutionary Model** was divided into five phases in the successful introduction of computer-assisted education, i.e. Introduction, Entry, Intermediate, Penultimate and Creation. The outcomes in each phase of the development and the infrastructure supporting those outcomes, were noted. Supporting factors are complementary to and sustain these outcomes. The outcomes and supporting infrastructure listed in Tables 2.4 to 2.8 are those of the **Classrooms of Tomorrow Project (ACOT)** (Apple Computer, Inc., 1990-1992), **CAMI Mathematics** (Vorster, 1995, 1996) and **Make It Happen!** (Zorfass, 1991, 1993) models, unless otherwise specified.

The different phases of the **Evolutionary Model** do not have a particular time limit and individuals will be at different phases in their personal computer-assisted integration development (Carter, 1996, p.32). This development takes time because it involves people, skills, attitudes, beliefs (Lippert, 1993, p.5), organisation and finance.

4 Development phases in the integration of computer-assisted education in the Evolutionary Model

4.1 Phase 1: Introduction

In the first of the five phases of the successful introduction of computer-assisted education, the technology is introduced into the school, for example, computers, network system and modems are installed. Time is spent checking if they work and how they work. Plans are drawn up and training begins. Teachers may spend time trying to teach with the computer by doing simple work.

Table 2. 4 Outcomes and infrastructure which contribute to the successful integration of computer-assisted education in Phase 1: Introduction

	OUTCOMES	
↕	**Instructional activity** • Computer use replicates traditional instructional and learning activities **Teacher interaction** • Identification of a steering or organising committee • Training of the teachers begins with word processing **General school** • Installation of the computers and complimentary technology, such as network systems, modems and telephone lines	↕
	SUPPORT INFRASTRUCTURE	
	Technical assistance • in the installation of the computers and complimentary equipment **Time to** • define the purpose of integration of computer-assisted education • develop shared vision with non-participant colleagues • plan in task teams • share frustrations and successes • train **Training** • in word processing	

The most crucial supporting factors here are the communication of enthusiasm and sharing the vision of a different kind of education or methodology. In this phase tabulated in Table 2.4, the planning and sharing of the vision are prerequisites which contribute to the successful integration of computer-assisted education (Knoetze, 1996). This phase may appear to be time-consuming but it is the foundation on which the integration rests.

4.2 Phase 2: Entry

In Phase 2 of the five phases of the integration of computer-assisted education, teachers start using the equipment. The computer is used mainly to support classroom instruction by means of drill-and-practice instruction or text-based work (Apple Computer, Inc., 1990-1992; Vorster, 1995). If a teacher needs support it is mainly of a technical nature whilst doing simple computer tasks.

During this phase, while completing simple computer tasks with the aid of technical support, the teachers lose their fear of the technology. In both **ACOT**’s evolutionary model and that of **CAMI Mathematics** the computer is used mainly in whole-class instruction and individualised seat-work (Apple Computer, Inc., 1992; Vorster, 1995) as tabulated in Tables 2.1 and 2.2. There is little change in classroom layout. Computer lesson work supports a predominantly behaviouristic approach to learning. The teacher needs to develop discipline strategies appropriate for the new classroom dynamics. Table 2.5 tabulates the support infrastructure which facilitates relatively stress-free and successful outcomes in the integration of computer-assisted education in Phase 2.

Table 2. 5 Outcomes and infrastructure which contribute to the successful integration of computer-assisted education in Phase 2: Entry

	OUTCOMES	
↕	**CURRENT OUTCOMES** **Instructional activity** • Computers are used mainly in drill-and-practice or text-based work • Established teaching methods and activities are supported by computer technology **acher interaction** • Stress levels of teachers are kept low with basic skill computer work • Teacher interactions are mainly of a technical nature • Technical assistance is given to teachers • Training of educators begins initially in word processing **NEW OUTCOMES** **Instructional activity** • Technical assistance is given to students	↕
	SUPPORT INFRASTRUCTURE	
	CURRENT SUPPORT INFRASTRUCTURE **Time to** • share frustrations and successes • train **Training** • in word processing **NEW SUPPORT INFRASTRUCTURE** **Technical assistance to** • develop teachers' confidence • develop teachers' use of hardware • facilitate students' use of computers **Time to** • evaluate outcomes (Kearsley, 1992, p.153) • share vision and enthusiasm **Training in** • word processing in subject area	

4.3 Phase 3: Intermediate

In Phase 3 of the integration of computer-assisted education, teachers and students use the computer as a tool. The word processor, database and spreadsheet are the main packages used. The students' computer work is completed more quickly than previously and the quality improves.

The role of the teacher changes to become more of a facilitator as opposed to being the focus of the instruction. Classroom interaction with students changes from technical assistance to sharing instructional strategies. Teachers move beyond drill-and-practice and text-based work to work of a more creative nature as they develop expertise in the medium. Teachers experiment with different computer applications. They investigate teaching strategies for problem-solving and higher-order learning. Physical classroom arrangements are made to optimise classroom space. There is a desire by teachers for more sophisticated hardware.

Table 2. 6 Outcomes and infrastructure which contribute to the successful integration of computer-assisted education in Phase 3: Intermediate

OUTCOMES
NEW OUTCOMES **Instructional activity** • Role of teacher gradually changes from instructor to facilitator • Students' work is done more quickly and quality improves • Students are motivated • Students peer tutor • There is a move from text-based instruction and drill-and-practice to word processors, databases, spreadsheets and graphics **Teacher interaction** • Collaboration on instructional topics between teachers • Teachers observe fellow teachers' classes **General school** • Curriculum is modified to make use of the different technologies • There is a desire for new technology (Musco, 1995, p.68)
SUPPORT INFRASTRUCTURE

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SUPPORT INFRASTRUCTURE
CURRENT SUPPORT INFRASTRUCTURE
Technical assistance to
• develop teachers' confidence
• develop teachers' use of hardware
• facilitate students' use of computers
Time to
• evaluate outcomes
• share frustrations and successes
• share vision and enthusiasm
• train
Training in
• team teaching
• word processing in subject area
NEW SUPPORT INFRASTRUCTURE
Time to
• discuss instructional strategies
• permit mentoring between teachers (Lyndes, 1995)
• permit peer observation
• permit team teaching
Training in
• databases, spreadsheets and graphics in subject area

4.4 Phase 4: Penultimate

Many changes in instructional strategies occur during the Penultimate phase of the integration of computer-assisted education tabulated in Table 2.7. Team teaching develops as a result of peer observation. Collaboration occurs as teachers share new instructional patterns and methods. The school timetable is juggled in order to accommodate team teaching. The teachers' organisational skills have to be well developed for the newly formed student groups. Much computer knowledge is needed from the teacher, i.e. technical and application skills. The teacher's role in the learning process is one of facilitator or collaborator rather than instructor.

Students get involved in collaborative and creative project work. Cooperative and group learning takes place. Many different packages are used during collaborative and creative project work rather than single computer packages. The computer packages are used as knowledge-building tools to support a growing constructivist approach to learning. With the constructivist approach to learning student grouping changes from homogeneous grouping to heterogeneous grouping or mixed ability grouping. New and better technology is required by the teaching staff.

Table 2. 7 Outcomes and infrastructure which contribute to the successful integration of computer-assisted education in Phase 4: Penultimate

OUTCOMES

CURRENT OUTCOMES

General school

- Curriculum is modified to make use of the different technologies
- Desire for new technology and better technology
- Students are motivated
- Students peer tutor

NEW OUTCOMES

Instructional activity

- Constructivist approach to learning replaces the behaviourist approach
- Different computer applications are used in learning
- Experimentation with student grouping
- Role of teacher gradually changes from facilitator to collaborator
- Students are actively involved in knowledge construction
- Students involved in collaborative and creative project work

Teacher interaction

- Experimental collaboration between teachers in interdisciplinary project-based learning

General school

- School timetable is rescheduled for team teaching

SUPPORT INFRASTRUCTURE

CURRENT SUPPORT INFRASTRUCTURE

Technical assistance to

- develop teachers' confidence
- develop teachers' use of hardware
- facilitate students' use of computers

Time to

- discuss instructional strategies
- evaluate outcomes
- permit peer observation
- share frustrations and successes
- share vision and enthusiasm
- team teach
- train

Training in

- team teaching
- word processing, databases, spreadsheets and graphics in subject area

NEW SUPPORT INFRASTRUCTURE

Time to

- attend conferences and presentations
- reflect on evaluation

Training in

- other computer packages in subject area
- teaching with student groups

4.5 Phase 5: Creation

The Creation phase in the development of computer-assisted education is never complete but is an ongoing process as new technologies are constantly being developed. Schools have to decide which new technologies best suit their instructional needs and adapt accordingly. Few schools have attained this ‘Nirvana’ (Vorster, 1995) owing to the costs and skills required. When schools reach this stage they realise what forces were unleashed by the integration of computer-assisted education, how so much in the learning/teaching process/system has changed.

The main feature of this last phase is that staff work in collaborative teams. Timetables are adjusted to allow team teaching and collaborative work. Teachers question their methods of teaching and evaluation. Much training has to be done as new teachers enter the teaching system but their movement through the preceding four phases is fairly quick as there is a knowledge and skill base in the school.

Students use the computer and other technology to create knowledge in the form of web pages, multimedia documents and multimedia presentations. Much of the learning is done in the constructivist mode. Students are motivated and keen to learn. Student verbal interaction is purposeful. The technology at the school will be inadequate most of the time, with demands ever spiralling. The phase has been tabulated in Table 2.8.

Table 2. 8 Outcomes and infrastructure which contribute to the successful integration of computer-assisted education in Phase 5: Creation

OUTCOMES
CURRENT OUTCOMES **Instructional activity** • Active involvement of students in knowledge construction • Assessment is either portfolio or authentic assessment • Constructivist approach to learning replaces behaviourist approach • Many different computer packages used in learning • Students involved in collaborative and creative project work • Students motivated • Students peer tutor **Teacher interaction** • Interdisciplinary project-based learning • Team teaching **General school** • Desire for new technology and better technology • Modification of the curriculum to make use of the different facilities • School timetable rescheduled for team teaching **NEW OUTCOMES** **Instructional activity** • Accommodation of more learning styles, individual needs and individual preferences (Kinnaman, 1994, p.74) • Balance between direct and project-based teaching • Knowledge creation • Multimedia programs used • Teacher acts as a collaborator in the learning process (O'Neil, 1995a, p.9) • Use of new technologies (O'Neil, 1995b, p.10)
SUPPORT INFRASTRUCTURE

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SUPPORT INFRASTRUCTURE

CURRENT SUPPORT INFRASTRUCTURE

Technical assistance to

- develop teachers' confidence
- develop teachers' use of hardware
- facilitate students' use of computers

Time to

- attend conferences and presentations
- evaluate outcomes
- permit peer observation
- reflect on evaluation
- share frustrations and successes
- share vision and enthusiasm
- team teach
- train

aining in

- teaching with groups of students
- team teaching
- other computer packages in subject area

NEW SUPPORT INFRASTRUCTURE

Technical assistance to

- select and source suitable hardware
- select and source suitable software

Time to

- act as a mentor
- do research on effective ways of teaching
- publish teaching experiences
- question the whole methodology of teaching

Training in

- new and innovative technologies

5 Summary

The integration of computer-assisted education has been discussed and defined. Three models of the development of computer-assisted education, the **Apple Classrooms of Tomorrow (ACOT), CAMI Mathematics** and the **Make It Happen! (MIH)** models were discussed and integrated into one new **Evolutionary Model**. This new **Evolutionary Model** was divided into five phases that include expected outcomes and the infrastructure necessary to sustain them.

The integration of computer-assisted education is more than just using computers. It changes the school organisation, finances, evaluation, method of teaching, type of learning and student work attitude. All the staff of a school are influenced by the integration of computer-assisted education.

The **Apple Classrooms of Tomorrow (ACOT) Model** is an open-ended look at technology-rich schools (Tierney, 1996, p.171). The changes in those classes were documented and are divided into five phases of Entry, Adoption, Adaptation, Appropriation and Invention. Each phase was described noting the outcomes and what was necessary to achieve those outcomes.

The **CAMI Mathematics Model** was described. The difference between the **CAMI Mathematics Model** and that of **ACOT** was that the **CAMI Mathematics Model** was about the gradual integration of computer hardware, software, financial resources and teacher skills. The hardware, software, financial resources and teacher skills are noted and the expected outcomes with the addition of more of the above.

The **Make It Happen! (MIH) Model** was discussed where a team of teachers deliberately focus on a curriculum and the integration of computer-assisted education, was discussed. This plan occurs over two or three years and the changes and actions in each step are noted.

The three models had common features which were synthesised into one **Evolutionary Model**. This model describes the five phases in the integration of computer-assisted education: Introduction, Entry, Intermediate, Penultimate and Creation. The outcome in each phase and what infrastructure supported that outcome is described. In the five phases it is found that in teaching the

- number of computer applications used changes from one to many;
- role of the teacher changes from facilitator to collaborator;
- methods change whereby the students becomes actively involved in their own learning;
- type of computer application changes from the information processor, the word processor, to the information creator, multimedia; and the
- type of learning changes from a behaviouristic mode to a constructivistic mode.

The teacher interaction changes whereby

- interdisciplinary work begins;
- verbal computer-related interaction changes from technical to collaborative;

- team teaching begins; and
- training in applications changes from technical use of the application to use of the application as a tool.

Within the school the

- curriculum is modified to integrate computers; and
- timetable is rescheduled.

The **Evolutionary Model** describes the changes which take place within a school while the support foundation of the **Evolutionary Model** describes the infrastructure necessary for the integration of computer-assisted education to take place. The infrastructure necessary for the integration of computer-assisted education were listed under the headings of staff, school and community involvement.

6 Conclusion

This chapter has looked at four models which describe the integration of computer-assisted education and the infrastructure necessary for the integration of computer-assisted education. Chapter 3 will describe the method used to investigate the integration of computer-assisted education at Pinelands High School. Chapter 4 will describe the findings of computer-assisted education at Pinelands High School. In Chapter 5 the findings of the integration of computer-assisted education at Pinelands High School will be synthesised with the phases of the **Evolutionary Model** and its necessary infrastructure.