# The Implementation of Application of Number

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# The Implementation of Application of Number

## 1   Abstract

Key Skills have recently been incorporated into the 16-19 curriculum, and there are plans to extend their influence further.  This paper is based on interviews with 26 members of staff and 11 students across five centres which offer Key Skills as part of GNVQ(s). Through qualitative analysis, it documents how the centres are delivering the Application of Number aspect of Key Skills, and the reactions of students and key members of staff involved in the delivery.

## 2   Introduction

In 1993 General National Vocational Qualifications (GNVQs) were introduced in England, Wales and Northern Ireland.  Together with other qualifications they formed a tripartite structure of 'academic' A levels, 'applied' GNVQs and 'vocational' NVQs. These new 'applied' qualifications were designed to develop "*general skills as well as ...specific working skills*" (White Paper: Education and Training for the 21st century).  With this in mind Key[1] Skills were incorporated into the GNVQ assessment framework.  Six Key Skill areas were identified; three were compulsory – *Communication, Application of Number and Information Technology* - and three were optional - *Working with Others, Improving Own Learning and Problem Solving.*

Although there has been a great deal of literature on Key Skills, this has mainly investigated what skills can be classified as "Key" (e.g., Oates, 1991; Further Education Unit, 1993; Hyland, 1994), the importance and desirability of including transferable skills into the curriculum (e.g. Baker, 1989; Confederation of British Industry, 1989; National Curriculum Council, 1990; NCVQ, 1995; Dearing, 1996) and the competence of individuals in these areas (e.g. Murphy et al., 1997).  Thus far there has been rather less written on how centres are actually managing the implementation of this initiative, (Oates, 1991 and 1996; Wolf, 1997) and even less literature which focuses specifically on Application of Number, which almost from the start has been recognised as problematic (NCVQ, 1993) although the research of Yeomans (1999) and Ecclestone (1999) may provide some insights into these issues.

To address the lack of literature about the implementation of Application of Number (AoN) a survey of centres who delivered GNVQs was undertaken at the end of the Summer 1998 term (McAlpine and Greatorex, 1999).  Centres could be classified into 5 models based on their responses to the questionnaire.

**Model 1** comprised those centres where Application of Number (AoN) was taught by Maths specialists (including for this purpose Basic Skills teachers), and was taught either as a separate AoN or Key Skills course, or was taught within the GNVQ course, but as separate teaching units.

**Model 2** comprised centres which varied in their staffing provision.  A number of these centres cited "devolved management" or "staffing reasons" as the variation in their provision.

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[1] Formerly Core

**Model 3** comprised centres where Application of Number was taught by Maths specialists, delivered in an AoN, Key Skills or GCSE course and where AoN was incorporated into GCSE. It was notable that these centres tended to be small 11-16/18 centres with limited GNVQ provision.

**Model 4** comprised centres where AoN was taught by GNVQ teachers, who integrated it with GNVQ teaching. From their comments, many of these centres implied that they would be hostile to the integration of AoN and GCSE maths as they are serving quite different purposes.

**Model 5** comprised centres where AoN was taught by Maths specialists, but was incorporated into GNVQ for at least some of the time.

The following table summarises the characteristics of each of the models. It should be noted that in model 2, there is variation in the way that AoN is organised, sometimes between the levels, sometimes between the subjects. This variation was also noted by Wolf (1997), so while it may be argued that these centres were merely mixing models within one institution, it did seem worthy of further investigation. It can also be seen from the table that the models are not mutually exclusive. Both models 4 and 5 organised AoN provision as part of the GNVQ course and both models 1, 3, and 5 involved Maths staff teaching AoN. The list of models illustrates that there is a variety of ways in which AoN is organised. This diversity in the organisation of Key Skills provision has been noted by Wolf (1997).

**Table 1 Summary of key identifiers and characterisation of each of the models**

| Model | Teachers | Organisation | Do GNVQ students study GCSE maths? |
|---|---|---|---|
| 1 | Maths staff | As a separate AoN/KS course | yes - some/all study GCSE Maths separate from AoN |
| 2 | Varies | Varies | Varies |
| 3 | Maths staff | Within a GCSE Maths course | yes - some/all study GCSE maths which incorporates AoN |
| 4 | GNVQ staff | Integrated part of a GNVQ course | yes - some/all study GCSE Maths separate from AoN |
| 5 | Maths staff | Integrated part of a GNVQ course | Varies |

**Table 2 Number of centres in each model by centre type**

|  | 11-16 Schools | 11-18 Schools | 6th Form Colleges | FE Colleges | Missing/ Other | Total |
|---|---|---|---|---|---|---|
| Model 1 | 6 (37.5) | 37 (32.7) | 1 (9.5) | 12 (27.2) | 1 (12.5) | 57 (28.2) |
| Model 2 | 5 (31.3) | 11 (9.9) | 7 (33.3) | 18 (40.9) | 5 (62.5) | 46 (22.8) |
| Model 3 | 1 (6.3) | 5 (4.5) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 6 (3.0) |
| Model 4 | 2 (12.5) | 24 (21.6) | 9 (42.9) | 5 (11.4) | 2 (25.0) | 42 (20.8) |
| Model 5 | 2 (12.5) | 26 (23.4) | 2 (9.5) | 6 (13.6) | 0 (0.0) | 36 (17.8) |
| Idiosyncratic | 0 (0.0) | 10 (9.0) | 2 (9.5) | 3 (6.8) | 0 (0.0) | 15 (7.4) |
| Late Returns | 2 | 1 | 2 | 0 | 2 | 7 |
| Total | 18 | 114 | 23 | 44 | 10 | 209 |

This survey of centres generated a wealth of valuable data, some of which is discussed in McAlpine and Greatorex (1999). To give the statistics from the survey a context and to gain details which were not necessarily accessible through a questionnaire a series of case

studies (one for each model) was undertaken. Some of the issues which arose from these case studies 'Numeracy' and 'Students' needs and abilities' are discussed in this paper. The aim in this paper is *not* to provide an in depth discussion of the research literature related to 'Numeracy' and 'Students' needs and abilities' but to report the issues which arose in relation to these themes for the staff and students that were interviewed.

# 3   Methodology

## 3.1   Identification of case study centres

The researchers chose a centre to represent each model as a case study. Using a case study for each model ensured that the whole range of provision of AoN was covered by this study. It was decided that if possible the sample should include all of the types of centres which were delivering AoN, and where possible centres which were "typical of their model" should be chosen. Five centres were duly identified for further study.

The researchers and a mathematics examination administrator examined the questionnaire returns of the centres which had accepted. The main criterion for choosing a centre as a case study to represent a model were:-

1. the "keenness" of the centre to participate - *to minimise rejection rates;*
2. further details of provision given by the centre - *to ensure that it was typical of its model.*

The responses to the survey were then used to identify "models" of how centres were choosing to structure their Application of Number provision and five centres each typifying one of the identified models were chosen to form the case studies. These details are given in McAlpine and Greatorex (1999).

## 3.2   Conducting the case studies

### 3.2.1   Interviews with staff and students

#### 3.2.1.1   Development of the instruments

A number of key people had been identified as holding important, yet distinct perspectives on the issues that we wished to explore. These were:-

Head of Mathematics department;
Member of Mathematics department;
Member of staff (not Mathematics department) who delivers GNVQ;
Member of Senior Management Team (Curriculum Co-ordinator);
Key Skills Co-ordinator;
Student studying GNVQ and GCSE mathematics;
Student studying (primarily) GNVQs, but not GCSE Mathematics.

Separate interview schedules focusing on different issues were developed for each role. At least one member of staff undertaking each role was interviewed in each case study.

**Table 3 Issues raised with participants**

|  | R | M | I | C | A | D | O | L | E |
|---|---|---|---|---|---|---|---|---|---|
| Head of Mathematics | | ✓ | | | | | | ✓ | ✓ |
| Member of Mathematics Dept. | | | ✓ | | ✓ | ✓ | | ✓ | ✓ |
| GNVQ staff member (not mathematics) | ✓ | | ✓ | ✓ | ✓ | | | ✓ | |
| Senior Management Team | ✓ | | | | ✓ | ✓ | ✓ | ✓ | |
| Key Skills Co-ordinator | ✓ | | | | | ✓ | ✓ | ✓ | |
| Student studying GNVQ and GCSE Maths | ✓ | | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| Student studying GNVQ but not GCSE maths | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | | |

**Key to the above table**
R      - Role/ Background
M     - Organisation of Mathematics Department
I      - Involvement with other forms of Mathematics Provision
C     - Contact with staff in other departments
A     - Attitude to Application of Number
D     - Delivery of Application of Number
O     - Organisation of Application of Number
L     - Links between pre/post 16 centres
E     - Modular examinations

The interviews were designed to be semi-structured, in that schedules were developed to focus the interview and to facilitate communication with the participant. Rather than being seen as rigid schedules which were to be followed in all cases, they were designed to form a basis for discussion which might go beyond the remit of the schedule either to explore areas more deeply or to discuss issues which the participants brought up spontaneously, details are given in McAlpine and Greatorex (1999).

## 3.3   Analysis

Transcriptions were coded using a Grounded Theory approach to construct a theoretical framework. The coding was generated from the data to form a picture of what staff and students were experiencing in each centre. The theoretical framework was developed from the issues that the participants raised. Once coding was complete, the participants' responses in each of the key issues (as identified by the framework) were summarised and charted so that the similarities and differences between models could be explored (McAlpine and Greatorex, 1999).

# 4 Results

The results outlined here are from a preliminary analysis of the data from the case studies. Further analysis may highlight different points and reach different conclusions.

## 4.1 Description of centres chosen as case study centres

The following is a description of the centres used for each case study. The case studies represented their model but also had their own distinct characteristics. The names of the centres are fictitious. These models are outlined in Table 1 above.

**Model 1**
The centre chosen to represent Model 1 centres was ***Elderflower Community College***. This mixed 13 - 18 school[2] was situated in a small town near the coast of England. Supported by the LEA as a County School, it had a comprehensive admissions policy and a population of over 2,000 students. It admitted all students who wished to attend the Sixth Form, although there was some concern that the Sixth Form should be seen as a rigorous place to be.

**Model 2**
The model chosen to represent Model 2 centres was ***Willow College***. This large Further Education college (approx. 16,500 students - 1,500 f/t; 15, 000 p/t) was situated on the outskirts of a market town in the centre of a predominantly rural area, from which it drew the majority of its students.

**Model 3**
The centre chosen to represent Model 3 centres was ***Acorn School.*** Like Elderflower Community College this was also a mixed, comprehensive, LEA maintained school, which took students from 11-18. Situated on the outskirts of a medium sized town which was close to a number of large cities, it primarily served the local community although some pupils came from further afield. The population was approximately 1,500.

**Model 4**
This model was represented by ***Hawthorn College***, a small mixed comprehensive sixth form college with strong ties to a local FE college, which was perceived by local 11-16 schools as "their" sixth form. The college was situated in what had been a northern industrial town, near other similar towns and a large industrial city.

**Model 5**
The centre which was chosen as a case study for model 5 was ***Sycamore College***. It was a Further Education college with three campuses, all situated in an inner city area in a large city in the Midlands. Until recently the college had been subsidised by the LEA but this was changing due to the new arrangements for FE funding. The achievement of young people in the area at GCSE mathematics was quite low and this was reflected in the number of GCSE

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[2] as indicated on the returned survey, although official data from the DfEE states that it takes students from 11 - 18.

retakes. The FE college was a mixed, post-16 institution, with 3,000 full time and 16,000 part time students.

## 4.2 Results from the interviews

**Key to codes for staff and students**

**MM** - member of Mathematics dept
**HM** - Head of Mathematics
**SMT** - Senior Management Team member
**KS** - Key Skills Co-ordinator
**GNVQ** - GNVQ teacher[3]
**GNVQ+GCSE** - student of both[4]
**GNVQ-GCSE** - student of GNVQ only

### 4.2.1 Elderflower Community College (Model 1)

#### 4.2.1.1 Students' needs and abilities

All of the staff at Elderflower Community College were supportive of the AoN initiative, and felt that it equipped students with essential skills, although there were differing interpretations of how this advantage was realised. **KS** felt that students needed to be made aware of the numeracy that was around in their everyday lives so that they could carry on to develop their own skills; **GNVQ+GCSE1** echoed this when talking of how the AoN had assisted her with the more financial aspects of her GNVQ. **MM**, on the other hand, felt that the key student need that AoN addressed was tackling numerical awareness in a supportive environment, and that AoN was, by nature, non-threatening. **MM**'s perception was borne out by **GNVQ+GCSE2** who talked of his loss of confidence in maths when he received his GCSE result although he found that the AoN classes were helping to rebuild that confidence.

There was a feeling from **SMT** and **GNVQ** that Key Skills generally and AoN in particular could have a vital role to play in raising achievement. Both of them spoke of the low level of ability of their incoming cohorts and their hopes that Key Skills might remedy this problem.

There was a desire for a separate certificate in Key Skills expressed by **KS** and **GNVQ**. It was felt to be unfair that a student could be denied their GNVQ because they had not managed to complete their Key Skills requirements. This attitude had, at least in part, been formed in response to the experience of a student with special needs who had attempted a GNVQ the previous year, but had been denied the certificate because his disability prevented him from completing all of the Key Skills requirements. Although **KS** acknowledged that it was in many cases essential to have Key Skills to practise certain occupations competently, he nonetheless felt that a separate qualification would sort out such anomalies.

#### 4.2.1.2 Numeracy

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[3] Note that in Hawthorn College two GNVQ teachers were interviewed - these are referred to as GNVQ and GNVQ2 respectively.
[4] Note that in Elderflower Community College two students who were studying both GNVQ and GCSE Maths were interviewed - these are referred to as GNVQ+GCSE1 and GNVQ+GCSE2 respectively.

At Elderflower Community College, **KS** emphasised throughout his interview that there was a need to have a clear distinction between "maths" and "numeracy". Although he appreciated that there was a great need for students to be numerate and to appreciate number, he did suggest that such skills might not be as essential as often is made out, and that it could, on occasion, be wrong to withhold a GNVQ certificate from someone who was not sufficiently numerate, and that such skills might well develop with maturity anyhow. Maturity notwithstanding, he did express concern (which was echoed by **SMT**) at the numeracy levels of the staff, and at the lack of confidence that they had in this area.

**SMT** felt that AoN was a positive development as it afforded students the opportunity to practise numeracy later in their school careers, and gave a second chance to students who were skill lacking the basic skills. **HM**, however, was not so enthusiastic - although he understood the need to raise students' numeracy, he felt that AoN tended to be too artificial.

Difficulty with judging an acceptable standard of numerical ability was expressed by **GNVQ**, who felt that this was an area where specialist maths support was required in order to ensure that activities were pitched at the correct level. **HM** suggested that students who held GCSE maths grade C could generally be described as numerate.

Although **GNVQ-GCSE** said that she felt confident in number work, she stated that she liked the "revision" aspect of AoN, and that of looking at familiar topics in a new light. **GNVQ+GCSE** also felt that AoN was supporting his numeracy. Although he felt confident in "mental arithmetic" he felt that more time devoted to AoN would assist this further. He suggested *...[you] always need to know the basics, really, just to get you by.*


### 4.2.2 Willow College (Model 2)


*4.2.2.1 Students' needs and abilities*

One of the features of Willow College was its strength in Engineering. Through this specialism a great deal of concern had arisen about the differing numeracy needs of students across different vocational areas. All of the staff who were interviewed mentioned this issue - suggesting that there was a higher level of numerical ability required in some vocational areas than in others.

There was, however, a feeling throughout the staff interviews that the introduction of Application of Number, although it might be unpalatable for staff and students alike, addressed a real weakness. An example is given below

> *Int        ...how do you feel about the inclusion of Application of Number...?*
> *GNVQ     Yes, I think that it needs to be there because students so much have seen mathematics just as mathematics, they don't realise how they're going to be forced to use it. For example, a girl came in, got grade G [in GCSE Maths] and is having to do percentages within her business course. So one needs to give [students] the opportunity to [practise] that.*

Perhaps because of the difference in the requirements of the different GNVQ occupational areas, the students who were interviewed suggested that one way to improve the Application of Number provision would be to introduce some form of setting so that those who required more assistance could get it, while those who grasped things more quickly could move on at their own pace.

*4.2.2.2   Numeracy*

One of the concerns of the mathematics staff at Willow College was that students' numerical abilities were not being allowed to develop because of the over-reliance on calculators.  **MM** suggested that basic numerical skills were being eroded through their use

> *...although I like calculators for their job, but I don't think adding 3 numbers together, do it in your head, is a calculator job - at least it might be but we ought to have the general ability, additions, subtractions, the basic numeracy things and I think that students coming through with a grade D and C or worse cannot do basic adding or subtracting, multiplication and division, they can't handle fractions at all, which is a serious deficiency.*

**HM** also returned to this theme in his interview.

> *...what we've found, over the last two weeks is all the students coming in we've diagnosed their mathematical ability, their numerical ability, adding and multiplying fractions, a half times a third without a calculator, there's less than 5% that can do it, with grades C and D at GCSE [Maths] because they've never had to ...[they just] put it in a calculator.  If you can't manipulate numbers, when that number becomes a letter or a symbol in algebra, they've got a stumbling block.*

**MM** seemed to link this lack of "mental arithmetic" to inappropriate content in the GCSE Maths syllabus, suggesting that there was too much algebra and trigonometry, which the majority of students would not use and not enough emphasis on practical mathematics

> *GCSE [Maths] is simply not working for a vast majority of middle ability students....I think that GCSE [Maths] needs to have a re-think, what are we using it for in a modern society - we don't teach them anything about how to handle mortgages, pensions, their own money management, very little in GCSE [Maths] about that, and yet we teach them stacks of algebra but only 2% of the population ever end up using it.*

The students who were interviewed at Willow College appeared to accord with their teachers' views.  Both of them talked of the need for "the basics" of numeracy, although they tended to link this more with GCSE Maths than with Application of Number which might perhaps have been expected - they saw AoN as being more of a support service to help them apply knowledge that they had already attained rather than to help them with fundamental numeracy.


**4.2.3   Acorn School (Model 3)**


*4.2.3.1   Students' needs and abilities*

At Acorn School there was a feeling that certain GNVQ students had less need of the AoN skills and tuition than others.  **MM** suggested that students who were resitting GCSE Maths were becoming overloaded by the amount of numerical work that they had in a week.  She noted that these students were the numerically weaker students, who did not have a particularly positive attitude to number, and that the AoN course was rather overloading them. One possible solution to this overloading was suggested by **HM**.  Through the course of the interview, his interest in a linked GCSE maths/AoN course grew, and he suggested that such a course could provide a *2nd chance* to students who had *slipped up on intermediate [GCSE] maths*.

There was also some debate about whether the AoN course was suitable for those students who had obtained a high grade in GCSE Maths, or who were studying Maths at A Level.  Both **KS** and **MM** implied that there was no real need for these students to study the AoN course.

**GNVQ** and **SMT** were more positive about the students' needs for AoN.  **SMT** obviously appreciated the resistance that some staff were experiencing from mathematically able students.  He emphasised the need of all students for numeric skills that they could transfer from one context to another.   **GNVQ** noted the importance of AoN, although she went on to mention the variation in demands that the Key Skills placed on students across the different

subject areas, and validly so as she felt that these skills were more important for students on some vocational paths than on others.  The students, although expressing no particular motivation for the course, suggested that it did have merit.  **GNVQ+GCSE** mentioned that it had made him more confident in his resit GCSE Maths course, while **GNVQ-GCSE** thought that it had been a useful refresher of her GCSE knowledge.

### 4.2.3.2   *Numeracy*

Little was said on this subject at Acorn School, although it was noted by **GNVQ** that AoN could perform an important support role for students who had not achieved in GCSE Mathematics.  However as the key issues in the framework overlapped points relating to 'Numeracy' have been mentioned in the discussion above.

## 4.2.4   Hawthorn College (Model 4)

### 4.2.4.1   *Students' needs and abilities*

There was a feeling at Hawthorn College that AoN was not adequately meeting the numeracy needs of students, although it was assisting with their requirements in the GNVQ course.  **HM** noted that there was a large difference in the numerical abilities among the students on the GNVQ courses, which made it difficult to get them all to the same standard. Numerical attainment in the locality of this college was low by national standards and therefore the span of attainment was wider than may be experienced in other colleges and schools.  Previously they had tried to meet this challenge by having separate classes, but the prior attainment span still made this difficult.  So **HM** ran the lessons as a workshop but it was still difficult to cope with the variety in attainment.  **HM** did not give a reason for the changes but more recently the GNVQ staff had begun to teach AoN.  This was how Hawthorn College had arrived at Model 4 provision for AoN.  **MM** noted that problems with fundamental concepts such as place value, were still occurring even among 16-19 year olds, and was finding that the maths department, despite having no official role in the delivery of AoN, was nevertheless being asked by students for individual support.  There was also a feeling from the GNVQ staff that students had different needs across the different GNVQ areas of study. **GNVQ**  for example commented that

> *some number skills are more applicable for say GNVQ in Engineering or something and other ones are applicable to Business so we're doing things that sometimes we don't really need to be doing, you know things like... dimensions and space, its not really relevant.*

**GNVQ2**  felt that AoN was meeting the needs of students studying for the Business Studies GNVQ.  It made them aware of the numerical content of the area - in particular, it drew them away from the idea of marketing as being all about design and led them into the issues around the analysis of markets.  He acknowledged that AoN was a weak area for the students, but commented that that this was a weakness in the population as a whole and that the students were merely reflecting a national deficiency.  This is the response that may have been expected from a defensive maths teacher rather than a GNVQ teacher.

Both of the students appreciated that the AoN was assisting their courses, however, they did feel that it was rather less important than GCSE maths, which was seen as both fundamental to the AoN aspect of the course and to future goals.

*4.2.4.2  Numeracy*

There was strong concern about the numeracy of the students taking the GCSE at Hawthorn College, although this was regarded as much of a given.  **GNVQ2** put this down to the fact that

> *maths and statistical analysis isn't a strong point for the population at large, so I think it is a product of  that I mean I think it is also maybe the statistical analysis is a particular weakness, because they are not used to looking at trends in data...even something as simple as a pie chart can often be misinterpreted but I think that that isn't so much that as a deficiency with us as more a case of the general population cause they are, our students, are sort of fairly average for the cohort...*

The maths department was not so fatalistic, and suggested that a higher level of maths input might increase the numerical abilities of the students they also felt more emphasis on the areas of deficiency of the students within mathematics, rather than within the GNVQ context, might boost their achievement.  **MM** drew on Piaget to suggest that the fundamental concepts underlying the mathematics must be given a chance to develop, while **HM** suggested that students were being taken onto the GNVQ courses who did not have the numeracy skills that they would require to succeed, but that AoN was not rigorous enough to develop this numeracy.  She suggested that spending more time on the fundamental number work might improve this situation.  When asked if she regarded AoN as a progression from GCSE maths, she responded that although it was not a progression academically, it was a progression in that you had to have the number there to start with before you could begin to apply it.


## 4.2.5 Sycamore College (Model 5)


*4.2.5.1  Students' needs and abilities*

A number of issues were raised at Sycamore College.  Like some of the participants at other centres, **MM** and **KS** noted that the needs of students varied across the vocational programmes, with some such as Engineering requiring a higher level of numerical ability than others such as Health and Social Care.  This caused problems in trying to develop suitable generic AoN provision which would adequately address students' needs.

Both **KS** and **GNVQ** noted that there was considerable resistance by some students to AoN which they saw as largely irrelevant to their chosen vocation.  This was certainly in evidence during the interviews with the two **GNVQ-GCSE** students interviewed, who repeatedly mentioned how irrelevant they saw the majority of their AoN provision, although at the same time noting that they appreciated the need for basic numeracy.  This tension between AoN provision and student's needs was reiterated by **GNVQ** who stated that although she was aware that numeracy levels needed improving, she was not convinced that AoN was adequately addressing this.  She also felt that it might be counter-productive to students' wider aims, by increasing their workload leading to additional stress.


*4.2.2.2  Numeracy*

There was a general consensus across the staff at this centre that the numeracy levels of the students in general needed improving, but that AoN was not substantially addressing this.

**HM** noted that a lack of progression in numeracy/mathematical qualifications might be hindering students' numerical development.  While **KS** noted that many students were entering the college with severe numerical deficiencies, which they tried to turn around in a

short space of time, **HM** identified that many students were left in limbo after completing one qualification and having no further qualification which adequately builds on that learning - a problem that he did not feel that AoN was addressing.

The **GNVQ-GCSE** students interviewed noted that although they felt that basic numerical skills were important, "maths" was largely irrelevant to their future. Throughout the interview when asked about AoN, they were very negative stating that they *just don't want to do [AoN]* and associated it heavily with maths. Both of the students admitted that they had not achieved much success in study in this area, and indicated that it was a source of stress. It would seem that this attitude was prevalent in the college; **GNVQ** noted that students tended to associate AoN with Maths, a subject in which they had previously experienced failure. She also noted that students generally found it irrelevant to their concerns and distracting from their primary vocational study.
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# 5  Discussion

## 5.1  Limitations with the methodology

A limitation was that in some instances the sample which was used was not quite the sample of people we had asked for at each centre. For instance at Hawthorn College the GNVQ teacher to be interviewed was on leave and the person organising the interviews at the college had nominated two GNVQ teachers to take the first teacher's place. So both teachers were interviewed and the extra data were included in the sample.

A Grounded Theory approach was used to analyse the data from this study. Foster and Sheppard (1980) suggest that data should be read with an open mind to make the most of them. Then the data are used to construct a theoretical framework within which to present research evidence. The widely recognised limitation with this approach is that it is difficult, indeed impossible, to read data with a completely open mind. Therefore the theoretical framework and research evidence will be coloured by the experiences and personal worldviews of the researcher(s). However the arguments of other authors can be used in defence of the analytical approach adopted for this study. Stanley and Wise (1983) and DuBois (1983) argue that subjective knowledge and personal experience are an integral part of the research process. Rich (1980) points out that even science which is generally considered to be 'objective' is value laden with racist and sexist biases.

The data were divided into themes within which the similarities and differences between the models could be compared. In this process the researchers were attempting to 'box' data into themes. It became apparent during the analytical process that the themes overlapped. To avoid this problem the researchers tightened the understanding of each of the themes and considered modifying the framework. However, the data were so inter-linked that it was impossible to develop themes which did not overlap, as is evident from the descriptions in the Results section.

At the outset of the study investigating the implementation of AoN appeared to be a focused project. However the interviews from the case studies illustrated that the implementation of AoN was affected by a multitude of factors, only 'Students' needs and abilities' and 'Numeracy' were discussed in this paper. This range of factors made it difficult to develop a manageable theoretical framework which could deal with all the issues raised by the participants, without imposing a framework onto the data. The multitude of factors also made

it difficult to trace similarities and differences between the models and to identify patterns in the data.


## 5.2   Research findings

The survey of centres and the subsequent description of the 5 models hinted that there was a diversity in the way that AoN was implemented. The models of delivery vary, depending on who teaches AoN and whether it is integrated into the GNVQ teaching programme or different classes are given.  These results are similar to those of Wolf (1997) who found that the delivery and organisation of Key Skills varied considerably between centres.  The preliminary analysis of the interview data presented here suggested that there are no obvious connections between the staff and students' reactions to AoN and the models that have been adopted by their centres.  The preliminary analysis of the interviews revealed more clearly than the survey that there was as much diversity in as between models.  It also illustrated that the situation in the centres was more complex than the survey results suggested. It has already been mentioned that the models are not entirely mutually exclusive and this may have confounded the result that there was not a straightforward relationship to be found between the staff and students' reactions and the different models.  It is possible that if the interview sample had been larger then a more defined pattern may have emerged.  There was an inevitable time lapse between receiving the questionnaire responses and visiting the centres. This time difference included the beginning of a new academic year which would have been an opportune time to instigate any changes in the organisation of AoN.  Wolf (1997) suggests that changes in the organisation and delivery of Key Skills in centres is very fast.  The interviews reflected what Wolf (1997) had found, some centres were in a state of flux in relation to their AoN provision, or they had recently experienced a number of changes as described by one member of staff at Hawthorne College (model 4).  This continual process of change may partly explain the lack of robust links between the interview findings and the models.

As the interviewing was somewhat exploratory and flexible, the issues of 'Numeracy' and 'Students' needs and abilities' were not discussed to the same extent in all centres.  So there appear to be gaps in the data where little or no information about an issue was collected in a particular centre.  For example, at Acorn School (model 3) the staff and students said little about 'Numeracy'.


### 5.2.1   Staff reactions


#### 5.2.1.1   Students' needs and abilities

Different views were voiced about 'Students' needs and abilities' within and between centres. The staff from Elderflower Community College (model 1) supported AoN and argued that it equipped the students with the knowledge and skills that they needed. Indeed a member of staff from this school hoped that AoN would raise the numerical achievement of low ability groups. But staff from Hawthorn College (model 4), found that in their experience AoN was

not meeting the numeracy needs of students (many fundamental concepts were still missing), although it was facilitating the GNVQ studies.  Similarly a member of staff at Sycamore College (model 5) did not believe that AoN was adequately addressing students' numeracy needs.  Members of staff from Willow College (model 2), Acorn School (model 3), Hawthorn College (model 4) and Sycamore College (model 5) pointed out that there are different numeracy needs in different occupational areas, even in the broad occupational areas covered by GNVQ.  Not only was there a diversity of numeracy needs in different occupational areas but as noted by staff from both Acorn School (model 3) and Hawthorn College (model 4) there were different student numeracy needs within the same broad GNVQ occupational area.  But they came to these conclusions for different reasons; the member of staff at Acorn School (model 3) argued that AoN was not needed for students who were taking A level mathematics.  This view is very different from the research findings of Hutton (1997) who argued that A level Mathematics did not necessarily equip student nurses for the mathematics needed in their role as nurses.  The member of staff from Hawthorn College (model 4) described a variety of ways that they had tried to meet the diversity of needs through separate AoN classes and workshops, then other approaches were considered.  This is a good example of the continuous change in delivery of Key Skills within GNVQs reported by Wolf (1997).  Despite all these innovations the students reportedly turned to Mathematics staff for help with AoN although these staff had no official role in teaching GNVQ or AoN. This is just one example of the innovation and commitment that has been demanded from teachers and lecturers to deliver AoN and meet students diverse needs.

Staff from different schools and colleges discussed the various positive and negative sides of AoN as it related to 'Students' needs and abilities'.  A member of staff from Acorn School (model 3) had the view that AoN was important for the transfer of skills.  This is an interesting point as English (1992) argued that there is no theoretical evidence that skills can be transferred.  From Willow College (model 2) came the view that AoN was unpalatable but it addressed the need to see mathematics in action.  Staff from Sycamore College (model 5) also found that their students were negative about AoN.  Other awareness raising roles of AoN mentioned were increasing students' awareness of the numerical content of occupations (Hawthorn College – model 4) and tackling numerical awareness in a supportive environment (Elderflower College – model 1).

Suggestions for future changes in Key Skills, GNVQ and GCSEs were given from different models.  For example, one member of staff from Acorn School (model 3) considered and warmed to the idea of linking GCSE mathematics and AoN to offer students a 'second chance'.  From Elderflower Community College (model 1) there was support for the new Key Skills qualification which has been suggested.

*5.2.1.2 Numeracy*

Different staff in the same centre, unsurprisingly, had different views of AoN and numeracy. For example, in Elderflower Community College (model 1) one member of staff argued that mathematics and numeracy were different, but another member of staff suggested that if students had grade C mathematics they were 'numerate'. The staff from Willow College (model 2), Hawthorn College (model 4) and Sycamore College (model 5) talked about the low numerical abilities of students, but had different views about the causes. From Willow College (model 2) the view was that the use of calculators and a less than satisfactory GCSE curriculum was the source of the problem, a member of staff from Hawthorn College (model 4) suggested that this was a national problem, while a member of staff at Sycamore College (model 5) suggested that a lack of clarity in progression routes could be contributing to the problem. From Hawthorn College also came the view that teaching of fundamental mathematics, not AoN, would raise standards in numeracy. This was a contrast to a member of staff at Elderflower College (model 1) who hoped that AoN would help raise standards particularly for lower ability students.

The staffs' evaluation of numeracy and AoN was equivocal. Some staff were more positive than others about AoN and numeracy. A member of staff at Hawthorn College (model 4) argued that AoN was not rigorous enough to meet the numeracy needs of students. A member of staff from Sycamore College explained that AoN and maths were a source of stress for their students, due to prior negative experiences. But a member of staff from Acorn School suggested that AoN was a good support for low mathematics achievers. This view was echoed by a member of staff from Elderflower Community College (model 1) who said that AoN was a second chance for low mathematics achievers to get to grips with numeracy.

## 5.2.2   Student reactions

*5.2.2.1   Students' needs and abilities*

The students' views were a little different to the staffs' views. The students' reactions to AoN and how they thought it was meeting 'Students' needs and abilities' varied within and across models. The students contrasted AoN with GCSE. A student from Acorn School (model 3) and another from Elderflower Community College (model 1) saw AoN as a good GCSE refresher and a Hawthorn College (model 4) student said that GCSE mathematics was more important than AoN. This accords with Wolf's conclusion that "GNVQs have not achieved the objective of equal standing with academic qualifications at the same level" (Wolf, 1997, 10). Students from Sycamore College (model 5) saw AoN as *maths,* which they thought was irrelevant to their future. They also found the majority of their AoN provision irrelevant to their GNVQ, but recognised that there was a need for basic numeracy. Students from Willow College (model 2) suggested that a way of meeting the students' needs at their College would be to introduce setting.

However there were also some common views across the models. Students from both Elderflower Community College (model 1) and Hawthorn College (model 4) said that AoN facilitated their GNVQ studies. Students from Elderflower Community College (model 1) and Acorn School (model 3) said that AoN had increased their confidence in their mathematical abilities. This evidence suggests that the students did see some merit in their AoN studies.

*5.2.2.2  Numeracy*

Elderflower Community College (model 1) and Willow College (model 2) students expressed different opinions about AoN and numeracy.  An Elderflower Community College (model 1) student suggested that AoN was supporting numeracy.  But a Willow College (model 2) student explained that the basics of numeracy would come from GCSE mathematics rather than AoN.  They were very clear about the purpose of AoN - its title gives it away - AoN was to help them to apply knowledge.

The students interviewed did appear to appreciate the importance of numeracy and *the basics*; several students mentioned the importance of good numerical skills, however in Willow College (model 2) and Sycamore College (model 5), there was a feeling that AoN was not adequately addressing this area.

# 6  Conclusion

The best way to summarise the results from the case studies is to use the word 'diverse'. There were diverse ways of implementing AoN delivery.  This finding replicates the results reported by Wolf (1997). There were also diverse views about the related issues of 'Numeracy' and 'Students' needs and abilities' within and between models. However there were also some views which were common to centres. There was no obvious link between the different models of delivery and the different views about these issues.  The innovation and commitment of staff to meeting students' needs and raising standards was obvious in the centres which were studied.

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