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The video-class system as a supportive strategy for affordable teaching and learning in schools

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Abstract:
Continuing teacher shortages (*inter alia* because of HIV / AIDS) and diminishing education budgets compel educationists to explore different strategies to meet the demands of a growing school population, especially in developing countries. The teacher-operated video-class system is such a strategy. This system and the rationale for its implementation are described. Research during the initial implementation phase of the system revealed that it had no negative effects on the quality of education and could lead to substantial savings in terms of teacher time, resources and budgetary expenses.

Opsomming:
Onderrig instansies vorm deel van die min instansies in die gemeenskap wat tegnologie nie as 'n integrale medium gebruik om produktiwiteit te bevorder na die oorsig van die dienste na die industriele revolusie. Die huidige ekonomiese situasie oor die algemeen in die wereld, en in Suid-Afrika as 'n spesifieke voorbeeld van 'n ontwikkelende land, vereis 'n oorsig van die situasie, omdat so 'n hoe persentasie van die onderwys begroting kanaliseer moet word as besoldiging van personeel. Dit is belangrik om maniere te bewerk waar die effektiwiteit van onderrig behoue gaan bly deur interaksie tussen die onderwyser en die leerder te behou, en nie 'n impak op die goeie werk van die onderwyser te he nie. Die voorgestelde onderwyser-beheerde video-klas stelsel kan sy doel dien. Die doel is eerstens om die basiese beginsels van die konsepte wat tot video-klas stelsel ontwikkeling gelei het te bespreek. Die tweede doel is om die tegnologie wat ontwikkel is om voorsiening vir behoeftes vir die video-klas stelsel te verduidelik. Die navorsingsresultate wat oor die effektiwiteit van die video-klas stelsel in die onderrig van Engels, Wiskunde vir graad 8 leerders, word ook gerapporteer. Ten einde word 'n video-voorstelling van 'n eiesoortige les getoon, asook die reaksie van leerders, onderwysers en ander belangstellende individue se mening oor die voordele en probleme van die video-klas stelsel.

Introduction and problem statement

Provision of the required quantity and quality of teachers is presently one of the major challenges in most education systems. The problem of teacher shortages has recently been exacerbated in developing countries by the impact ofHIV/AIDS (World Bank, 2002:5). This problem in the developing world cannot, however, be effectively addressed by merely recruiting student teachers in greater numbers, or by introducing more favourable teacher-leamer ratios in schools. Not only is the latter solution pedagogically and didactically counter-productive (the ratios are already at 1 :33.1 or more) but there are also not sufficient numbers of learners with the required qualifications emerging from school systems to provide in the need for future teachers (Schlemmer, 2004). The problem is further complicated by the fact that, even if sufficient numbers of student teachers could be recruited, most of the education departments in the developing world expe-

rience difficulties in funding their training programmes as well as their future salaries. Because of these difficulties, other solutions to the problem have to be found in order to avoid possible crises in the education systems of developing countries.

Not all creative solutions are appropriate, however. An appropriate solution should comply with criteria such as the following:

- It should promote (or at least maintain) the current levels of effectiveness in schools;
- An increase in the teacher-learner ratio should be possible without negative impact on the quality of education;
- It should reduce the workload of teachers, and
- It should be pedagogically and didactically sound.

Compliance with criteria such as these will help schools, as well as the education system in general, to remain functional. 'Functionality' in this context means that not only should appropriate pedagogical care be taken of learners during their sojourn in the system, but the numbers of learners successfully exiting the system should also be increased to optimum levels. In other words, increases in output should be effected without compromising the quality of leamers' teaching-learning experiences in schools.

F or the purposes of this project, several solutions to the problem (e.g. special incentives, mentorships, apprenticeships, shorter teacher-training periods) have been considered and found wanting in terms of the criteria mentioned above. The implementation of technology in solving the problem was found to be more suitable (Schlechty, 1997), despite the fact that its application has frequently been questioned. The use of technology has primarily been rejected as being a product of technicism, technocracy, globalisation, capitalism and consumerism, as leading to feelings of alienation and exploitation by learners and of being subjected to manipulation by heteronomous global forces (Benson, 2003). However, according to Muller (1998 :9), education institutions are among the last (since the Industrial Revolution) to implement technology in an integrated manner for the improvement of their effectiveness and productivity.

The solution to the problem of teacher shortages in developing countries as set out in this article, *viz*. the use of a teacher-operated video-class system, has been devised to comply with the criteria stated above. It is also an attempt to implement technology in an integrated and responsible manner for the purpose of increasing the productivity of schools without compromising standards as well as their output in terms of leamers successfully completing their school careers.

Purpose of this article and methodology

A technologically based solution to the problem described in the previous section, in the form of a teacher-operated video-class system, was developed and patented (Steyn, 2001: Patent 2001/4284) during 2000-2001. The purpose in this article is to outline the rationale and criteria for its development and implementation, to describe the features of the system, to report on the results of its initial implementation and on the advantages of the system that emerged during the initial implementation phase.

Rationale for developing the teacher-operated video-class system

The fundamental reason for the development of the system, *viz*. teacher shortages and limited education budgets, especially in developing countries, has been alluded to. In a recent report, the World Bank (2002) pointed out that HIV/AIDS was draining the 'supply of education, eroding its quality and increasing the cost of the education sector. It pointed out that Africa, in particular, appeared to be experiencing sharp increases in mortality rates among teachers and administrators at all levels of education. Even where teachers were present, they were often ill and ineffective,

or poorly qualified. Schools had to make do with whatever was available. Education systems even tended to cut corners on teacher education. Education budgets had to accommodate higher levels of teacher education and hiring costs to replace teachers lost through AIDS, as well as for the payment of full salaries of teachers who were absent due to illness, and additional salaries for substitute teachers. Especially disturbing was the fact that the absence of a teacher deprived whole classes of children of education. It has been estimated that about 860,000 learners in sub-Saharan Africa were deprived of education by the loss of teachers due to AIDS during 1999 alone (Piot & Kelly, 2002:xvi, xviii, 11).

The South African education system is a case in point. It currently employs in the region of 350,000 teachers (Morrow, 2004). Given an attrition rate of 5%, approximately 17,500 new teachers have to be added to the system annually. A recent study on teacher supply and demand in South Africa showed that, if the projected effects of AIDS were also taken into account, some 30,000 new teachers would be required annually (Crouch, 2001). Ifa student teacher drop-out rate of 10% during their four years of training is also brought into the reckoning, the intake should increase to approximately 45,000 per annum. This intake represents about 12% of all the candidates that exited the school system in 2000. Since not all school-leaving candidates can comply with the formal requirements for entering teacher education courses, this intake represents approximately 66% of those who passed the final school grade with matriculation exemption (university admission passes) (Strauss, Van der Linde & Plekker, 2000).

The recruitment of such a percentage of school leavers for the teaching profession is not realistic. Many school leavers object to considering the teaching profession as a career for the following reasons: the low remuneration received by teachers, the poor working conditions, the low status of the teaching profession, and the fact that those who qualify for teacher education also qualify for training towards more lucrative professions (Beeld, 2004).

The problem of teacher recruitment is exacerbated by the present economic slump in many countries. In South Africa, for instance, although more than 23% of the annual national budget is routinely allocated to education, it still does not supply adequately in the needs of the education system for a growing population. A disproportionately high percentage is allocated to teaching staff and other personnel. The Gauteng province of South Africa, which spent more than 85% if its 2002 budget on staff remuneration, compares favourably with the other eight provinces, which each spent more than 90% on this item (Jacobs, 2000: par.B). Because of these conditions, education authorities find themselves continuously struggling to cut expenditure. This often lead to increases in teacher-learner ratios, which in turn tends to impact negatively on the functionality, quality and output of schooling (Van der Westhuizen, 2002).

As has been suggested above, a solution to the problem of teacher shortages has to be found which would facilitate increases in teacher-learner ratios without impacting negatively on the quality of the system.

The basic criterion with which the solution had to comply: effective education

As has been indicated, technology-based solutions to societal problems have been severely criticised in the past. A technology-based solution to the problem of teacher shortages would obviously be subject to similar criticism if it leads to a decrease in educational effectiveness. It was, therefore, incumbent upon the developers of the teacher-operated video-class system to take cognizance of what 'effective education' entailed.

Teaching can be defined as complex, intentional activities between teachers and learners for the purpose of assisting learners to acquire the competencies (knowledge, skills and attitudes) required for serving their respective communities later in life. The following are typical charac-

teristics of teaching (Nieuwoudt, 1998:39-53):

- Teaching is an intentional activity directed at particular aims and the mastery of specific content is required for reaching the aims. At least two persons are involved, namely, the teacher and the learner (Woolley, 2004).
- The interaction between the teacher and the 1eamer refers to and includes interpersonal exchanges, teaching strategies, maintenance of order and discipline, and evaluation/ assessment (Wiltz, 2001). Teaching occurs in a particular teaching-learning environment or setting (Tappert, 2000).

Effective school education depends on three conditions:

- Localisation of content: In outcomes based education, for instance, the content should be relevant to the real world of the learner.
- The teacher as role-model: The teacher should be capable of facilitating learning according to the particular needs of the learner as well as be able to serve as a motivator.
- Interaction among learners: Learners should be enabled to interact with each other, *inter alia* in group learning (Nieuwoudt, 1998:39-53).

These characteristics of teaching are always contextualised and particularized by a teaching paradigm. Some teachers (or schools) operate within a positivist paradigm (Lenhardt, 1990: 20-23), whereas others prefer (for instance) a post-positivist constructivist paradigm (Nieuwoudt, 1998: 7). In all of these paradigms, the effectiveness of education depends on the success attained by the teacher in performing an informative, organising and guiding role in the teaching-learning activity. It is these roles of the teacber have to be targeted by the proposed technology-based solution developed for addressing the problem of teacher shortages.

The teaching-learning situation is further characterised by interaction between teacher and learner (Nieuwoudt, 1998:39-53). The teacher should, for example, grasp every opportunity to guide, explain and organise the learning content, and the learners, for example, should always be given opportunities for asking and answering questions. Interaction in a teaching-learning situation can manifest itself in many ways: in the form of inter-active study-guides (Schlosser & Anderson, 1994), or assignments, which are forms of delayed response to teacher inputs. However, from observations in many classrooms, it is clear that up to 70% of all learners in class situations elect not to interact directly with the teacher although they seem to take advantage of the interactions between their fellow-learners and the teacher (Steyn & Combrinck, 2002:4).

Teaching-learning interactions can occur in traditional classrooms as well as in non-traditional ones. The latter refers to environments or situations where teachers and learners are neither personally nor simultaneously present but are able to interact with each other by means of interactive or one-way media (such as video or CD recordings) (Allardyce, 1995:2; Russell, 1994:57). In non-traditional 'classrooms' the presence of the teacher remains pedagogical and didactical but is not personal (Willocks, 1996). Research has shown that teaching and learning are as effective and productive in such virtual classrooms as in traditional interactive classrooms (Russell, 1993 :3). In non-traditional or virtual classrooms, extensive use can be made of technology in the form of video and audio recordings, compact discs and computer software, virtual reality and virtual interactivity. Emotional (joy, enthusiasm) and intellectual (interest, curiosity, questioning attitude) reactions and responses can be evoked in such virtual teaching-learning situations to the same extent as in traditional interactive situations (Yeh, 2004).

Features of the teacher-operated video-class system

The teacher-operated video-class system is an adapted version of a system used in higher education systems in the United States of America (Nieuwoudt, 1998:39-53). It entails the

integration of standard teaching methods and video techniques, and its process reproduces actual classroom activities for the purpose of providing effective education. Exchanges and activities occurring in traditional classrooms are videotaped for use by learners who were not present in the classrooms in which the recordings were made. One of the advantages of this system is that teachers are not expected to adapt or effect any major changes in their classes for purposes of the video recordings. They can continue with their normal teaching and instruction practices, without any major changes.

The video-class taping unit forms the core technology of the system. The unit consists of a video control unit, cameras, microphones and television monitors (Figure 1).

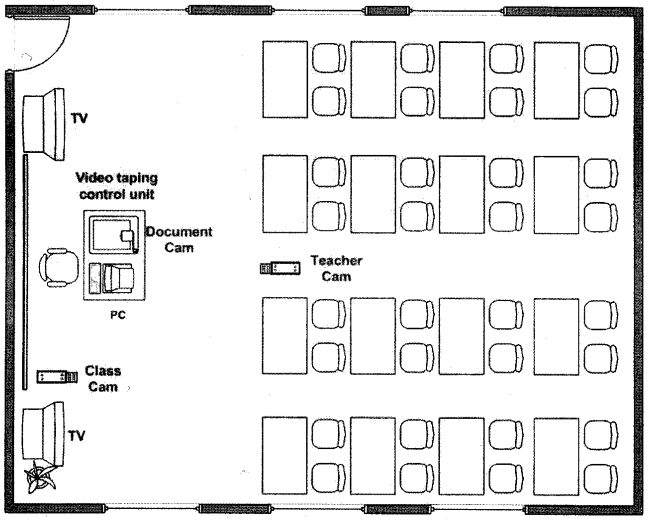

Figure 1 Classroom organisation for the video-class system

Typically, three video cameras are used: the main camera records the actions of the teacher while teaching (see Photo 1); the class camera records the responses of the learners and interactions with the teacher (see Photo 2); the document camera records the documentation used by the teacher, much as an overhead projector is used (e.g. for illustration material see Photo 1).

Photo 1

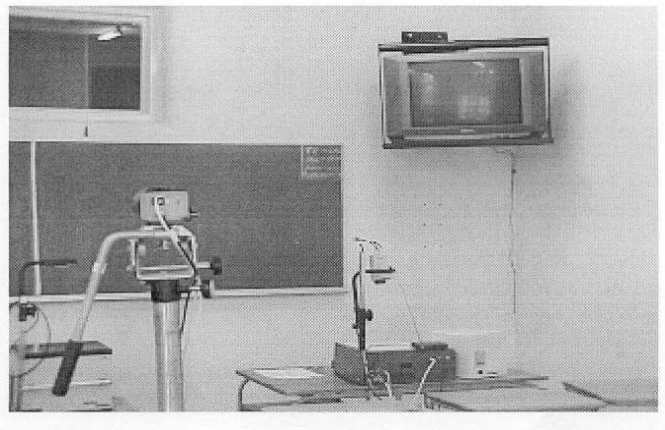

Photo 2

A microphone attached to the lapel or dress of the teacher records the presentation of the teacher and is active for the duration of the lesson. This microphone is also linked to all the cameras. There are also peripheral microphones linked to all the cameras; their purpose is to record the verbal contributions of the learners.

The video-control unit (see Photo 3) consists of the following components: a video/audio switch for use by the teacher (editor) for the combination of video and audio inputs by means of three video ports and two sound jacks; a camera control unit that focuses and zooms all the cameras separately; a standard wireless receiver for the lapel microphone, and a standard VHS video machine for recording all the activities. Photographs are of the original prototype of the video-control unit and the compact second proto-type.

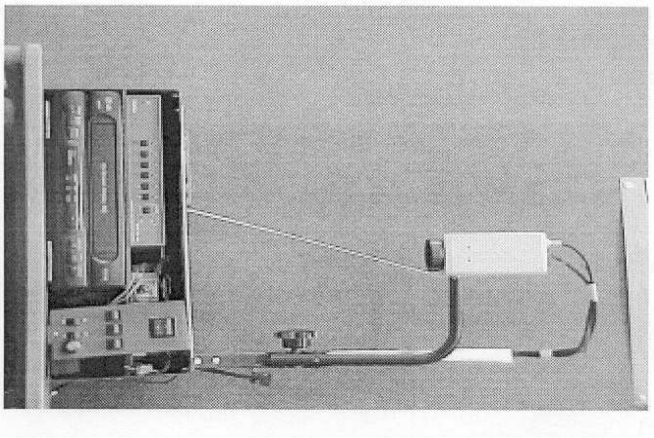

Photo 3

The television monitors are placed in strategic positions in the classroom and also used in the place of the overhead projector. The cameras are all connected to the control unit by means of RG5l coaxial video cables. The microphones are wireless. The television monitors are connected to the output ports of the video machine by means of ordinary video/audio coaxial cables. Two-way splitters are used as necessary. Figure 1 shows the positioning of the various components in the classroom.

The teacher operates the video-class taping unit herself by means of an infrared remote control unit. She edits the recording while teaching by deciding which camera will record a particular facet of the lesson, and then switching to that camera. She can also use the main camera for wide or close-up shots of herself or of the teaching area. She can also switch to the class camera or to the document camera (in the place of an overhead projector). The fact that the teacher herself remains in charge, and can edit the proceedings in the classroom herself, makes this a user- friendly system. The teacher takes all decisions with regard to the presentation and its pedagogical-didactical effectiveness. It takes only a few practice runs for a teacher to master the different switches. With practice, switching between cameras becomes an automatic reflex.

The system also requires timetable changes in order to release the teacher from regular teaching duties during certain periods. The following can, for example, be used as a timetable for the teaching of Mathematics in Grade 9 (see Table 1).

During the periods marked Vt (class 9a) the lesson is videotaped by the teacher, followed by periods marked Tc, during which the teacher is present to facilitate learning and to solve problems. During periods marked Vp (classes 9b to 9d) the recorded videotape is played back in the absence of the teacher. This is followed by periods in which the teacher is present to

facilitate learning and to follow up on the playback of the videotape. The recording of lessons should be rotated among the classes in order to ensure that all the classes receive the same exposure to the teacher.

Table 1 Example: Mathematics Grade 9 (6 periods a week)

Class	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6
9a	Vt	Tc	Vt	Tc	Vt	Tc
9b	Vp	Tc	Vp	Tc	Vp	Tc
9c	Vp	Tc	Vp	Tc	Vp	Tc
9d	Vp	Tc	Vp	Tc	Vp	Tc

Vt = videotaping session; Tc = teacher present in classroom to actively facilitate learning;
Vp = video playback by technician; teacher absent.

The teacher-operated video-class system in practice

The theoretical conditions with which the teacher-operated video-class system had to comply were discussed earlier. Once the system was completed and installed in two schools, a few questions pertinent to the educational effectiveness of the system had to be answered:

- How does the system affect the academic achievements of the learners?
- How does the system affect the level of discipline in the classroom?
- How do the teachers and learners respond to the changes brought about in the classroom climate?

To find answers to these questions as well as to evaluate the sustainability of the system, a pilot study was undertaken in two secondary schools. In each of the schools two subjects, English and Mathematics Grade 8 level, were selected. These subjects were chosen because they require different teaching and learning strategies. In each of the schools, three Grade 8 classes were involved in the study. In each case the' A' classes were used for the videotaping of lessons whilst the 'B' classes were used for playback episodes. The 'C' classes continued as usual, thereby serving as control groups. The research was conducted during the third quarter of the 1999 academic year. In each subject, the learners took a pre-test and two post-tests.

After an exposure of eight weeks to the video-class system, the results of the three tests were subjected to an analysis of variance (ANDY A) to discover whether there were any significant differences in the achievements of the three groups in each school. It was found, with regard to Mathematics, that there were no significant differences between the recorded, playback and control groups in any of the schools. This implies that the video-class system has no positive or negative influence on the academic achievement of learners. No differences of practical significance were found to exist between the epistemological beliefs of low and high achievers in Mathematics in the various classes (Nieuwoudt, 2003: parr.5.6.2.1; 5.8.1.1). This is in agreement with the findings of Lowry and Thorkildsen (1990), namely, that the use of a video-class system does not have any negative impact on the teaching and learning of Mathematics. Huge (1990) also found that video recordings of lessons in this subject could be successfully used to compensate for the absence of teachers (see also Monteith & Nieuwoudt, 2000:5-6). Fourie (2000) reported similar results for the teaching of English, though not on the basis of rigorous experimental testing.

This research revealed that the teacher-operated video-class system had no negative effect on the academic achievements of the learners, at least in these two subjects at Grade 8 level.

The maintenance of discipline in the playback classes was also a main concern. A surveillance camera was used and observed by the relevant teachers and headmasters. Analyses of the video tapes revealed that there were no differences in the discipline of classes where a video was played and the general conduct of the learners in comparison with the recorded classes where the teachers were present. The learners remained interested in the video recording and conducted themselves as if the teacher were physically present. This research revealed that the video-class system had no negative effect on the discipline of the learners.

In order to determine how teachers and learners responded to the changes brought about in the classroom climate by the implementation of the system, Drinkwater (2000) interviewed those involved, as well as their headmasters. She found nothing negative with regard to the implementation of the system and concluded that the implementation of the system did not affect classroom climate. It had no effect on the teaching experiences or the responsibilities of the teachers, or on the learning activities of the learners.

In conclusion, the hypothesis can be developed that the video-class system will not impact negatively on the teaching and learning of school subjects. The levels of achievement in ordinary contact classes can also be maintained in video play-back classes. Similarly, it can be expected that the video-class system will have neither a negative nor a positive influence on the classroom discipline and classroom climate.

Advantages of the teacher-operated video-class system

The system has several advantages, of which the following are the most prominent:

- The system can be developed and implemented at relatively low cost.
- Use of the system involves relatively low-level and easily accessible technology.
- Although the system depends on technology, the teacher always remains in charge, available in person to facilitate learning, and to assist individuals as well as groups of learners with mastery of difficult subject content. The system allows for effective teacher-pupil contact and interaction.
- Teacher monotony caused by the duplication of lessons is decreased.
- The system is based on the principle of delayed response by learners to the inputs of the teacher. In doing so, it promotes independent and self-regulated learning.
- The system promotes school-based in-service teacher education: experienced and successful teachers can be selected for presenting video-taped lessons, and less experienced teachers can be temporarily employed as technicians for the play-back phase.
- The localisation of learning content, the involvement of the teacher as a role model and the culture of learner interaction, which are all features of effective education, are retained.
- The system enables education managers to increase teacher-pupil ratios without increasing actual class sizes.
- The system provides savings of approximately 40% of teacher time, which can be put to better use than the duplication of classes. This amounts to savings in the education budget of up to 25%.
- The system can lead to willingness on the part of school administrators, parents, teachers, and learners to explore other teaching strategies, in the process overhauling and renewing the provisioning of education with a minimum of changes.

Concluding remarks

The teacher-operated video-class system appears to be a viable, sustainable and cost-effective

supportive strategy for effective teaching and learning in schools. It seems, in fact, to be the only viable alternative for effective education within the constraints of decreasing teacher numbers and diminishing education budgets. The research reported here revealed no effects detrimental to the effectiveness and productivity of education. On the contrary, the research showed that the video-class system has several advantages, not the least of which is the savings brought about by the more effective use of teacher time and the concomitant savings to the education budget.

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