ALM-4 University of Limerick - Keynote Address

Maths is for Living

Dr Con Power
Business Consultant

Maths as an Academic Discipline:

I recently read an article which was written about twenty-five years ago by Prof Bryan Thwaites who was then Principal of Westfield College University of London. In it he observed that 'it has been a long-standing claim of mathematicians that mathematics is the queen of sciences.' Bryan Thwaites went on to say that 'a claim for mathematics is now evolving in men's minds which is of far greater significance. This is the claim that mathematics is the central intellectual discipline of the civilised or technological society' and 'that as society develops so its quantitative aspects assume even greater influence and dominance over its qualitative features' with the result that 'whether we like it or not, mathematics will soon pervade all the organised activities of our society'.

In some universities, mathematics self-stands as a Department whereas in others it is sometimes linked with and even subsumed into Science. No matter where it is placed, mathematics is correctly promoted, for example, by Sheffield Hallam University for whom I undertook some business development work recently, as 'creative, useful and stimulating' with the added attraction that 'the language of mathematics is essential for the professional in the twenty-first century'. A very interesting point about Sheffield Hallam University which may well be shared to varying extents by other universities is that degree courses are so structured as to combine the study of mathematics with study in areas such as biomedical science, technology, social & cultural theory, or gender studies as well as providing the opportunity to take a degree with the focus solely on mathematics and its applications. Even the honours degree which focuses solely on mathematics explores its use in solving problems within physical, environmental, medical, industrial and commercial contexts.

In order that the student can understand the basis of mathematical applications in other areas, tuition is given in the first year of the course in some elementary science and in business studies. Information technology (IT) and communication skills are used throughout the course. Core competences which are addressed include mathematical modelling and problem solving as well as analytical studies and statistics. The major point which I want to make in reference to this example is that mathematics is no longer seen solely as the academic discipline in its own right, which of course it is, but it is also increasingly recognised as an essential tool-kit for use in a wide variety of life situations for work, for leisure, and for quality of life activities.

Maths as a Life Skill:

As mathematics pervades all organised activities of our society, it is probably true to say that we will be increasingly emphasising the central role of personal empowerment through mathematical competences. This could well be the cornerstone for a wider definition of the role of mathematics in the technological age of the information society.

Mathematics plays a central role in the life of each person as a -

- citizen
- member of the workforce - employed, self-employed, or unemployed
- person not in the workforce

The role of mathematics in the life of the individual is multi-faceted and serves the individual as -

- an investor
- a borrower
- a consumer
- a saver

The role covers the full spectrum of -

- occupational, professional, and vocational pursuits
- leisure
- study

The Italian Mathematicians:

Before commenting on modern society, it might be worth recalling the history of mathematics, more particularly the colour of some of the Italians of the Renaissance period. This colour is vividly illustrated in a quotation from Bergamini (1972) when he states:

The men who solved the cubic, all Italians, were as colourful a crew of mathematicians as ever trod the roads of history. Most of them were self-made men, only a step removed from the counting-house drudgery of solving compound-interest and simple insurance problems posed by the booming mercantile needs of the day. Having risen above mere practical reckoning, the great Italian algebraists were by and large a shrewd and opportunist lot, as much at home among the card cheats and stiletto-wielding assassins of Renaissance back alleys as they were in the University chairs to which they aspired and sometimes rose.

I will leave it to the mathematicians of today to determine where they might fit in this picture!

Developments in Society and Technology:

The 'civilised' or 'technological' society to which Thwaites made reference has been evolving for some time. In my view, one of the most important societal developments was the enactment of the Public Library Act 1850 which permitted the establishment of public libraries in England. In terms of broadly-based public education, this was followed by the Education Act 1870 which introduced compulsory primary education in England and Wales.

Geddes & Grosset (1996) make the following very interesting observation which links education and industry:

'The movement for educational reform can be traced to the late eighteenth century, but another century had to pass before change affected the lives of working people. In Germany and the United States, and later in Japan, politicians recognised that, if a nation were to remain competitive in the new world, it needed an educated labour force. All across the industrial world there was a huge increase, not only in basic education but in the provision of higher education. Literacy and numeracy were at last seen as functional skills, rather than as the prerogative of a privileged elite'.

The development and growth of the trade union movement is directly relevant in this regard. Trade unions were forbidden by law in Britain in the year 1800 and were subsequently given full legal status in stages under the Acts of 1824, 1859, 1869, 1871 and 1901. The Trades Union Congress (TUC) was formed in 1868. Of fundamental importance were the extension civil rights such as voting rights for adult citizens, women's rights, and the development of various social movements.

In technological terms, I am sure that there were very many developments which particularly over the period of the last two centuries laid the foundations for the modern society of which Thwaites spoke.

A few major technological advances which I would list as being relevant to putting in place the infrastructure for an age which depends upon and respects a wide role for mathematics include the following.

- 1837 - the first practical telegraph line was patented by Sir William Fothergill Cooke and Sir Charles Wheatstone
- 1876 - the first telephone was patented by Alexander Graham Bell
- 1927 - the first automatic telephone service was inaugurated in London
- 1939 - 1944 - the first computer was built by Howard Aiken and IBM.

In addition to developments in society and technology, growing commercial sophistication reinforced the move to a more numerate society. In my view, one of the most important steps in that regards was the establishment of the Institute of Chartered Accountants in Scotland, the first such Institute in these islands, which received its Royal Charter in 1854. This was followed by the establishment of the Institute of Chartered Accountants in England and Wales in 1870 (Chartered in 1880) and the Institute of Chartered Accountants in Ireland in 1888.

The development of the accountancy profession was, of course, partly as a result of the introduction of legislation governing the establishment and conduct of limited companies. The concept of the joint-stock company is not, of course, a new one and the idea goes back to the 16th Century if not further. One of the best known early joint-stock companies was the East India Company which received a British Royal Charter in the year 1600. The early years of development of these companies led to a number of disasters, mainly because of lack of understanding and a low level of numeracy among investors. One of the most famous incidents which led to heavy financial losses for a large number of investors was the 'South Sea Bubble' in 1719. In modern times, the legislation which underpins the establishment of limited companies can be traced back to the British Companies Act of 1855. Incidentally, also in modern times the problems caused by a low level of economic literacy and numeracy was seen in the riots in Albania when in 1997 many citizens incurred heavy losses due to the collapse of schemes relating to the pyramid selling of shares.

Over and above the points of detail in relation to technology or to legislation, I think that one of the most important developments in shaping the modern world and in broadening the horizon of human experience was the wider availability of air travel. We must remember that all of this has happened during the present century. Orville & Wilber Wright when they set out in 'The Flyer' at Kitty Hawk, North Carolina on 17th December 1903 could hardly have foreseen the extraordinary contribution which they were making to the economic, social, and cultural advancement of society. Developments were very rapid after 1903 with the first crossing by air of the English Channel on 25th July 1909 and the crossing of the Atlantic non-stop from Newfoundland to Ireland by Alcock and Brown in 1919.

Maths for the Worker:

Reference to commercial developments brings me to the topic of employees understanding the accounts of their employer organisations. The ITGWU (now part of SIPTU), which was then Ireland's largest trade union, in 1977 produced an excellent guide to understanding company accounts. This was the book 'Account for Yourself' by Rosheen Callender. The book was written mainly for use on training courses run by the ITGWU itself for trade union officials, shop stewards and members generally. The foreword written by the then General Secretary of the ITGWU contained two observations which are directly relevant to the promotion of a greater level of numeracy in the workforce.

Account for Yourself is, in part, a response to the growing need of trade union officials, shop stewards - and indeed ordinary workers who may take no direct part in industrial negotiations - to get to grips with mastering and utilising financial information.

But the democratisation of industry cannot proceed to meaningful levels without far-reaching changes on both sides of industry. Horizons must be broadened even to cope with the existing situation; they will need to be hugely expanded and stretched to meet future demands. One example is in the area of accounting; we will all need to become a lot more financially literate, and numerate.

The book, in addition to dealing with the legislative basis for various types of enterprises, lists the various sources of commercial information in Ireland and assesses the nature and content of annual reports of companies. Over three-quarters in volume of the content of the book relates to the use of quantitative information derived from an examination of the Balance Sheet and the Profit & Loss Account together with the construction of 'Cash flow' and 'Sources and Uses of Funds' Statements. In addition, there is a very interesting chapter on the calculation of accounting ratios relative to profitability, liquidity, productivity, added-

value and capital structures. Matters such as inflation, depreciation, the valuation of assets and corporate taxation are also covered.

Even of more immediate and direct relevance to the worker are the questions of personal taxation and net take-home pay. The vast majority of workers come within the code of taxation and single people earning little more than the average industrial wage even experience the impact of taxation at the higher rate. Many may be tempted to allow the PAYE system to function automatically for them. It must be remembered, however, that some tax-free allowances must be claimed and that some reliefs and allowances require the submission of documentary evidence. This is, for example, the position in relation to mortgage interest relief which, while it is now allowed only at the standard rate of income tax, is still a most valuable relief, particularly during the initial five years of a first mortgage. Other reliefs, in addition to personal allowances, relate to medical insurance, permanent health insurance, rent relief for private rented accommodation, and various reliefs for tax-based investments. The only safe course to ensure full benefit from all statutory reliefs and allowances is to learn to prepare one's own return and to request an annual balancing statement from the Inspector of Taxes.

Over and above the question of taxation and, indeed, of PRSI, there is the even more fundamental question of pay rates. In Ireland, the mainstream discussion, particularly over the past decade, has been on national agreements such as the current Partnership 2000 and its predecessors. The terms of the pay elements of these national agreements are, of course, all about numbers and an understanding of percentages, growth rates, gross and net pay and relativities.

Maths for the Social Welfare Recipient:

The current code of Social Welfare is quite complex and the Social Welfare (Consolidation) Act, 1993 brings together over eighty years of Social Welfare law. The need for a high level of numeracy is obvious from an examination of the complexity of the system and of the very wide range of schemes, many of which are interlinked. There are, for example, no fewer than eleven classes of pay-related social insurance contributions and there are at least 24 major Social Welfare payment schemes. Thirteen of the 24 schemes are means-tested, and the rules for means-testing may even differ as between some schemes. There are an additional 16 supplementary schemes which give extra benefits such as fuel allowance, free travel, electricity allowance and others. A total of 79 different explanatory leaflets are available from the Department of Social Welfare. Qualification for Social Assistance or Social Insurance payments is clearly a complex operation. In addition, there is an appeals system but, in order to use it, the appellant must necessarily understand the complexities of the system. Such an understanding primarily requires a reasonable level of numeracy.

Maths for the Home Owner:

Home ownership represents for most people the single largest expenditure decision that they will make. The home owner is an investor and as such is naturally interested in monitoring the value of that investment. Figures which are important in this context include inflation, interest rates, exchange rates (relative to borrowing possibilities within the European Union), and the current property values. The Housing Statistics Bulletin is published quarterly by the Department of the Environment and contains a wealth of information about house construction, housing loans, and house prices (both new and second-hand). Indeed, some of these statistics are now of major news value and, for example, the national dailies of 10th June 1997 carried headlines of soaring house prices with the value of second-hand houses increasing by up to 20% in certain parts of the country in the year to March 1997. The report records that in the year 1996 more than 61,000 new loans to the value of almost £3 bn were

approved by the building societies, the banks, other financial institutions and the local authorities. This was an increase on a figure of just under 50,000 new loans valued at just over £2 bn in 1995. There are currently about 480,000 mortgages outstanding in Ireland with a value of over £13.25 bn.

The vast majority of home owners acquire their property through mortgage finance. There are many different ways of acquiring a mortgage from a building society, insurance company, or bank and there is the topical question of fixed rate and variable rate mortgages. The need for a degree of sophistication in terms of numeracy has been emphasised recently in an article in the Sunday Times dated 15th June 1997 which reported that the British Government is to ask the Office of Fair Trading to investigate the way mortgage repayments are calculated after research by consumer interests has suggested that British mortgage holders are currently being over-charged by up to £1 bn per annum. The implication here is that knowledge of mathematics coupled with a self-confidence in the use of figures could well achieve a significant saving for the house owner.

Maths for the Investor:

A growing number of people are becoming investors in property, shares, and in a wide variety of other financial instruments. The business and finance pages of the national dailies are more widely read and assimilated than heretofore as are the specialist financial publications. In Ireland, as in Britain, the recent public flotation of Norwich Union has widened the net of individual shareholding. In the case of Ireland, the flotation put free shares in the hands of 150,000 shareholders and this should result in a boost in business for stockbrokers and for the Stock Exchange. It will also mean that more people will seek to understand the language and the figures of the financial markets and to understand the composition of and movements in the ISEQ, FTSE, Dow Jones, and other indices.

In another area of investment, it has recently been reported by the Financial Times Service (June 1997) that many investment property practitioners cannot speak the language of other investment markets and are, therefore, at a disadvantage particularly when dealing with institutional investors. The Investment Property Forum (IPF) in the UK published two reports on the issue, one which examined the educational role which the IPF can undertake for its members and the other which examined the knowledge, skills and standards which are required in order to improve the understanding of investments by practitioners. The Royal Institution of Chartered Surveyors and the British Property Federation support the provision of appropriate education programmes for property professionals.

There are obviously many other investment areas in addition to shares and property. All require an enhanced level of numeracy on the part of both market practitioners and investors.

Maths for the Consumer:

The buzz word in business in competitiveness and this is reflected also in the mass retail and consumer markets, partly by price competition and by special offers. There are, of course, other specialist market niche positions based on quality and prestige but I think it true to say that numbers as in prices and bonus offers drive many mass markets. The implication for the consumer must surely be a need for a greater understanding of numbers in order to more effectively compare and assess competing offers, particularly where the 'package' presented may have a number of elements such as price, low interest, or interest-free loans, 'points', or bonuses. The approach to 'packaging' by the seller varies depending on whether we are talking about motor fuels, groceries, cars, or household durables. In all cases, however, we must remember the old maxim of 'caveat emptor' or 'let the buyer beware' when it comes to the complex presentation of more than one numeric parameter in order to sell a commodity.

Maths for Leisure:

A simple level of numeracy is all that is required for some numbers games such as bingo and the lottery. The level becomes far more complex when we look at horse-racing, greyhound racing, and other sports which combine skill and chance with potential risk and reward. The study of form, particularly in horse-racing, requires a sophisticated level of numeracy as do the complexities of both bookmaker and tote betting. In terms of statistics, Ireland has 26 racecourses for horse-racing. Excluding point-to-point racing, these 26 racecourses in 1996 had a total of 258 fixtures between them with an aggregate of 1,807 races. Tote betting amounted to almost £20m and bookmaker betting to almost £74m with race prize-money of about £14m. The average attendance at fixtures was over 4,600 persons.

An understanding of numbers is important in all competitive sports where scores are awarded. This is so in golf, cricket, tennis, and the many other spectator sports whose popularity is being promoted by mass news media. Even in the case of football, the level of numeracy required is now greater than the ability just to understand the rules and the scores. Competitions such as the World Cup divide the participating teams into Groups and for each team in each Group statistics are kept of games played, wins, draws, losses, goals for, goals against, and cumulative points. The mathematics comes interesting particularly when there is equality of points among runners-up in Groups and the focus in on which teams will meet in Quarter Finals and Semi Finals.

Maths for Public Administration:

Numbers play a central role in providing the statistical back-drop for public administration at national, European Union, and international levels. Economists quote statistics from the publications of OECD, the Council of Europe, the United Nations, the World Bank, and the European Statistical Office. In the case of Ireland, for example, the Central Statistics Office issues a wide variety of reports mainly on a monthly, quarterly, and annual basis. Two of the monthly series which are of popular interest are those relating to the Live Register (statistics of unemployment) and the Consumer Price Index. For those who require information on a broader basis, there is the Economic Series published monthly which provides up-to-date information and five years retrospection for a selection of 152 short-term Economic Series. The main chapters Prices; Industry; Building & Construction; Agriculture; External Trade; Distribution, Transport & Tourism; Services; Finance; Labour; and Vital Statistics.

The annual Statistical Abstract is a publication of well over 400 pages which is divided into fourteen main sections and contains more than 400 statistical tables. Many of these are specialised in nature and are of concern primarily to interest groups and representative bodies. Others such as trends in house prices and statistics relating to crime and of wide public interest and form the basis of news media commentary.

Probably the two most public manifestations of the need for numeracy on a broad basis are the annual Budget Speech / Finance Act and the periodic General Elections.

The format of the Budget Speech of the Minister for Finance consists of a review of the economy in the previous year, the economic outlook for the current year, a review of last year's Budget outturn, and a statement of relevant developments in Ireland, in the European Union and internationally.

After the preliminaries, I think that it is true to say that the Budget is all about numbers and about the 'packaging' of those numbers so as to gain the best possible political advantage.

The Minister gives details of public finances including Exchequer borrowing and debt management. After that the Minister gives in great detail the various proposals for taxation and Social Welfare. Some of the taxation proposals naturally relate to new initiatives and in the 1996 Budget, for example, in addition to more general issues relating to employers' PRSI and corporation tax, specific measures were introduced relating to the Business Expansion Scheme (BES), the film industry, the mining industry, business relief relative to Capital Acquisitions Tax and additional reliefs for developments in Dublin's Docklands. Social issues which were addressed in the 1996 Budget included measures to assist the long-term unemployed and improvements in a range of social benefits such as the Family Income Supplement, Child Dependent Allowances, Unemployment Assistance, One-parent Family Payments, and others. In summary, the measures introduced by the Budget affected the vast majority of citizens whether employed, self-employed, unemployed, or outside of the workforce. As an aside, the increase in the general income exemption limits for tax meant that about 18,000 people were removed from the tax net and the changes in the basis of calculation of income thresholds for the Family Income Supplement affected about 12,000 families.

Maths for the Citizen:

1997 is a very good year in which to be talking about numbers which whet the appetite of the individual citizen. I am, of course, referring to the 1997 General Election. The Election count is fundamentally a statistical exercise, particularly on television and in the print media. Radio programmes, probably because of format, must necessarily have somewhat more of a human interest focus over and above any consideration of the personality of the presenter.

The Irish electoral system of proportional representation is one which requires a good understanding of numbers. The simplest numbers are those which relate to the size of the electorate, the turnout, the number of spoilt votes and the valid poll; after that the figures become far more exciting. The first calculation which is of significance relating to the count in each of the 41 constituencies is the quota. This is calculated by dividing the valid poll by the number of seats in the constituency plus one, and adding one to the answer, ignoring any decimal points.

The mathematical complexities of the PR system might best be demonstrated by reference to the count and the result in, for example, the Limerick East constituency.

Number of Seats:	5
Total Poll:	50,049
Spoiled Votes:	384
Valid Poll:	49,701
Quota:	8,284

There were fourteen candidates in this constituency and the number of first preference votes cast for each ranged between 12,581 for Willie O'Dea (FF) to 108 for Denis Riordan (Ind).

The percentage of the first preference vote received by each party which had a candidate or candidates elected and the number of seats won with that vote was as follows:

Party:	*% Vote:*	*No of Seats*
Fianna Fail	39.72	2
Fine Gael	26.51	1
PDs	12.42	1
Labour	5.44	1

The first preference votes cast for each of the five candidates who were elected were as follows:

Willie O'Dea (FF)	12,581
Michael Noonan (FG)	10,092
Eddie Wade (FF)	4,798
Desmond O'Malley (PD)	4,358
Jim Kemmy (Lab)	2,702

It is interesting to note that John Ryan (DL) with 3,403 first preference votes, despite having 701 first preference votes in excess of Jim Kemmy was eliminated after the tenth count and Mary Jackman (FG) who had 382 first preference votes in excess of Mr Kemmy failed to be elected although she was still in the final count. The electoral fate of Mr Ryan shows clearly the importance of transfers and the operation of PR.

Willie O'Dea and Michael Noonan whose votes both exceeded the quota were elected on the first count. The final votes of the other three candidates and the count at which each was subsequently elected are given below:

Eddie Wade (FF)	9,639	8th count
Desmond O'Malley (PD)	8,419	9th count
Jim Kemmy (Lab)	7,173	11th count without reaching the quota

On an overall basis relating to all 41 constituencies, it is of interest to note that the candidates elected in each of 23 constituencies were the candidates who were ranked in order of first preference vote. In 16 of the 18 remaining constituencies, a candidate with a higher first preference vote was eliminated on the result of transfers and a candidate with a lower first preference vote was elected. In each of the other two constituencies, two candidates, each with higher first preference votes were eliminated on transfers in favour of a candidate with a lower first preference vote. These constituencies were Dublin South Central where Eric Byrne (DL) with 4,586 first preferences and Michael Mulcahy (FF) with 4,574 first preferences were eliminated and Pat Upton (Lab) with 4,224 first preferences was elected; and Limerick East which has already been mentioned above.

Maths in the School Curriculum:

There are currently 33 subjects in the Leaving Certificate curriculum. One of these is mathematics, and of the remaining 32 subjects, at least 9 require significant core mathematical competences, and at least a further 4 require some mathematical competences.

Subjects which in my view require a significant mathematics input include :

Accounting, Agricultural Science, Applied Mathematics, Chemistry, Construction Studies, Engineering, Physics, Physics & Chemistry, and Technical Drawing.

Other subjects which in my view require some competence in mathematics include :

Agricultural Economics, Business Organisation, Economics, and Geography.

In my view the presentation of mathematics, both in the schools and to adult learners, should to whatever extent is appropriate be related to applied subjects which are being studied by the pupil or which have formed part of the work or life experience of the adult learner. I believe that within any balance curriculum problems relating to Science, Applied Science, Engineering, Business, and other applied subjects, should be introduced as an integral part of the mathematics syllabus. In doing this, I also believe that a greater emphasis should be placed upon graphical presentation of information, including computer graphics, in recognition of the fact that in society generally and in the news media there is a growing emphasis on chart and diagram formats for presenting information.

The relationship between mathematics and the various applied subjects could be reinforced to the benefit of the student if a team approach was taken by subject teachers to the presentation of a balanced student-centred curriculum. An integrated curriculum approach rather than an approach based upon discreet, unrelated, single subjects has much merit in my view because of the importance of mathematics as a preparation for and a core subject within a wide range of higher education courses. A study of the entry requirements to each of the Irish universities, the DIT, WIT, the Colleges of Education, and the RTCs shows that in the vast majority of cases a pass or better in mathematics is essential. This is not only the position in relation to degrees, but applies also as the norm to courses leading to the National Certificate and National Diploma. In practical terms within a school situation, this would mean that a student would attend a structured course rather than attend a course in each of a series of self-standing subjects. The basis for such an approach exists in the grouping of subjects within the Leaving Certificate but, unlike the situation in countries such as France and Germany, which have a wide variety of structured courses leading to the equivalent of the Leaving Certificate, Ireland continues to rely on the single subject approach.

In summary, I believe that mathematics forms a bridge or link within and between many work and life activities. The role of mathematics is both reactive in terms of responding to social, cultural and technological advances, and it is dynamic in terms of participating in leading many of those advances. In other words, mathematics is an intellectual and functional life skill which plays an integrated mainstream role in society. In my view, this practical approach should be reflected also in the education system, not only at the higher education level, but also at primary, post-primary and adult education levels to whatever extent is appropriate in each case having regard to the planned educational outcomes for each course.

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