Can there be an Evidence Base for Mathematics Teaching?

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Abstract

In this paper the idea of an evidence base for teaching is critically examined on the basis of contributions that educational psychology made to the understanding of teaching and learning. The author argues that teaching in general and teaching mathematics in particular cannot be conceived of as having an evidence base that prescribes how to teach in a technological sense, but only a scientific base, which demands competencies like intuition, improvisation and judgement to be used constructively by teachers.

Keywords: evidence base, mathematics, teaching, technology

Introduction

I have been invited to open this conference – even though I am neither a mathematician nor an adult educator. I am a simple educational psychologist who – however – is confronted time and again with the question of how his discipline can be put to practical use. This is the origin of the title of my presentation, which aims at comprehensively framing the learning – or more precisely the teaching – of mathematics.

The organisation behind this conference is focusing on *learning* mathematics – more specifically *adults* learning mathematics. To me, this name expresses a certain scepticism towards teaching – particularly institutionalised teaching.

Traditionally, educators have a hard time imagining learning without teaching. John Dewey can give us a vivid illustration thereof. In his classic *How we think*, which is still worth reading today, he writes:

> Teaching may be compared to selling commodities. No one can sell unless someone buys. We should ridicule a merchant who said that he had sold a great many goods although no one had bought any. [...] There is the same exact equation between teaching and learning that there is between selling and buying (Dewey, 1938; 1989, p. 35f.).

If only – one is tempted to say, particularly in the context of mathematics education. But precisely the teaching of mathematics shows that Dewey cannot be right. While there is a logic or a semantic relationship between selling and buying, the relationship between teaching and learning is *not* a logical but an empirical one and therefore a contingent one. It is probably no coincidence that this forum, which leaves the relationship between teaching and learning open in its name, exists in the field of mathematics.

However, teaching *does* play a role, as it is also implied by the theme of this conference: Adults Learning Mathematics – Inside and Outside the Classroom. At least *inside* the classroom not only learning, but also teaching is taking place. And insofar as today's focus is on 'Inside the classroom', the theme of my presentation, which will focus on teaching, might not be as unsuitable as it might seem at first sight.

Nevertheless, this should not stop me from taking seriously the scepticism towards teaching, which is expressed in ALM's naming – although it is probably less a scepticism towards teaching, but rather a certain reservation towards a premature *linking* of teaching and learning.

This seems all the more important, as even in the field of empirical classroom research we have found ourselves confronted with models which pass off teaching as causal for learning. Already the classical process-product paradigm used in classroom research is based on a simplistic, linear causal model. The same can be said about the model of educational productivity developed by Herbert Walberg or about the various input-output models, which are riding high in the standards movement or international large-scale assessments.

Moreover, in the German speaking context, a flood of terms has established itself in recent years, virtually promoting the same reductionism: Words like teaching-learning situation, teaching-learning setting, teaching-learning arrangement, even teaching-learning methods, teaching-learning activity and teaching-learning process imply that we are dealing with a homogenous, self contained occurrence, meaning that teaching and learning are connected like a system of communicating tubes.

Learning not only seems to be *directly* attached to teaching, it also seems to emerge causally from teaching. Where teaching is done the right way, the message is, successful learning inevitably will take place. By directly linking the teachers' teaching with the learners' learning – at the conceptual or empirical level – all practical problems of classroom teaching, including the mathematics classroom, seem to dissolve miraculously.

This brings me to the topic of my presentation. Because in its own way evidence-based education is also promising that learning can be directly linked to teaching if only its recommendations are followed. My presentation is structured as follows:

1. In a first step I will illustrate what is meant by evidence-based education.
2. In a second step I will present arguments against the idea of an evidence base by looking into my discipline's history.
3. In a third step I will try to systematise these objections by drawing a distinction between complexity and complicatedness.
4. Finally, I will conclude my presentation with a short outlook.

What is Meant by Evidence-Based Education?

What is meant by evidence-based education respectively evidence-based teaching? Do not worry, I will not go into details. We all have heard that we should follow the example set by medicine and align our actions as educators to scientific evidence. Just like many other terms in the field of school and education, which quickly lose their conceptual clarity once they hit the ground of everyday life, the concept of evidence-based education is already showing signs of wear. This is countered by the fact that evidence is ascribed to the term evidence itself. We cannot help but taking the call for basing educational actions on evidence as evident. We are therefore confronted with the triviality that also the field of education should consider results obtained by scientific research.

However, the question framing my presentation is not about this triviality. This is why I would like to briefly outline what I have in mind when I talk about basing teaching on evidence. My point of reference is Robert Slavin. In a paper which he presented at the 2002 annual meeting of the American Educational Research Association he laments the backwardness of educational research. While other

sciences had reached the 21st century a long time ago, educational research is just about to leave the 19th:

> At the dawn of the 21st century, education is finally being dragged, kicking and screaming, into the 20th century. The scientific revolution that utterly transformed medicine, agriculture, transportation, technology, and other fields early in the 20th century, almost completely bypassed the field of education (Slavin, 2002, p. 16).

Even though this quote talks about a *scientific* revolution, Slavin's position is not rooted in science or the philosophy of science, but in educational practice. The examples provided by medicine, agriculture, transportation and technology are examples of applying scientific results. His lamentation is therefore not about science or scientific insights themselves, but about a science who seemingly has nothing to say about the improvement of practice.

You can call this a Baconian understanding of science. Francis Bacon demanded science to unequivocally contribute to the improvement of the human condition. Scientific progress is technological progress which is at the same time human progress. It is the objective of science 'to endeavour to renew and enlarge the power and empire of mankind in general over the universe' (Bacon, 1620, p. 129). According to evidence-based education this should also apply to the educational universe.

So what is up for discussion is the *practical relevance of science*, an issue that goes hand in hand with a specific understanding of practice, which is hidden behind the concept of effectiveness. The progress which Slavin reports in relation to agriculture, medicine and technology should also find its way into the educational system, meaning that education and teaching should be as effective as the work of farmers, physicians and engineers.

So when we ask, what evidence-based teaching means, then the answer is that first of all it is about practice – evidence-based practice – and secondly it is about the effectiveness of this practice – evidence of effectiveness. The purpose of scientific research is to provide this evidence.

In order to assess whether an educational programme is effective, we need causal knowledge. The method of choice when it comes to generating causal knowledge is – according to the creed of most psychologists – the experiment, which is why the evidence demanded by Slavin can only be gained if educational research is adopting rigorous experimental research methods:

> [...] the experiment is the design of choice for studies that seek to make causal conclusions, and particularly for evaluations of educational innovations. Educators and policymakers legitimately ask, 'If we implement Program *X* instead of Program *Y*, or instead of our current program, what will be the likely outcomes for children?' For questions posed in this way, there are few alternatives to well-designed experiments (Slavin, 2002, p. 18).

Slavin continues by noting that 'Once we have dozens or hundreds of randomized or carefully matched experiments going on each year on all aspects of educational practice, we will begin to make steady, irreversible progress' (p. 19).

So when I ask whether teaching mathematics can be based on evidence, the answer will be determined by this understanding.

Arguments against Evidence-Based Education

I will not try to present a systematic criticism of evidence-based education. Rather I would like to take a walk through the history of educational psychology to identify existing arguments for countering this technological understanding of educational practice. My walk will start at the end of the 19th century and end in the beginning of the 21st.

Talks to Teachers

In 1899 William James published his famous *Talks to Teachers on Psychology* which he previously presented to various audiences in numerous places. The first chapter carries the title 'Psychology and the Teaching Art'. By addressing himself directly to the teachers, he expresses his suspicion that they might expect him to provide specific information about mental processes, which would enable them 'to labor more easily and effectively in the several schoolrooms over which you preside' (James, 1899, p. 5). However, James believes that he is not able to fulfil these expectations. He admittedly is far away from disclaiming

> For psychology all title to such hopes. Psychology ought certainly to give the teacher radical help. And yet I confess that, acquainted as I am with the height of some of your expectations, I feel a little anxious lest, at the end of these simple talks of mine, not a few of you may experience some disappointment at the net results. In other words, I am not sure that you may not be indulging fancies that are just a shade exaggerated (p.5)

One could be under the impression that James had his discipline's youthfulness and its still inadequate findings it had to offer in mind. But this is only partly true, because his main argument is another. It would be a great, indeed a very great mistake, he says,

> If you think that psychology, being the science of the mind's laws, is something from which you can deduce definite programmes and schemes and methods of instruction for immediate schoolroom use. *Psychology is a science, and teaching is an art*; and sciences never generate arts directly out of themselves. An intermediary inventive mind must make the application, by using its originality (p.7 – my emphasis, W.H.).

James calls on logic and ethics as analogies. Never until now has logic taught a person right judgement, just as little as ethics has not yet lead anyone to virtuous actions. While science is able to set boundaries, it cannot say what we ought to do *within* these boundaries.

> A science only lays down lines within which the rules of the art must fall, laws which the follower of the art must not transgress; but what particular thing he shall positively do within those lines is left exclusively to his own genius. One genius will do his work well and succeed in one way, while another succeeds as well quite differently; yet neither will transgress the lines (p. 8).

According to James, a teacher's educational action needs to comply with psychology – nothing more and nothing less. In order to be a good teacher, one therefore needs a certain talent,

> a happy tact and ingenuity to tell us what definite things to say and do when the pupil is before us. That ingenuity in meeting and pursuing the pupil, that tact for the concrete situation, though they are the alpha and omega of the teacher's art, are things to which psychology cannot help us in the least (p. 9).

James then makes use of a metaphor which might surprise us: He compares the art of teaching to the art of war. While here and there the principles are 'simple and definite' their application is difficult, particularly because there exists an unpredictable counterpart whose intentions and plans are not easily accessible.

Technology of Teaching

James presented his *Talks to Teachers* before behaviourism rose to power in American psychology. If we were to identify a predecessor for the evidence movement, it was behaviourism. Skinner, whose self-conception as a scientist is known to stand in the tradition of Francis Bacon, advocated a position diametrically contrary to that of William James, namely a psychology which is able to *directly* guide teachers' actions. Skinner also talks about 'The Art of Teaching', but what he means by that is something quite different from James. *His* art is technology in disguise – accordingly the book's title in which Skinner's essay was published reads: *The Technology of Teaching* (1968).

Skinner beliefs that a technology of teaching can be immediately deduced from the science of learning: 'Education', so Skinner says, 'is perhaps the most important branch of scientific technology' (Skinner, 1968, p. 19). So important, in fact, that Skinner used his insights about controlling the learning process, to create teaching machines. Just like Slavin, Skinner envisions us at the threshold of a revolution in our educational system.

> There is no reason why the schoolroom should be any less mechanized than, for example, the kitchen. A country which annually produces millions of refrigerators, dishwashers, automatic washing machines, automatic clothes driers, and automatic garbage disposers can certainly afford the equipment necessary to educate its citizens to high standards of competence in the most effective way (Skinner, 1968, p.27)

Scientific Basis of the Art of Teaching

Thankfully we have moved on from behaviourism, but not from the technological concepts upon which it is based, which brings me to my next station on my walk through the history of educational psychology: Nathaniel Gage. In 1978 Gage's title *The Scientific Basis of the Art of Teaching* was published in which he presented an overview of where empirical education research stood at the time. Just like William James' book also this publication was based on presentations which Gage had given, namely at the Teacher's College at Columbia University.

In the first chapter he explains the title of his book. He differentiates between a 'science of teaching' and a 'scientific basis for the art of teaching'. 'The former idea, a science of teaching, claims much more and is in the end, I think, erroneous. It implies that good teaching will some day be attainable by closely following rigorous laws that yield high predictability and control' (Gage, 1978, p. 17).

Gage considers this to be impossible for reasons we already have heard of from William James. Practical actions require virtuosity or in the words of Gage 'intuition, creativity, improvisation, and expressiveness' (p. 15), meaning the readiness and ability to deviate from given schemata, rules and formulae. As mentioned before, Gage's reasoning is similar to that of James: The teaching situation is too complex, particularly with respect to its social dynamics, which is why teachers depend on judgement, intuitive insight, sensitivity and presence of mind.

In his argumentation Gage is taking a further step by pointing out that not only teachers, but also physicians and engineers depend on their judgement, as practical actions generally contains both 'artistic elements, [and] a scientific base' p. 18). Professional action is not limited to applying covering laws. It also contains the element of 'knowing when to follow the implications of the laws, generalizations, and trends, and, especially, when *not* to, and how to combine two or more laws or trends in solving a problem' (p. 18).

Donald Schön (1983) further elaborated this understanding of professional practice some years later in his work *The Reflective Practitioner* – however without referring to Gage.

Gage did not change his position in his later years. Even in his posthumously published *A Conception of Teaching* he quotes a phrase from the previously mentioned book and points to the necessity of experience as basis for teaching:

> The teacher will learn from experience when she should stay close to the implications of the covering laws and when to depart from them. And she will learn from experience whether the structure of the present theory helps her think constructively about her teaching. (Gage, 2009, p. 149)

Covering laws are useful, but they cannot be applied in a simplified manner. Without experience it is impossible to adequately use scientific evidence.

Evidence Does not Speak for Itself

I will take another leap in time for my third example and by doing so will step into the proverbial lion's den. Even if you have never heard of evidence-based education (what I do not think), you will most certainly have heard of John Hattie.

It is a rare occurrence for English research literature on school and teaching to be translated into German. Apart from the previously mentioned book by Gage which was published in 1978 and translated into German one year later, another publication which met this fate was *Fifteen Thousand Hours* by Michal Rutter and his colleagues. Published in 1979 it was also translated into German one year later. I cannot recall any other translations ever since. But Hatties' *Visible Learning* is another example of an English book about school and teaching research that is considered to be so important by many that it was translated into German last year.

The book about which the *Times Educational Supplement* said it would reveal the Holy Grail of teaching (Mansell, 2008), is clearly situated in the field of evidence-based education. Already on the first page of the English edition it states that *Visible Learning* represents 'the largest ever collection of evidence-based research into what actually works in schools to improve learning' (Hattie, 2009, p. I). However, Hattie not only wants to know what works, he wants to know what works *best*. The preface states: 'The major message [of this book, W.H.] is that we need a barometer of what works best [for students, W.H.]' (p. IX – accentuation removed). What surprises most is that Hattie presents this message in the form of a story.

In the book's reception this aspect has not yet been considered adequately (cf. Herzog, 2014). Effect sizes and their presentation in rankings of determinants of student learning stand in the foreground – even though already the book's title indicates that Hattie aims for more, because 'visible learning' is a metaphor. And for Hattie this metaphor contains a message more important than listing effect sizes.

Evidence alone is not enough, he tells us:

> Certainly it could be claimed that more than 800 meta-analyses based on many millions of students is the epitome of 'evidence based' decision making. But the current obsession with evidence-based too often ignores the lens that researchers use to make decisions about what to include as evidence, what to exclude, and how they marshal the evidence to tell their story. It is the *story* that is meant to be the compelling contribution – it is my lens on this evidence (Hattie, 2009, p. 237 – his emphasis).

The lens through which he examines the multitude of meta-analyses is a story: the story of visible teaching and learning. 'The major argument is that when teaching and learning is visible, there is a greater likelihood of students reaching higher levels of achievement' (p. 38).

This means that the story of visible teaching and learning, which Hattie tells us, is not derived from his hundreds of meta-analyses, but serves – as lens – to make sense of them in the first place. Without the story all those effect sizes would stand like lone trees in which we could not see a forest called teaching. This perspective is all the more remarkable as Hattie acknowledges that his story is by no means the only one possible. 'The 'story' told in this book about visible teaching and visible learning is one set of plausible hypotheses to fit a model to these data and the data to the model – there are certainly many more' (p. 248).This statement provides a strong relativisation of the concept of evidence-based education – ironically by an exponent of the very movement.

If we were to measure the evidence movement by its own yardstick, namely the guidance of educational practice, then it is precisely Hattie who shows us that in a strong sense this is impossible. He says the following about the relationship between evidence and practice: 'Evidence does not provide us with rules for action but only with hypotheses for intelligent problem solving, and for making inquiries about our ends of education' (Hattie, 2009, p. 247). His message, therefore, is not that teachers should orient themselves along the listed effect sizes, but rather that they use the reported

results as hypotheses for intelligent problem solving by conducting their own research in their own classes. With this message, however, Hattie is far closer to James and Gage than to Skinner and Slavin.

The Essence of the Argument

Our short walk through the history of educational psychology has shown us that the idea of basing teacher actions on evidence can by no means be considered to be evident. The arguments found in James', Gage's and Hattie's writings carry too much weight against an evidence basis for education for us to be bewitched by Slavin's siren songs. Still open, however, is the question, what precisely constitutes the core of this criticism. This is what I would like to illustrate now.

I have mentioned the analogy between the art of teaching and the art of war used by William James in order to illustrate his position. Interestingly, Lee Shulman uses a similar analogy almost 90 years later. Shulman has, as you probably know, conducted a series of studies examining the work contexts of teachers and physicians and in doing so also compared the two groups. Time and again you can find clear statements in his writings regarding the high complexity of teaching.

In a festschrift for Nathaniel Gage with the telling title *Talks to Teachers* one can find the following: 'If there is any kind of medicine that resembles teaching, it may be emergency medicine on the battlefield' (Shulman, 1987, p. 384). With this Shulman makes clear that a teacher in a classroom is exposed to much higher degrees of complexity than a physician examining a patient – unless he finds himself in the emergency room: 'When 30 patients want your attention at the same time, only then do you approach the complexity of the average classroom on an average day' (Shulman, 2004, p. 504). Shulman is convinced 'that classroom teaching [...] is perhaps the most complex, most challenging, and most demanding, subtle, nuanced, and frightening activity that our species has ever invented' (p. 504). He might be slightly exaggerating, but his keyword is essential: *complexity*. Complex situations demand more than technological actions than ever imagined by the evidence movement.

Complexity needs to be differentiated from complicatedness. In an essay entitled *Science and Complexity*, the mathematician Warren Weaver discusses three kinds of problems: problems of simplicity, problems of disorganized complexity und problems of organized complexity. The first group of problems is the subject of classical physics, the second can be accessed with statistical analysis while the third presents an enormous challenge to the sciences. It includes problems 'which involve dealing simultaneously with a sizeable number of factors which are interrelated into an organic whole' (Weaver, 1948, p. 539). It is unlikely that Weaver thought of teaching when writing this, yet a school class is a perfect example for his term of organised complexity.

Unfortunately, Weaver does not tell us how to deal with problems of organised complexity. Rather his essay concludes with reflections about the boundaries of science. Science has presented impressive results for dealing with problems of simplicity, whereas the hard problems, namely the problems of organized complexity, still lie ahead.

It is obvious that classroom research is dealing with this last kind of problems in Weaver's sense. David Berliner confirms this, although he does not talk about easy and hard *problems*, but about easy-to-do and hard-to-do *science*. 'Easy-to-do science is what those in physics, chemistry, geology, and some other fields do. Hard-to-do science is what the social scientists do and, in particular, it is what we educational researchers do' (Berliner, 2002, p. 18).

Berliner names three reasons why educational research is so difficult. Firstly, the strong and uncontrollable influences which emanate from the contextual conditions of the research situation and which practically exclude a generalisation of the achieved results in the form of universal principles or covering laws. Secondly, myriads of interactions of the n-th order between the variables of a study which push the researcher into a wilderness of mirrors. And thirdly, the short half-life of educational knowledge due to the historic relativity and the social character of educational phenomena. These three characteristics of educational matter make educational science 'the hardest science of all' (p.18).

However, this does not exclude the experimental method from educational research. One merely has to be aware that researching a complex issue with the analytical methods of science is based on an idealisation. This idealisation is based on treating a complex matter *as if* it were complicated. Only under these circumstances the strict criteria demanded by the experimental method can be met. Indeed, the physicist Hans-Peter Dürr (1995), who recently passed away, argued that the approach used by the natural sciences relies on reducing complexity treating it approximately as complicatedness.

Adopting this point of view one can argue that the complexity of educational matters is not inaccessible to experimental research as it is advocated by the evidence movement. One only has to be aware of the idealisation that is assumed by using this method. For the knowledge base of educational practice, however, this means that the 'evidence' which science provides is of limited use for this practice. While the researcher may treat a complex phenomenon as if it were complicated, the practitioner rarely is confronted with this option. (S)he has to consider conditions which the experiment excludes by design: multicausality, interactions between conditional factors, non-linear relationships, feedback loops, dynamic processes which constantly change the causal structures, etc. Teachers are confronted with events which are difficult to foresee, which often accumulate, hardly ever leave time for in depth reflection and demand immediate reaction (see Herzog, 1999; 2002, p. 419ff.). Complexity also entails that no situation is exactly like any other.

A Short Outlook

We have now found the systematic argument which speaks against basing teaching on evidence in Slavin's sense. The idea that professional educational practice could be withdrawn from the necessity of subjective decisions and be based on evidence gained from randomised experiments is simply absurd. Science, as it is presented to us now, is without doubt helpful for understanding educational practice, but only of limited use if the aim is guiding or prescribing this practice. And this is not the case because educational research can be accused of being backward and therefore being responsible of the practitioners' knowledge deficit, but rather because this deficit is the result of a *constitutive* difference between the research situation and the practice situation.

By reverting to Shulman we have linked this difference to the concept of complexity. In the words of Berliner, we could also talk about contextuality. In the end, both mean the same – once from the scientific and once from the practical perspective. Shulman rightly differentiates two kinds of complexity: social and contentual complexity:

> [...] all teaching – even the ostensibly simple teaching of arithmetic – is incredibly complex and enormously demanding. [...] It is not only the multiplicity of roles that we, as teachers, have to play [...] that makes teaching complicated. The pedagogy of subject matter for understanding is both a handful and a mind-full all by itself (Shulman, 2004, p. 512f.).

In one instance we deal with social complexity – because teaching usually takes place in a class situation. In the other instance we must deal with contentual complexity – because the relationship between teaching and learning is not a logical but a contingent one. 'We thus encounter two sources of complexity: the intellectual demands of deep disciplinary understanding paired with the social demands of coping with the unpredictability that accompanies such teaching (p. 513).

Both forms of complexity – the social as well as the contentual – play a key role in the teaching of mathematics, but while the social complexity is not specific to mathematics, the contentual is.

As far as I understand ALM's activities it seems to me that this is even the focus of your organisation. By focusing on adults it becomes more than clear that the abstractness and universality of mathematics present specific challenges for its learning. And while I do not think that these challenges are only specific for adults, they become clearer in this context – as if examined with a magnifying glass. Engaging with adults' mathematical competences does not least of all mean to become aware of the contextuality of using mathematics. Competences stand for the ability to act, that is, they are ideally useful out of school – in 'real life', where one cannot help but take the context into account. Every

situation in which mathematics is applied is unique in its own way. Mathematical knowledge can therefore never simply be applied, but has to be adapted to the specific situation.

Mathematics is therefore integrated into daily actions to the same extent to which knowledge about teaching is only of practical use if it is anchored in the teacher's actions. The relationship between theory and practice is therefore comparable in the case of mathematics itself and its teachings. Shulman goes back to Aristotle in order to characterise this relationship between theory and practice: '[...] theories are about *essence*, practice is about *accident*, and the only way to get from there to here is via the exercise of *judgment*' (Shulman, 2004, p. 534).

There is no mechanical link between theory and practice. One cannot do without the power of judgement: 'The process of judgment intervenes between knowledge and application. Human judgment creates bridges between the universal terms of theory and the gritty particularities of situated practice (Shulman, 2004, p. 534).

This reminds us of William James: *his* name for human judgement was an intermediary inventive mind.

My question which heads this presentation has therefore to be answered with *no* – provided that evidence is understood in the sense of Slavin and that of other representatives of the evidence movement, namely orienting educational practice along a technological understanding of science. However, if we understand evidence rather in its everyday sense, then an evidence base is also possible for the teaching of mathematics.

But we would be better advised to call it a scientific base or a knowledge base, in order to avoid misunderstandings. A knowledge base cannot be used technologically – as we have seen in James and Gage and how it was confirmed by Shulman. It presupposes intuition, creativity, talent for improvisation and judgement. Humans stand between knowledge and its application – in the form of a teacher in general or in the form of a mathematics teacher more specifically.

In my opinion this makes a teacher's job much more interesting than if it were reduced to that of an implementing body of educational research, research which aims at dictating to the last detail what works and what not and how the teacher has to behave in the classroom.

As you can see, I have managed to come full circle and returned to mathematics. I apologise for not drawing a bigger circle, as I am a mere educational psychologist. But I do hope that this presentation has provided a useful framework for your discussions in the coming days and therefore laid a fruitful ground for all the others to come.

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About ALM

Adults Learning Mathematics – A Research Forum (ALM) was formally established in July, 1994 as an international research forum with the following aim:

- To promote the learning of mathematics by adults through an international forum that brings together those engaged and interested in research and development in the field of mathematics learning and teaching.

Charitable Status

ALM is a Registered Charity (1079462) and a Company Limited by Guarantee (Company Number: 3901346). The company address is: 26 Tennyson Road, London NW6 7SA, UK.

Aims of ALM

ALM's aims are promote the advancement of education by supporting the establishment and development of an international research forum for adult mathematics and numeracy by:

- Encouraging research into adults learning mathematics at all levels and disseminating the results of this research for the public benefit.

- Promoting and sharing knowledge, awareness and understanding of adults learning mathematics at all levels, to encourage the development of the teaching of mathematics to adults at all levels for the public benefit.

ALM's vision is to be a catalyst for the development and dissemination of theory, research and best practices in the learning of mathematics by adults, and to provide and international identity for the profession through an international conference that helps to promote and share knowledge of adults' mathematics teaching and learning for the public benefit.

ALM Activities

ALM members work in a variety of educational settings, as practitioners and researchers, to improve the teaching and learning of mathematics at all levels. The ALM annual conference provides an international network which reflects on practice and research, fosters links between teachers, and encourages good practice in curriculum design and delivery using teaching and learning strategies from all over the world. ALM does not foster one particular theoretical framework, but encourages discussion on research methods and findings from multiple frameworks.

ALM holds an **international conference** each year at which members and delegates share their work, meet each other, and network. ALM produces and disseminates Conference Proceedings and a multi-series online Adults Learning Mathematics – International Journal (ALMJ).

On the ALM website http://www.alm-online.net, you will also find pages of interest for teachers, experienced researchers, new researchers and graduate students, and policy makers.

- **Teachers:** The work of members includes many ideas for the development and advancement of practice, which is documented in the Proceedings of ALM conferences and in other ALM publications.

- **Experienced Researchers:** The organization brings together international academics, who promote the sharing of ideas, publications, and dissemination of knowledge via the conference and academic refereed journal.

- **New Researchers and Ph.D. Students:** ALM annual conferences and other events allow a friendly and interactive environment of exchange between practitioners and researchers to examine ideas, develop work, and advance the field of mathematics teaching and learning.

- **Policymakers:** The work of the individuals in the organization helps to shape policies in various countries around the world.

ALM Members

ALM Members live and work all over the world. See the ALM members' page at www.alm-online.net for more information on regional activities and representatives, and for information on contacting your local membership secretary.

How to become a member: Anyone who is interested in joining ALM should contact the membership secretary. Contact details are on the ALM website: www.alm-online.net.

Membership fees for 2014:

	Sterling	**Euro**	**US Dollar**
Individual	20	24	32
Institution	40	48	80
Student/unwaged	4	6	8
Low waged	Contribute between full and unwaged		

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ALM is managed by a Board of Trustees elected by the members at the Annual General Meeting (AGM), which is held at the annual international conference.

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Adults Learning Mathematics – Inside and Outside the Classroom

ALM Proceedings Supervising Editor: Anestine Hector-Mason, Ph.D

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These proceedings include both refereed and non-refereed papers. Peer reviewed papers are indicated with an asterisk (*) next to the title in the table of contents.

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