Higher Dimensions: Galton & Abbott

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Introduction

It does not take long, upon arriving at King Edward's school (KES), to feel the depth of the history. The first time you are called, as a teacher, to sing the school song encapsulates this quintessentially; for me this happened when I found myself on the front row of the Big School stage at Founders' Day about 6 weeks into my first term. Then, the more elderly teachers would slink to the back since it may allow for a judicious nap, especially if you were agile enough to position yourself behind Mr Connor, but when the school song arrives, new blood are unlikely to have been briefed for what to expect. Lucky enough to have been handed the words (not a given) I found myself having to work out the unfamiliar tune being sung in the hope to pick it up, since the rest of the front line were belting it out with gusto. Knowing neither that some lines of the marvellously florid Victorian verse would randomly repeat, nor that the boys will start literally yelling other lines directly at you without warning, I remember seeing boys in my new Divisions form noting my bewilderment with distinct satisfaction.

Given the huge numbers of links to the past now available, I wondered, in my role as Head of Department, if there were any Mathematical figures of prominence which might be worth celebrating? Erstwhile Chief Master John Claughton delighted in telling tales of the classmates of Field medallist Richard Borcherds, who apparently played 'chicken' deep into their Maths exams, with the loser being the first one to open the question booklet. A quick dig excitingly uncovered a seldom-mentioned Old Edwardian named Sir Francis Galton, who pioneered the development of what would become the entire field of Statistics, only for any reader to then become quickly aghast at what he used it for. The plaque in his house in London (fig 1) labels him "explorer, statistician, founder of eugenics" and this provoked my primary conundrum: how could someone so intuitively intelligent, so robust in his calculations and so unusually widely travelled come to such morally repulsive conclusions? Was his work well-intentioned but perverted by those who would succeed him? Might he have been misunderstood? Or were the morals of the time, where an Englishman's superiority had, to them, already been demonstrated beyond debate by the Empire's dominance, simply unknowable to modern minds? Either way, he seemed like a dead end as a subject for a full school assembly. I filed Galton away as an uncomfortable mathematical fruitcase, only for, a decade later, this same question to resurface following a conversation concerning a different Mathematical KES alumnus.

On the train home from University station one afternoon, Mark Dennis, Professor of Theoretical Physics at the University of Birmingham, was discussing with me the 2016 Nobel Prize for Physics (this is very Mark), which was shared by two former Scots that had worked at UoB (Thouless & Kosterlitz, with American Haldane). Their work greatly used extending topology; a Mathematical topic both Mark and I had once studied at the University of St.Andrews (it should be noted that my level of study was dwarfed by Mark's, but this is also true for most of the human race). Topology is, essentially, the study of Shapes and whilst its

applicability to quantum theory is no doubt of great use I, as a Pure Mathematician (albeit one who enjoys the subject's Statistical implications), was always far more drawn to the groups and patterns contained therein. Common to both theory and the practice, however, is the idea of shapes existing in higher dimensions (and, indeed those between the integer dimensions) and Mark blithely threw at me the coincidence that Birmingham had this topological overlap of both these Physicists in their past as well as Edwin A. Abbott.

Abbott was not a name I had encountered before when looking up old Edwardians, but Mark knew that Abbott had taught at the school in 1862 before ultimately becoming Headmaster at the City of London School (CLS) from 1865-89. Abbott is more widely known for his book "*Flatland*" (which I had heard of but not read) which also deals in dimensionality far before it was done in the commonplace way Mathematicians and Scientists do today. A light-hearted but profound publication, "*Flatland*" was published at a time after Galton's cousin Darwin's work had started to eliminate the sacrilegious veil around what would soon swiftly evolve into the genre of science fiction, and Mark encouraged me to read it. Many things struck me when doing so, but the one that touched a nerve was the satire of the very same societal structures that axiomatically determine people's role in the world based on their classification that Galton had not only endorsed but built his life's work upon. In this short book, though, here was a man who also had KES in his past (Galton's time as a student had been a few decades before Abbott's tenure), had also (like Galton) studied at Cambridge, had similar, enormous mathematical flair and intellectual sparkle and yet who seemed to be satirising the very assumptions that Galton had incorporated. What made these men so different, and did they ever cross paths? Pulling the thread of these two questions evolved into my sabbatical from KES in summer of 2026, the research from which I chronicle here.

Sir Francis Galton

In order to visit Galton's grave (figs 4-7), a great deal of time is needed threading a path through a picturesque corner of England. Huge estates loom far from imposing, pristine automatic gates, horses wait in fields with a patient, bewildered air and there are regular outraged banners calling on the Chancellor of the Exchequer (by her first name) to take her taxes elsewhere. The Claverdon that Galton grew up in does not feel as far removed from today's counterpart as much as most other parts of the UK will when separated by 200 years, but it is still curious to find Galton buried here, given that he permanently moved away from a very young age. Dying aged 88 and fully 14 years after his wife had passed, having had no children, the default to return him to his kin, whom he lies beside, makes a sort of sense, especially given how much he believed in the hereditary nature of family, if not its other implications. The grave is worn but prominent, with a plaque in the church opting to attend to the enormity of Galton's indisputable scientific legacies. Heredity is the word adorning his resting place, but it is the word Eugenics that decorates the plaque on his resplendent, alabaster-hued London residence (figs 1-3).

Early Life

Galton grew up a prodigy, born after sisters who indulged his enormous curiosity and startling academic prowess. He was raised in relatively idyllic, carefree circumstances, dreaming of Ancient Greece, but the reality of needing one day to step up to the family name and fortune (both were locally prominent) saw him sent to a miserable boarding school in France and, latterly, KES, where Francis Jeune had, at the age of 30, recently become Headmaster. A stern, hawkish figure, Jeune seemingly inherited a rowdy crowd and ruled with impunity, laying foundations of discipline and structure in his boys through fear and drill. Galton's phenomenal talent for noticing and recording the events around him was put to early work, as he wincingly accounts Jeune thrashing "*11 boys in 8 minutes*" when his charges failed to accurately represent grammar on cue. Jeune, for his part, rated Galton, whose archives include his old school reports where Jeune "*regards him with particular interest*" since he has "*great powers: if he will apply them he must hold a very distinguished position both in his school and in the world hereafter*." (Fig 19) Galton did not enjoy his time at KES, frustrated by a curriculum too focussed on drilling and lacking in "well-taught mathematics and solid science." Most public schools followed such traditional models, although not for too much longer.

If the innocence had not been fully beaten from the young Galton, his next plunge would have hardly helped, when his family decided that medicine was the career for him, working at Birmingham General Hospital. He found the work intellectually rewarding but physically exhausting, and periods of intense study that led to lengthy recovery would become a pattern that would recur throughout his life: Galton often seemed to struggle with switching himself off. Moving to Trinity College in Cambridge did not help with this and, suddenly finding himself amongst peers operating at levels he had never previously experienced did not sit well, leading to some form of breakdown. He later spoke of how his "ill health" held him back at Cambridge, although the degenerating health of his father would admittedly

also have been a key contributor. This is what one assumes was a chastening time for him, but there are many occasions when he seems to have barely perceived failure. Danger also seemed to be a blind spot, and a couple of near-death experiences appear in his biographies, one where he was dragged under the paddles of a steamer that crashed into Battersea bridge as he stood on it.

Galton the Geographer

Galton had become a curious man in both meanings of the word, whose pursuit of perfection and knowledge through quantifying the world would soon become a life-defining zeal. It was, therefore relatively late that he found his true calling - the era of exploration needed men with courage although, with Galton, one could argue it was a blindness to risk and a limited understanding of the concept of his own limits. Thriving on new stimulus, the tales of Galton's subsequent trips to Africa were filled with the colourful chaos of the era, but his persistence and attention to detail also saw him return bearing substantially more information than any of his peers (and in greater detail), to instant celebration. Immediately authoritative in his writing, Galton the Geographer became prominent in Victorian society, published and feted widely as he published "*The Art of Travel*", laying the model for all others to survive and thrive in the wilderness of the world. Whilst sometimes florid, this work was enormously influential and some of the practices he pioneered survive even to this day.

An engineer and a tinkerer, he would play with various contraptions throughout his life (in a moment of what would become satirical irony on a galactic scale, he literally invented the dog whistle) and we have a functioning Galton board in the KES Maths department, demonstrating the Binomial distribution in 3 seconds better than any teacher ever can. His scientific determination and true superpower (measuring) complemented his new position in society and allowed him the opportunity to drive enormous progress in meteorology, where he uncovered the anti-cyclone and drew the world's first ever weather chart for *The Times*. Work on the concept of mental imagery broke new ground and lay down key foundations for the burgeoning discipline of psychology. Galton grew in stature by forging new paths by occupying positions none had previously done and then substantiating them with his recorded evidence. He was enormously perceptive of his surroundings, and few would consider arguing with anyone with his track record until, of course, younger and more swashbuckling explorers' tales emerged over the decades to thrill the Victorian crowd (one occurrence included Galton getting into an entertaining spat with the 'sensationalist' HM Stanley).

Married to Louisa (contentedly, if passionlessly, it would seem) and without children, Galton's dwindling career was turned on its head when his cousin Charles Darwin published his famous work. Both inspired and astonished by the implications (and determined to at least match the achievements of a family member), Galton became increasingly convinced that uncovering heritage through generations was something for which his unique skills were optimally suited: to measure, isolate and enhance "eminence". This would

become his entire life's subsequent purpose and so in here, after one of science's most glorious quantum leaps, immediately lies the shadow of eugenics.

Eugenics

Galton's age and experience now complemented his direct, forthright demeanour. Nuance would often be seen as trivial (or statistically negligible - more of which would follow) and this led him to turn his powers of quantification to identifying the traits that were of most value to society. It is tempting to cast aside the morality of the time as monstrous, skewed by the era's overwhelming, axiomatic perception that Victorian Britain was the greatest society that humans could build; how could one consider any other answer when the Empire ruled the world? But cracks were forming - disease & death were prevalent amongst a working class growing in size and Galton felt it was his calling to manifest practical lessons from Darwin's great theory. How easy would it have been for a man who has spent his life ploughing new furrows to allow space for doubt? Galton's life and, indeed, the world of Victorian society would have made it clear that the men who speak with uncertainty in their voice do not get heard by many. He also preferred to learn from first principles and did not spend much time digesting the work of others; this vacuum would allow him to build strong connections to his theories but also, hypocritically, isolated him from all the material which he had not himself collected. Galton was certain that his data was the way true knowledge would be revealed, and so built systems, questionnaires, collection stations and an organisation devoted to measuring his fellow man- at one point amassing 150,000 entries over 2 years. It allowed him to clear the path for Statistics as its own subject, which would ultimately become the tool by which all scientific purpose is established. From his work the calculations and reasonings for 'co-relation', regression, standard deviation, the Binomial and (Bivariate) Normal distributions would be built, but in time every cog the workaholic Galton forged in his zeal to prove his eugenic theories would ultimately reveal their emptiness, not that Galton would ever know.

The publication of his work "*Hereditary Genius*" set Galton on a path from which he never escaped, not that he ever expressed the desire to. From this moment onwards, his ingrained snobbery, increasing disdain for tact and unyielding forthrightness in his own pronouncements ensured that his intellectual echo chamber, whilst small, was also robust. It is hard to imagine the scientific world in which Darwin had blown everything wide open and locating purposeful, logical implications whilst ignoring the media furore of being "descended from monkeys" proved challenging for many. Fancying himself as a rebel, Galton saw Darwin's dismantling of accepted wisdom as an intellectual call to arms and wanted to kick down his own small-minded, established 'truths.' Hereditary Talent and Character were held as all-important, as he laid the path to his pithiest and most famous contribution to the debate: the very phrase "*Nature vs Nurture*". Galton did not argue that the latter was irrelevant, but only in the way education catalyses the components. Education assists you to board the train, but only those who already have a ticket can ride and that was dependent entirely on your stock. Known inferiority, Galton argued, should not be condoned, and those known to be deficient should be sponsored by the state to become celibate, hence removing their contribution in future generations (this became known as negative eugenics). Criminals should be sterilised for the same purpose, and the

finest minds should make their way to the countryside, to breed with those from the finest female stock (his consideration of the roles of women was as shuddersome as you might imagine). Galton proposed a society where schools worked closely with their local eugenic stations, where accurate measurements would allow us to identify the strata in which breeding should then occur (positive eugenics). He knew this would not be easy to establish, but was convinced that this way the degeneration that was threatening the Victorian ideal could be overturned. The logic for all of this was, for Galton, easy to demonstrate given the proliferation of eminence within those families where eminence had been demonstrated by family's elders. The conclusion was clear: eminence was something to be inherited.

Hereditary Genius is a challenging, rambling read. The statistical perception of spread of data, variation and the power of numbers is elegant and clear, but the logical presumptions behind their interpretation are sweeping: at no stage does Galton consider that, unlike height or chest size, "eminence" is in any way less straightforward to quantify since it was nakedly and consistently measurable by the amount of biography that the lives of such men generated. It goes without saying that moral horror spots such as Galton's blithe dismissals of lower races, mediocre classes, and how to deal with imbeciles can make it difficult to filter out any positives but there are mathematical problems too: the statistical area of Sampling Theory and ways to minimise bias was decades beyond Galton's presumptions as he wholeheartedly collects data within pre-existent strata. Although this was noted at the time, it was the accusation that he may be friendly with some of the families declared to be 'eminent' that he defends himself against (although his own indifference towards social awareness may have taken care of this issue as well).

There is a pervading peculiarity from the very start of the work that Galton goes to incredible lengths to address issues of accuracy in the areas that he perceives as troublesome but ignores swathes of other logical issues without any comment. He seemingly draws axiomatic lines arbitrarily but then goes into enormous detail based on these very decisions, such as age from when eminence might occur, or uses of the lengths of published obituaries to quantify it. His confidence is extraordinary and he is steadfast in his determination, once he has set his course. Whiffs of hypocrisy can be found too, when he breezes past the enormous weight allotted to the Cambridge exams which he himself failed to excel in, but the clarity of the Maths, the use of numbers to make cases and the authority he presents in most of his work cannot be ignored.

It is worth, at this juncture, mentioning two further types of bias which we now commonly monitor. 'Survivors' bias', where only the winners remain visible, torpedoes much of Galton's work. When an anti-vaxxer points to how their great-grandfather was never inoculated, the response comes that peers of that generation for whom this approach was ineffective cannot make similar cases for their own great grandchildren, on account of having died before they had any. Assuming that only what is visible is valid is a catastrophic overstep that Galton and many of his peers maybe had to make in order for us to learn how to better handle statistics. I am aware, though, how easy it is to look back upon the people forging modern science with such obvious condescension, especially whilst "post hoc ergo propter hoc" remains as big an issue in the present for those looking to take purposeful steps in

science or, indeed, politics. For Galton, once he had crunched the numbers in his astonishing haul of data, the idea that years of precise, repetitive calculation could actually be purposeless would have been understandably appalling, and this remains a danger across the modern world, whenever people seek legacy for their careers. This leads to the subtler 'Confirmation bias' that still plagues modern science, in which we tend to find what we are looking for more often than we should. Would Galton have ever taken solace if he knew that the preposterous number of computations he did were ultimately pointless in purpose, but enormously important in the structure and approach they set up for future work? It is a nice thought, albeit a sentimental one.

Legacy

Many of Galton's documents, inventions and papers lie at Imperial College but, given they are well recorded, I instead pursued the artefacts stored by the Royal Society, of which Galton was vice-president for 5 years. In the letters I saw on my visit (figs 8-14), his attention to detail is immediately clear, with scribbles among scribbles to ensure he says precisely what he wants to convey. The records of his data are many, structured efficiently but carefully in accessible formats, whilst the famous graphs point the way toward the techniques that would be his most valuable legacy. In hoping to learn about the man behind the numbers, I asked to see a letter summarised as Galton writing about a waylaid colleague but, rather than see something more human, instead all one finds are fiercely direct practicalities. Galton recognises "*a serious breakdown*" (something Galton had first-hand experience of) but focuses only on the fellow's "*fitness for present office*". Since the gentleman (G.M.Whipple) was someone whose "*services had long been valuable*", Galton proposes offering £200 instead of £400 and suggests approaching the Prime Minister for at least £50! Another 'personal' note, concerning a surgeon named Professor Marshall (who had a reputation for dullness), is even more direct - Galton suggests that a recent paper be "*buried in the archives*" to prevent his work "*being disposed of elsewhere*."

So what conclusions should be drawn from such a peculiar talent? Reflecting on the man's legacy, I have been struck by how often one sees in the news a prominence of the effects of people around the world transitioning between previously established cultures (geographically, physically, psychologically & otherwise). Adding in the growth of AI, understanding how we culturally react to reducing people to measurable values is as least as important as it ever has been. Indeed, the world's richest man speaks as Galton did of his love of the Ancient Greeks and is prominent in seeking to conceive as many children as he can, for, he argues, the betterment of us all. The US Health secretary has said that autistic kids "*will never pay taxes*", whilst his boss talks often of the inherent weaknesses possessed by his enemies: Sir Francis Galton is tough to stare at but still of note for the modern world.

Amid his many other eccentricities (statistical evaluations of the handsomeness of various inhabitants of the world based on his own traffic light criteria, ludicrously convoluted formulas to perfect the brewing of tea) Galton lived in London as a figure of reverence, especially in his later years when other equally impressive Mathematicians would jump on the more heinous parts of his work with great abandon and actually manage to make them

worse. Galton, for his part, was content to be wheeled about and mumble on his own eminence, no doubt deeply gratified to be fulfilling his own definition of the term. There were other works of import that stemmed from his unyielding research; his work on fingerprinting, which emerged from his eugenic data, revolutionised that emerging science, paved the way for all of biometrics and is considered by some to be his principal legacy. The Copley Medal and a knighthood followed to reward his zeal, attention to detail and persistence.

These fundamental gifts paved the way for science of enormous import, but the profound irony of his work ultimately eluded him. His pioneering of correlation revealed that, if "Nature" was all important then his own coefficients should be near to 1. If "Nurture" was the key then they should be near to zero: Galton had developed the perfect tool to demonstrate that the overall picture on this matter was profoundly, intricately complex. Galton would instead cling to regression, which he held to be the manifestation of society's failure to heed the lessons of Eugenics, hence its name. Galton saw that extreme single data points would often be followed by less extreme ones, but had not appreciated the role of independence. For him, the fact that the correlation calculation was not perfect was down to the interference caused by Nurture; he was seemingly cursed to only interpret new information within the context of the model he had long since settled upon. To Francis Galton, the answer to any problem was always simple, always measurable. When first encountering him, I simply concluded that the world he inhabited pushed him in a direction that he could not have had the perspective to escape. Until I read "*Flatland*."

Figs 1, 2, 3: Galton's house in Rutland Gate, London.




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SIR FRANCIS GALTON
1822 - 1911
EXPLORER STATISTICIAN
FOUNDER OF EUGENICS
LIVED HERE FOR FIFTY YEARS

Figs 4,5,6,7: Galton's grave & memorial by Claverdon Church (6 miles east of Warwick).



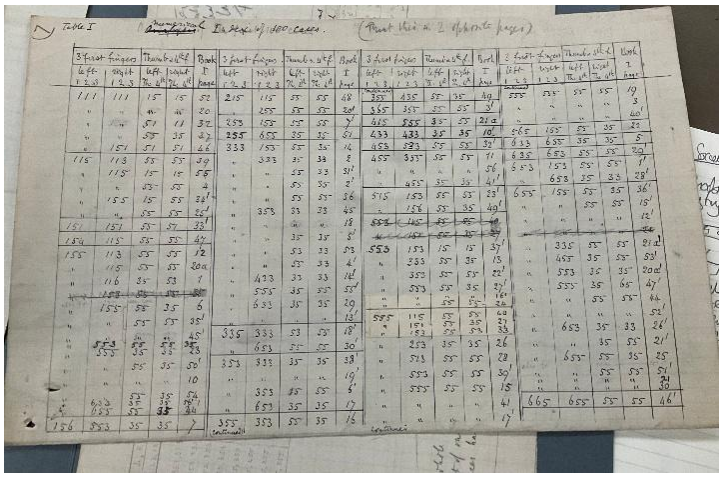


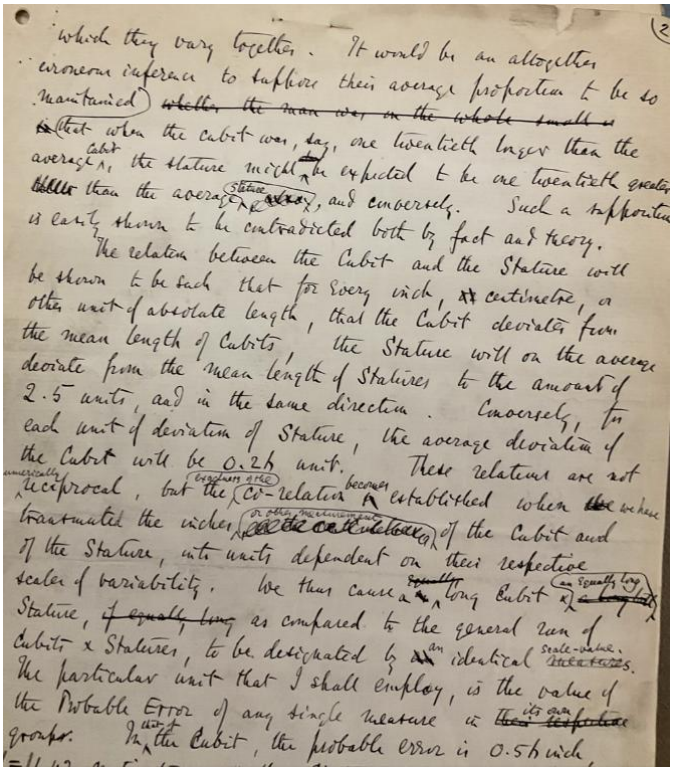




Figs 8-16: author's images, used by permission of the Royal Society.

Fig 8 (right): Primary data Galton collects for fingerprints



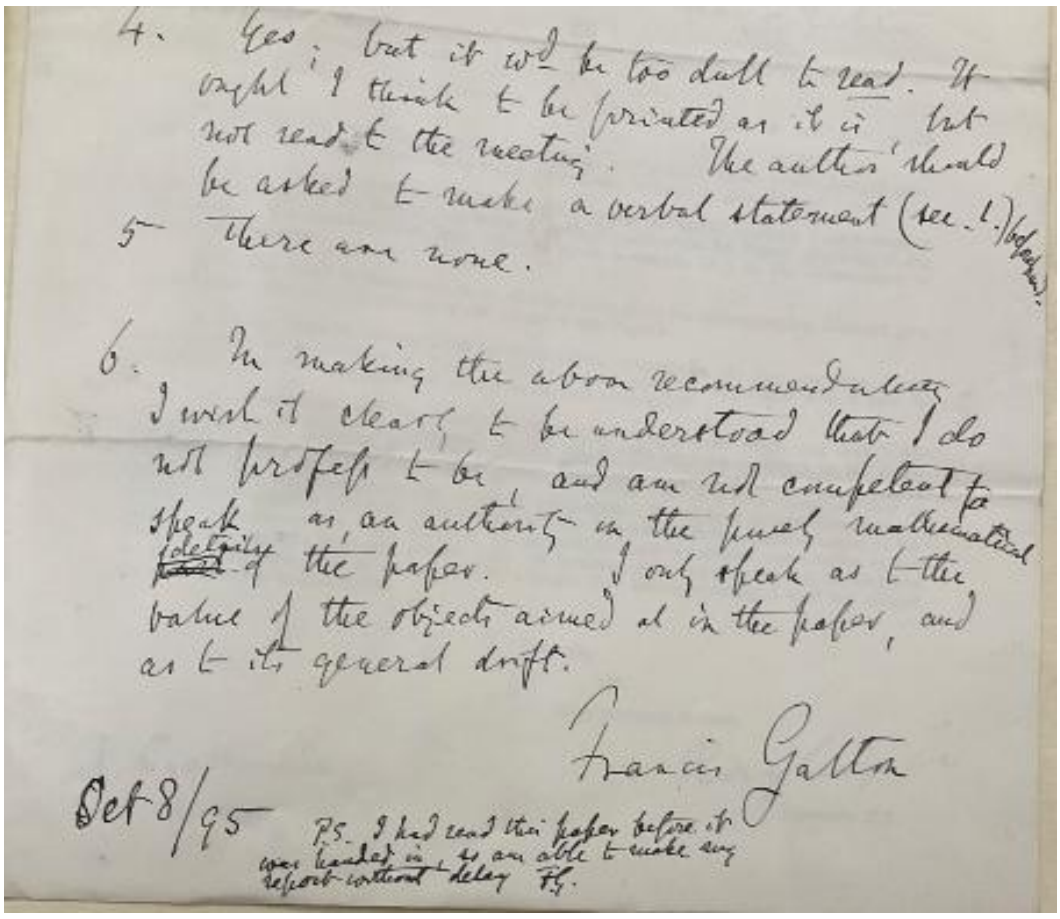


which they vary together. It would be an altogether erroneous inference to suppose their average proportion to be to maintained ~~whether the man was on the whole small or~~ that when the cubit was, say, one twentieth longer than the average, the stature might be expected to be one twentieth greater than the average, and conversely. Such a supposition is easily shown to be contradicted both by fact and theory.

The relation between the Cubit and the Stature will be shown to be such that for every inch, or centimetre, or other unit of absolute length, that the Cubit deviates from the mean length of Cubits, the Stature will on the average deviate from the mean length of Statures to the amount of 2.5 units, and in the same direction. Conversely, for each unit of deviation of Stature, the average deviation of the Cubit will be 0.4 unit. These relations are not numerically reciprocal, but the co-relation becomes established when the whole is transmuted the inches, or other measures, of the Cubit and of the Stature, into units dependent on their respective scales of variability. We thus cause a long Cubit to be equally long as compared to the general run of Statures, to be designated by an identical scale-value. The particular unit that I shall employ, is the value of the Probable Error of any single measure in its own group. In the Cubit, the probable error is 0.5 inch,

Fig 9 (left): Galton's notes mention "one twentieth larger than The average", still used in science as the go-to p-value. He also mentions concepts of "average deviation" and "probable errors". Marvellously, much of his work is scribbled on scraps of squared paper or randomly grabbed envelopes. Science flowed from the man, and he felt it was his duty to catch as much of it as possible.

Fig 10
A personal favourite, where Galton says of a paper that its "general drift" has value but providing the Maths is correct; a sentence all KES teachers who have marked an IA know well.



4. Yes; but it will be too dull to read. It ought I think to be printed as it is but not read to the meeting. The author should be asked to make a verbal statement (see 1.) before.

5. There are none.

6. In making the above recommendations I wish it clearly to be understood that I do not profess to be, and am not competent to speak as an authority on the purely mathematical ~~validity~~ of the paper. I only speak as to the value of the objects aimed at in the paper, and as to its general drift.

Francis Galton

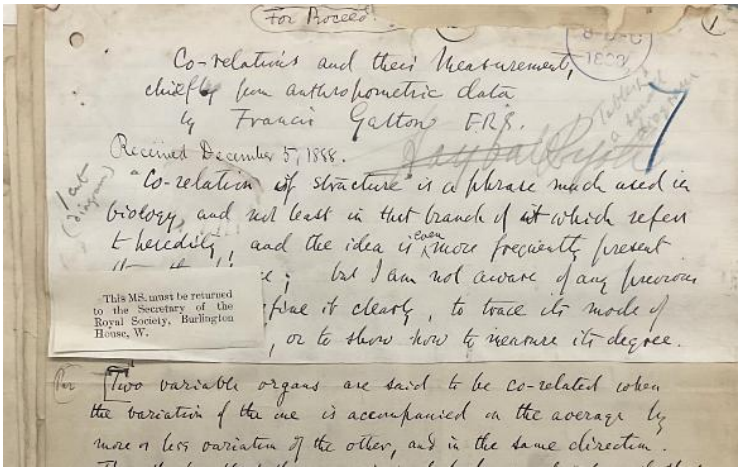
Oct 8/95

PS. I had read this paper before it was handed in so am able to make any report without delay FG.

Figs11-14: Galton's Notes for an upcoming paper.

Uses of "co-relation", something his own Grandfather had investigated but not quantified.

Many of the form and notations Galton instigates (e.g. $\frac{1}{2}(Q_3-Q_1)$) are used to this day.



For Proceed.

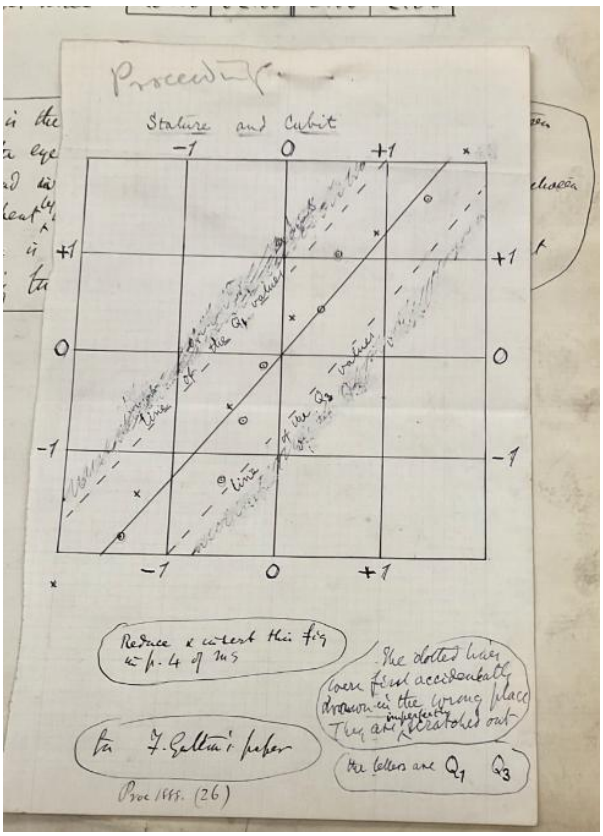
Co-relations and their Measurement,
chiefly from anthropometric data
by Francis Galton F.R.S.

Received December 5, 1888.

"Co-relation of structure" is a phrase much used in biology, and not least in that branch of it which refers to heredity, and the idea is often more frequently present to us; but I am not aware of any process to trace it clearly, to trace its mode of ..., or to show how to measure its degree.

This MS. must be returned to the Secretary of the Royal Society, Burlington House, W.

For Two variable organs are said to be co-related when the variation of the one is accompanied on the average by more or less variation of the other, and in the same direction.



Proceed

Stature and Cubit

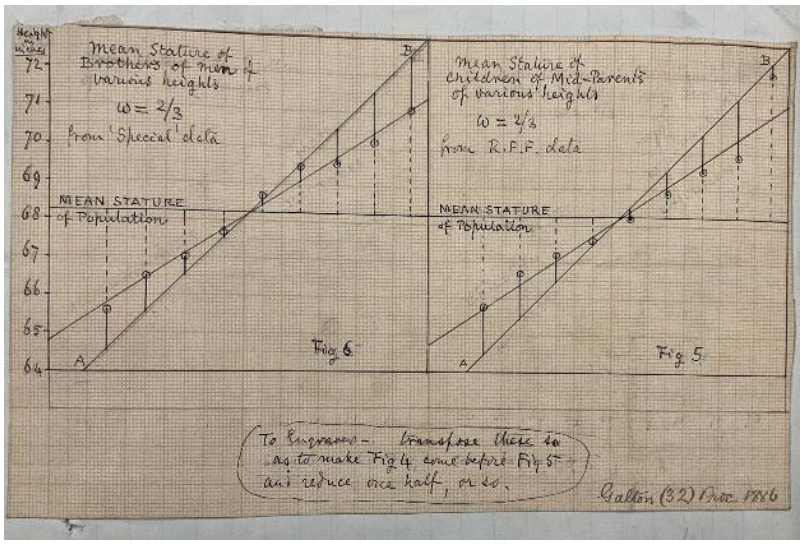
Reduce & insert this fig at p. 4 of MS

The dotted lines were first accidentally drawn in the wrong place. They are to be scratched out.

In F. Galton's paper

Proc 1888. (26)

The letters are Q_1 Q_3



Mean Stature of Brothers of men of various heights

$\omega = 2/3$

From 'Special' data

MEAN STATURE of Population

Fig 6

Mean Stature of Children of Mid-Parents of various heights

$\omega = 2/3$

from R.F.F. data

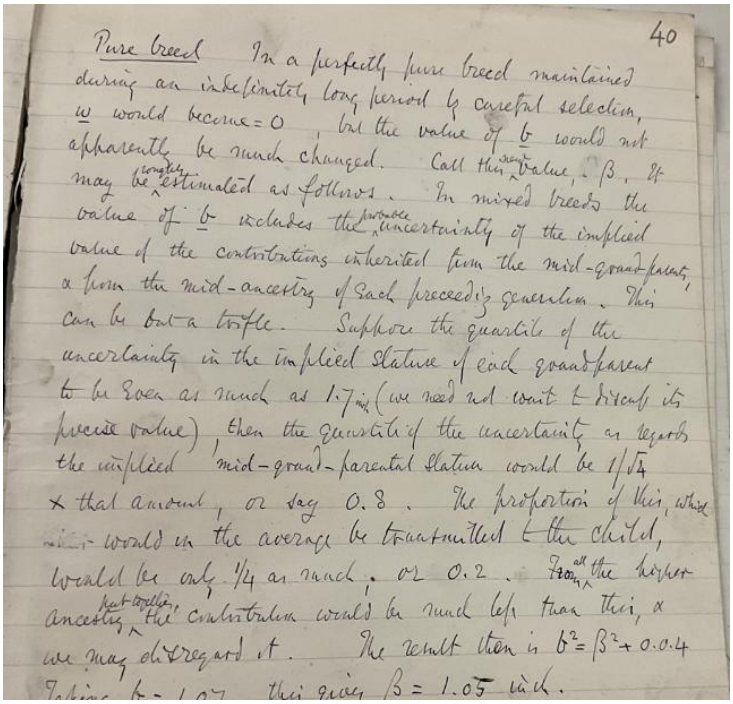
MEAN STATURE of Population

Fig 5

To Engraver — transpose these so as to make Fig 4 come before Fig 5 and reduce one half, or so.

Galton (32) Proc. 1886

of the first, second and third quartiles division. Calling these measures in any one series, Q_1, M, and Q_3, I take M, which is the Median or middlemost value, as that whence the deviations are to be measured, and $\frac{1}{2}\{Q_3-Q_1\}=Q$ as the Probable Error of any single measure in the series. This is practically the same as saying that one half of the deviations fall within the distance of $\pm Q$ from the Mean value, because the series run with fair symmetry. In this way I obtained the following values of M and Q, in which the second decimal must be taken as only roughly approximate. The M & Q of any particular series will be identified by a suffix, thus M_c & Q_c will stand for those of the Cubit, and M_s, Q_s for those of the Stature.



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Pure breed In a perfectly pure breed maintained during an indefinitely long period by careful selection, $\underline{w}$ would become = 0, but the value of $\underline{b}$ would not apparently be much changed. Call this new value, β. If may be roughly estimated as follows. In mixed breeds the value of $\underline{b}$ includes the probable uncertainty of the implied value of the contributions inherited from the mid-grandparents, & from the mid-ancestry of each preceding generation. This can be but a trifle. Suppose the quartile of the uncertainty in the implied Stature of each grandparent to be given as much as 1.7 in. (we need not count $\frac{1}{2}$ inch in its precise value), then the quartile of the uncertainty as regards the implied mid-grand-parental Stature would be $1/\sqrt{4}$ × that amount, or say 0.8. The proportion of this, which would on the average be transmitted to the child, would be only 1/4 as much, or 0.2. From all the higher ancestry, but chiefly the contribution would be much less than this, & we may disregard it. The result then is $b^2 = \beta^2 + 0.04$ Taking $b = 1.07$ this gives $\beta = 1.05$ inch.

Fig 15: the first 2 words show where Galton is almost always headed.

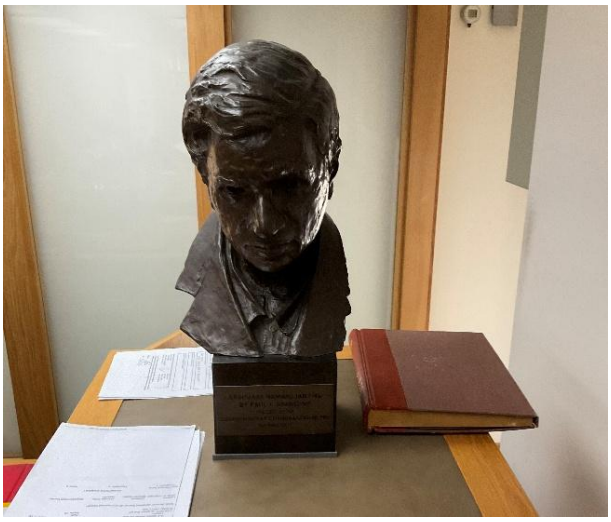
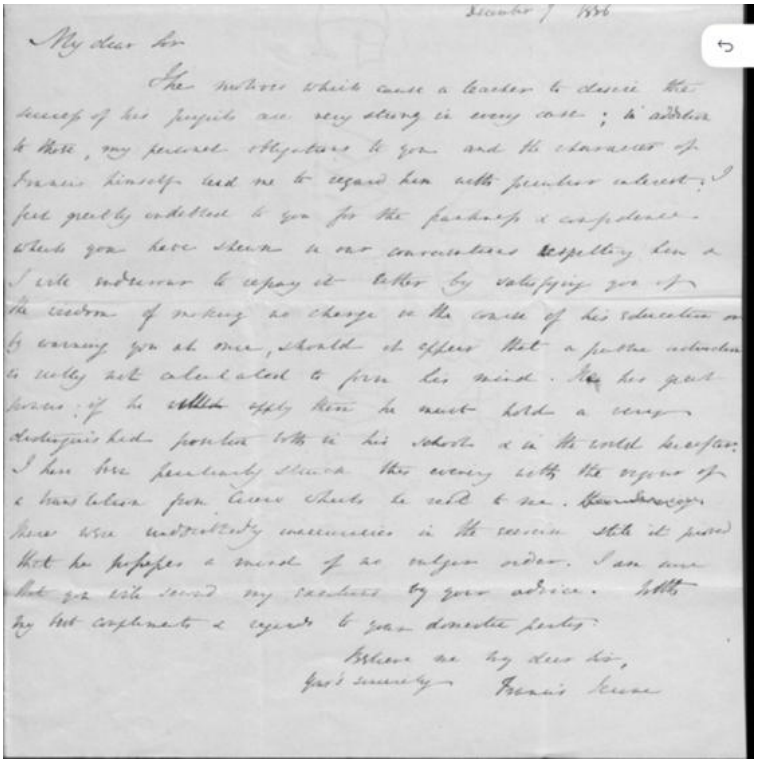


Fig 16
Ramanujan's bust in the Royal Society



January 7 1886

My dear Sir

The motives which cause a teacher to desire the success of his pupils are very strong in every case; & addition to these, my personal obligations to you and the character of Francis himself lead me to regard him with peculiar interest. I feel greatly indebted to you for the friendship & confidence which you have shown to our connection, especially him & I will endeavour to repay it better by satisfying you of the wisdom of making no change in the course of his education on by carrying you at once, should it appear that a further interval is really not calculated to free his mind. May his great powers if he will apply them he must hold a very distinguished position both in his School & in the world hereafter. I have been pleasantly struck this evening with the vigour of a boy's letter from Greece which he read to me. Remarkable there was undoubtedly unconscious in the expression which it proved that he possesses a mind of no vulgar order. I am sure that you will accept my confidence by your advice. With my best compliments & regards to your domestic party

Believe me my dear Sir,
Yours sincerely Francis Jeune

Fig 17 Letters from the Galton Archive contain school exchanges Over Greek translations and report comments from Francis Jeune. I will aim to get "he possesses a mind of no vulgar order" into one of my future reports.

Fig 18: Galton's Portrait in the National Portrait Gallery.

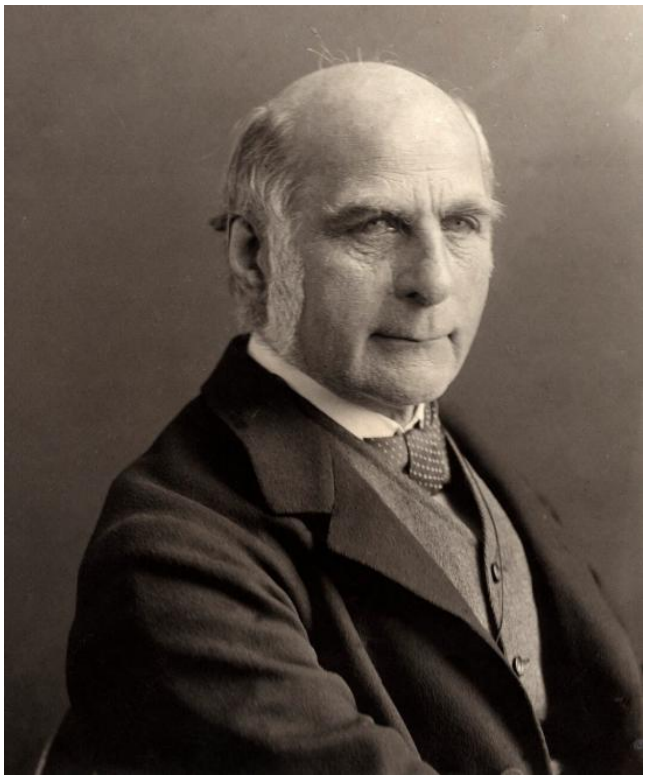


Fig 19,20: The Athenaeum Club as it is today, round the corner from the Royal Society. A Gentlemen's club for those with significant intellectual interests, this was primary networking engine for data, he was prominent and involved for decades. Entry is by invite only so the picture of the library is a library picture.





Edwin Abbott Abbott

As an educator with nearly 3 decades behind me, I can vouch for how easy it is to get tangled in the flotsam caused by the pace of change that, indeed, any 21st century career must handle. When reading Abbott's letters from his time as Headmaster of CLS, I was first struck by how cathartic it was to read him encountering the same core problems that a modern teacher of boys would meet! Complaints from parents about erroneous attendance scores, reports of boys mucking about by the toilets or gripes about colleagues who were not following precise protocol are all recorded and replied to with a calm, supportive, clear purpose. Digging into Galton's letters in the hopes for something of the man yielded the opposite, but almost every record of Abbott is in some way illuminating, giving an impression of a teacher, in the fullest sense of the word. Edwin Abbott Abbott is described as a listener with an open, questioning manner, a fierce, impish intellect and a commitment to progression that transcended the Victorian definition of the word.

I liked him immediately.

Early Life

Abbott's parents were cousins (hence the doubling of the name) and his father also was a teacher and classicist; a stupendously detailed thesaurus of Alexander Pope quotations that he wrote was eventually completed by his son after his death and remains an influential guide (fig 36). Abbott attended CLS as a boy and excelled, moving later to St. John's, Cambridge to study Classics for many years. As an undergraduate he was the senior medallist, was later elected to a fellowship and was soon ordained. Having decided to marry, which was not permitted of fellows, he moved to teaching which led him to KES.

Abbott worked as a 'Composition Master' (classics teacher) for 2 years under Charles Evans (another tough taskmaster but one who at least promoted Mathematics), but his main contribution to KES was to come years later, when he campaigned to the governors to appoint his friend and colleague Alfred R. Vardy as Chief Master. Vardy had been a fellow pupil at CLS and, though it was Abbott who was appointed school captain, both attended Cambridge and Vardy had become a Fellow at Trinity. Vardy would later work at CLS with Abbott for a time and they both would ultimately become one of the most influential and best-loved leaders for their prestigious academic institutions. Vardy was apparently reluctant at first, succumbing to Abbott's persistent faith in him and subsequent commendations of Vardy's "dignity, sincerity," and "generous and unselfregarding" nature that persuaded the KES governors to name him as Evans' successor in 1872, a post Vardy would hold till the end of the century.

At CLS

Lauded for his style of teaching, Abbott won the Headmastership at the City of London School in what was considered a surprise at the time. The earliness in his career of such an appointment (aged 26) was rare, and Abbott had to immediately deal with managing many masters who not only had taught him relatively recently, but also had unsuccessfully

gone for the job themselves. Under these pressured circumstances, Abbott was successful startlingly quickly. His first steps demonstrated the value he placed on breadth in education, coupled with the confidence to modernise the curriculum. His promotion of Science to the forefront (he described labs as 'hidden worlds' to explore) when other schools (including KES) had leant more towards the Classics in which he had himself thrived, was both bold and effective. Extra teachers were brought in to embed this, whilst Arithmetic and Latin were also given prominence, and he regularly encouraged his boys to study beyond the curriculum. CLS became the only public school requiring all boys to study English language and literature, and his knowledge of Shakespeare and Pope, Milton & Scott were formidable. Abbott knew that rote learning led to only a limited understanding, and built courses that would develop thinking over cramming: proof was valued higher than tedious computations. He also sustained the progressiveness the school's intake, with Jewish and Catholic as well as less wealthy boys having a wider access to education than previously. His peers took note; he was made secretary at HMC at the age of 34, and the numbers of boys sent to the top institutions (and the degree of feedback upon their quality) propelled CLS upwards in stature.

His most notable pupil was surely H.H.Asquith, the liberal Prime Minister of 8 years, whose talents for broaching compromise in different coalition governments were ultimately undone by a declining empire, fumbles around suffrage, violence in Ireland and the small matter of the First World War. Before history dealt him such a troubled hand, Asquith was a resilient, hard-working student from a relatively humble background, that Abbott nurtured and valued, making him school captain in 1869. Asquith in turn would consistently speak of Abbott with enormous respect throughout his career, once saying at a gathering of old boys "*I am certain… that there is no man now living to whom I lie under the same debt of obligation*." Incidentally, the science in Asquith's CLS education would draw him to Galton when shadow Home Secretary, and he helped progress the work Galton had done on fingerprinting. Indeed, it was Asquith who awarded Galton his eventual knighthood.

Aflame with intellectual energy and possessing a deep and serious distrust of intellectual slackness, Abbott would go out of his way to praise those who won his respect; there are letters in the London archives from authors he corresponded with after simply enjoying their work. As an Anglican Priest, his moral conviction seemed to play as large a part as dogma, and his philosophical writing in later life would reconcile these. Possessing the sonorous voice of a preacher that could both charm and command, boys would speak of "eyes that would look straight through you." For Abbott, a liberal education and religious morality were indivisible: study and knowledge of the world led to an evolution of morality and love "*by which we approach God himself*." After "*Flatland*" was published, some took the idea of a higher dimensional being projecting themselves into ours as being as a literal explanation for the divine, but Abbott was quick to dismiss this, believing that God was not bound by any such logic or mathematics. He was, however, happy to satirise a church that was overly dependent on ceremony instead of accessibility and future progress.

Abbott and his wife had two children during their time at CLS, in a period of success and happiness, but the determination that Abbott applied to his work did take a toll. Having being appointed so young, he also retired early from the role since the levels of

commitment he felt were necessary to do the job at the levels it deserved were diminishing. The task of equipping the CLS campus for his curriculum had been hugely demanding and Abbott wanted to commit to his writing, standing down in 1889. In the London archives there is a commemorative book of astonishing beauty, given to him and signed by the staff body, filled with effusive praise.

Flatland

Flatland overlapped with Abbott's later years at CLS and was published in 1884- although technically anonymously since Abbott's name was not seen on the first run. Jokingly printed as the work of pseudonym "A. Square", Abbott did little to deny his authorship but also seemed to enjoy the game of it (one wonders if the name is a pun on Abbott Abbott, hence A^2). There was not enormous acclaim or impact made when the book first emerged, and such esteem would not happen until later editions caught the public imagination in the 1920s: it was not even mentioned in his Times obituary when Abbott passed. The only mention of it in the KES archives is in a jovial report from the debating society from 1901, where one 'A.E. Measures' describes himself as "*Member for Utopia and Flatland*", to, one presumes, much hilarity. The book itself, however, would become the thing for which Abbott is most remembered and its overlap with Galton's world and our modern perspective remain vivid.

Flatland is a diary of a man living in a completely 2-dimensional world. The first part of the book is his description of its rules and history, but in the second he is visited by a 'Sphere' from a 3D world, who proceeds to obliterate our poor narrator's grip on what he had previously held to be an obedient, privileged existence. In the final part, these two try to reconcile their positions to limited effect, as it appears the elders of Flatland had long known of this truth, but suppressed it. The genres of both Science Fiction & Fantasy were in their infancy, and whilst *Flatland* shares some DNA with other dystopian works of sci-fi that would appear around the turn of the century, it is really more of a fantasy tale (if in doubt: *Star Trek* is sci-fi and *Star Wars* is fantasy!). The piece had an enormous impact on many later authors and one needs only to look at Alan Moore's *Watchmen*, one of the following century's most lauded works, for a similar brainwashed dystopia where extra-dimensional beings befuddle the masses and a diary is left to reveal the underlying truth to a brainwashed populace.

The central satirical themes in *Flatland* come in the first section, where the rules by which its meritocracy is defined: shape is all important and breeding leads to future, "superior" beings. Abbott, in what was on the face of it a work of mathematical whimsy, directly confronts eugenics, painting an outcome of the rules Galton proposed that has led to ignorance and tyranny. Knowing that attacking the immorality of eugenics would be blithely ignored as the sentimental yearnings of a bleeding heart, Abbott tackles the practicality of eugenics, immediately illustrating that, when classes are divided by quantification, the choice of what quantification is used (and who controls that) becomes paramount. "*Survival of the Fittest*" had already been adopted as the widely known phrase it is today, but the idea of what 'fittest' actually means had not yet exhausted the debate

that the phrase demands. In *Flatland*, there are pages about how clear and purposeful the structuring of the "natural laws" of polygons operate, which, to any readers' eye, are immediately pompous, arbitrary nonsense: Anna Neil describes Flatland as "*a society in which dreams of racial progress nurture cultural intolerance*". Abbott arguably does not directly address one specific type of bigotry (talks of how irregularity in shape and colour are dealt with could refer to social class or race) but there is one exception: the role of women in Flatland.

After the first edition was published, Abbott was stung by criticism that the book promoted a dreadful treatment towards women, to the extent that some readers had assumed that the attitude of his narrator was not being satirised or subverted but actively endorsed. Women are straight lines in Flatland and kept at home for 'their protection', although notably their 'sharpness' makes them dangerous and another reason to keep them behind closed doors. Failure to see women as anything other than "one-dimensional" is sustained throughout the novel and their position is no better by the end, when A. Square seems barely to notice their plight in the shadow of his other revelations. Abbott worked throughout his life to champion the education of women (through home teaching, since the primary institutions would not recognise women's achievements, no matter how profound) and was aghast at the suggestion that his sympathies lay elsewhere, clarifying the point for later editions.

Perhaps the most compelling theme is that knowledge varies hugely with perspective. A. Square's entire universe is obliterated in one moment, and it forces him to ask the question of what other paradigm shifts might be out there. *Flatland* plays with the idea of iterating A. Square's experience to what a 4D manifestation in our world may look like (which the Sphere amusingly balks at), well before it became the substance of future physics and future fiction (Christopher Nolan's *Interstellar* fixates on this). This idea was being kicked about within Abbott's social circle by Mathematicians of the era such as Charles Howard Hinton (who coined the term 'tesseract'), whose colleague, Howard Candler, was Abbott's closest friend, and to whom "*Flatland*" is dedicated, but the implication of what this means further beyond 4D is the most compelling. The still relatively young Mathematics of Fractals has since illuminated shapes whose dimensionality lies between integers (the Sierpinski gasket, fig 37, has neither length since it cannot be drawn in one visit, nor area since it contains empty "gaps", and we now measure its dimensionality as therefore between 1 & 2- 1.58 to 3sf or $\left(\frac{\ln 3}{\ln 2}\right)$ to be precise). If geometry can be opened to uncountable infinities in a single stroke, what else might be? We were learning that dimensionality itself was not something we can take for granted; Bertrand Russell would later speak of this and use a similar approach to Abbott's explanations when tasked in later years to explain Einstein's Theory of Relativity to a mostly bewildered public. A. Square, for his part, learns little, merely substituting his devotion of 2D to 3D.

Others, including Hinton (himself a highly colourful character), would take the mathematical and conceptual themes further, but Abbott's later work was far more philosophical, and he eventually let others dig into the practicalities of how a 2D universe operates with its zero/negligible "height". HG Wells would soon use multidimensionality in "*The Time Machine*" in 1895 and then properly kick open the door to what would become

modern science fiction ("*The Island of Dr Moreau*" followed soon after, which certainly overlaps with eugenic themes).

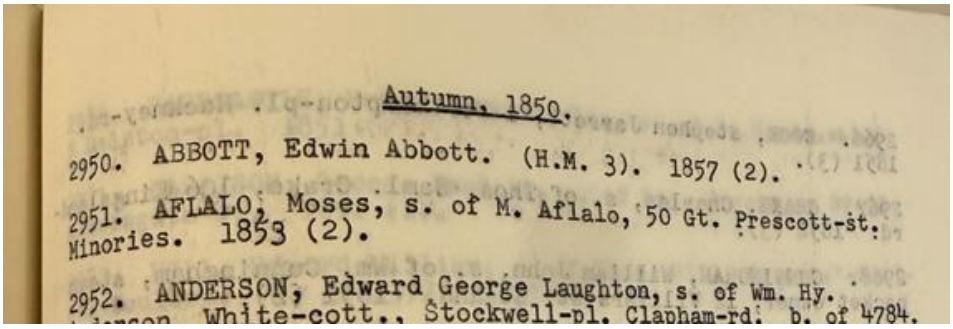
Later Years

Written as a series of letters, "*The Kernel and the Husk*" shows Abbott unafraid to challenge the church on matters of high dogma. Abbott felt that too much was being invested in the miraculous nature of religion, to the detriment of future generations' connection to spirituality. The 'husk' of taking miracles literally was, to Abbott, overwhelming the 'kernel' of the spiritual essence of Christianity, although the work drew sharp condemnations from what remained a conservative church (he published it anonymously). His later work would be more analytical and academic, working closely with his devoted daughter when illness and age ultimately limited his movements.

His 56-year marriage ended when his beloved Mary passed in 1919, and when Abbott died 7 years later, he was buried in Hampstead cemetery beside her, not far from where they lived (for future visitors - their grave requires you to contact the council beforehand to get clues to its location). All material on Abbott paints the picture of a truly heroic polymath of high moral character, whose life reflects endeavour, persistence, creativity, devotion and courtesy. He even liked a pun.

Figs 20-34 courtesy of the London Archives:

Fig 20: Record of Abbott's metriculationat a student at the City of London school. Much of the material was donated by CLS.

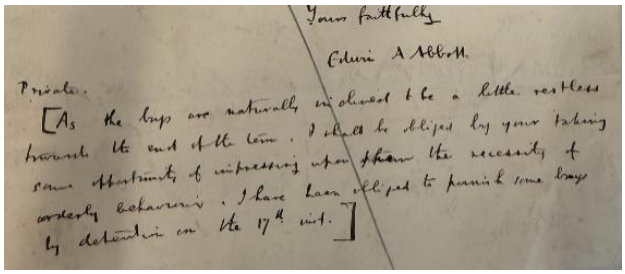

Autumn, 1850.

2950. ABBOTT, Edwin Abbott. (H.M. 3). 1857 (2).

2951. AFLALO, Moses, s. of M. Aflalo, 50 Gt. Prescott-st. Minories. 1853 (2).

2952. ANDERSON, Edward George Laughton, s. of Wm. Hy. White-cott., Stockwell-pl. Clapham-rd. b. of 4784.

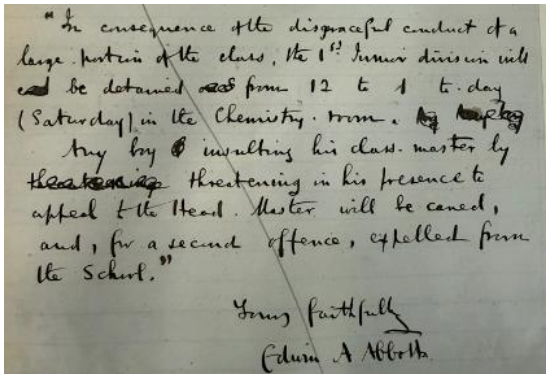
Figs 21-25: There were delightfully many notes written to masters, dealing with parents complaining about unorthorised absence, detentions, neatness of boys' writing, rudeness, "disorder near water closets" (in red ink!), poor arithmetic, HMC visits and some staff not following his directions. Plus ça change!
His tone is always warm, considered and respectful.



Yours faithfully
Edwin A Abbott.

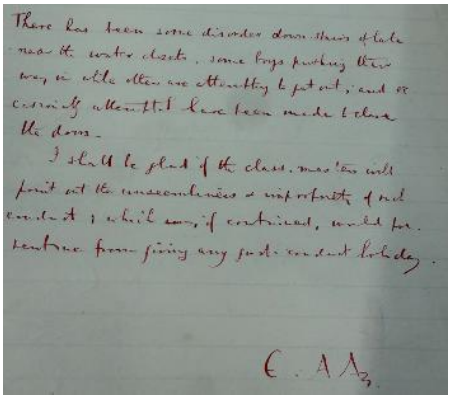
Private.

[As the boys are naturally inclined to be a little restless towards the end of the term, I shall be obliged by your taking some opportunity of impressing upon them the necessity of orderly behaviour. I have been obliged to punish some boys by detention on the 17th inst.]



"In consequence of the disgraceful conduct of a large portion of the class, the 1st Junior division will be detained from 12 to 1 to-day (Saturday) in the Chemistry room. Any boy who insulting his class master by threatening in his presence to appeal to the Head Master will be caned, and, for a second offence, expelled from the School."

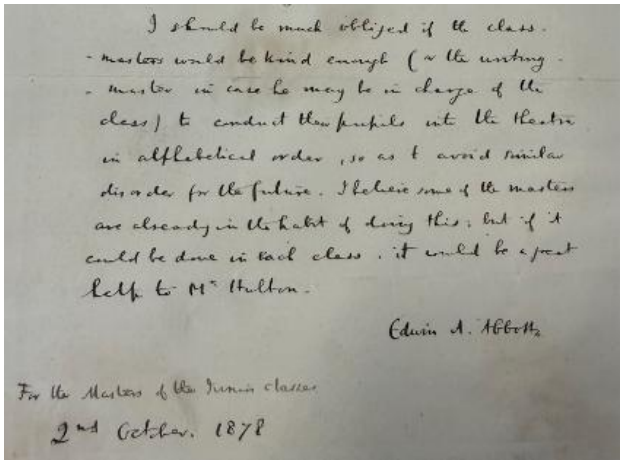
Yours faithfully
Edwin A Abbott



There has been some disorder down there of late near the water closets. Some boys pushing their way in while others are attempting to get out; and occasionally altercations have been made to close the doors.

I shall be glad if the class masters will point out the inconveniences & infrequently of such conduct; which even, if continued, would forbid sentence from giving any further indulgence.

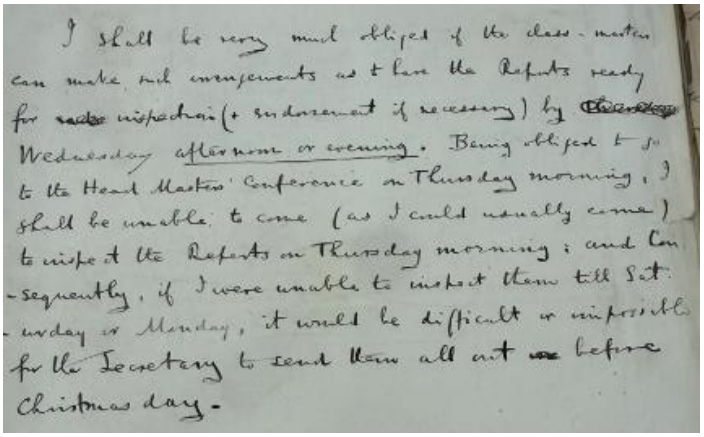
E. A A.



I should be much obliged if the class masters would be kind enough (& the visiting master in case he may be in charge of the class) to conduct their pupils out the theatre in alphabetical order, so as to avoid similar disorder for the future. I believe most of the masters are already in the habit of doing this; but if it could be done in each class, it would be a great help to Mr Hulton.

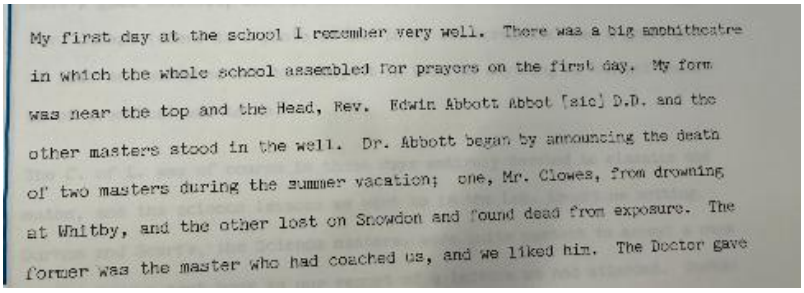
Edwin A. Abbott

For the Masters of the Junior classes
2nd October. 1878



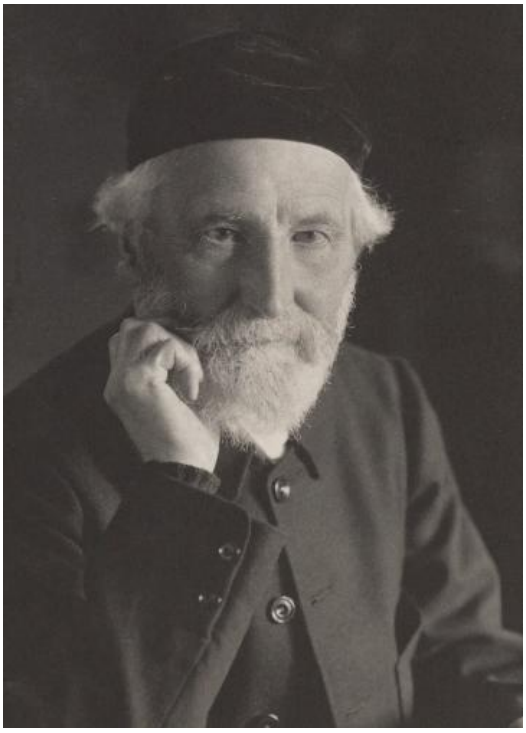
I shall be very much obliged if the class-masters can make all arrangements as to have the Reports ready for inspection (& endorsement if necessary) by Wednesday afternoon or evening. Being obliged to go to the Head Masters' Conference on Thursday morning, I shall be unable to come (as I could usually come) to inspect the Reports on Thursday morning; and consequently, if I were unable to inspect them till Saturday or Monday, it would be difficult or impossible for the Secretary to send them all out before Christmas day.

Fig 26: From a CLS boy's biography- quite the start of term assembly:

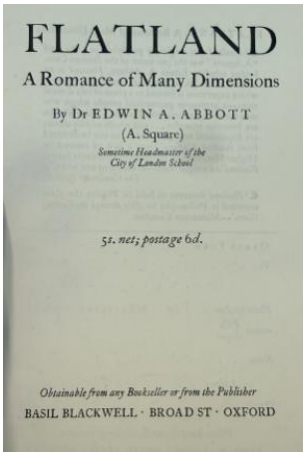


My first day at the school I remember very well. There was a big amphitheatre in which the whole school assembled for prayers on the first day. My form was near the top and the Head, Rev. Edwin Abbott Abbot [sic] D.D. and the other masters stood in the well. Dr. Abbott began by announcing the death of two masters during the summer vacation; one, Mr. Clowes, from drowning at Whitby, and the other lost on Snowdon and found dead from exposure. The former was the master who had coached us, and we liked him. The Doctor gave

Fig 27 Abbott's picture at the National Portait Gallery.
His resemblance to Michael Gambon's filmic portayal of a ficticious but equally learned and quicksilver Headmaster is, one assumes, a glorious coincedence.



Figs 27, 28: Pre-Amazon order forms for Flatland



FLATLAND

A Romance of Many Dimensions

By Dr EDWIN A. ABBOTT

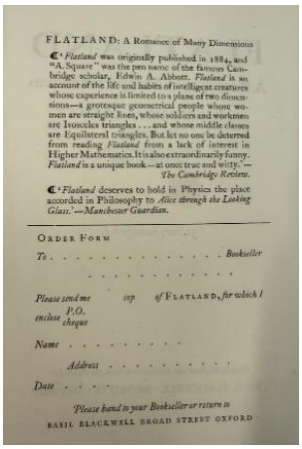
(A. Square)

Sometime Headmaster of the City of London School

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FLATLAND: A Romance of Many Dimensions

'*Flatland* was originally published in 1884, and "A. Square" was the pen name of the famous Cambridge scholar, Edwin A. Abbott. *Flatland* is an account of the life and habits of intelligent creatures whose experience is limited to a plane of two dimensions—a grotesque geometrical people whose women are straight lines, whose soldiers and workmen are Isosceles triangles . . . and whose middle classes are Equilateral triangles. But let no one be deterred from reading *Flatland* from a lack of interest in Higher Mathematics. It is also extraordinarily funny. *Flatland* is a unique book—at once true and witty.'—*The Cambridge Review.*

'*Flatland* deserves to hold in Physics the place accorded in Philosophy to *Alice through the Looking Glass*.'—*Manchester Guardian.*

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. . . . . .

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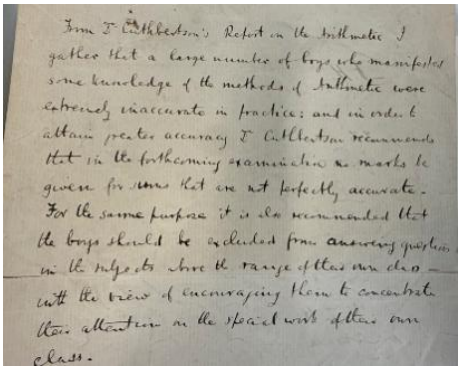
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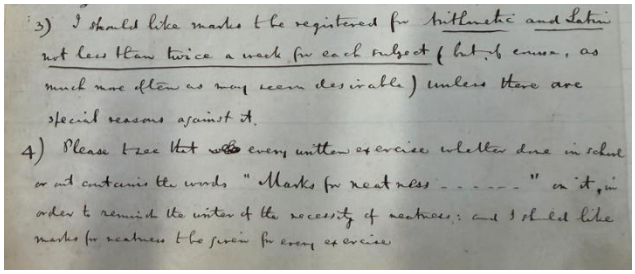
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Figs 29, 30: Abbott was influential in modernising curricula, with Arithmetic & Latin (underlined) promoted, but the physical sciences elevated CLS above what other schools were offering.

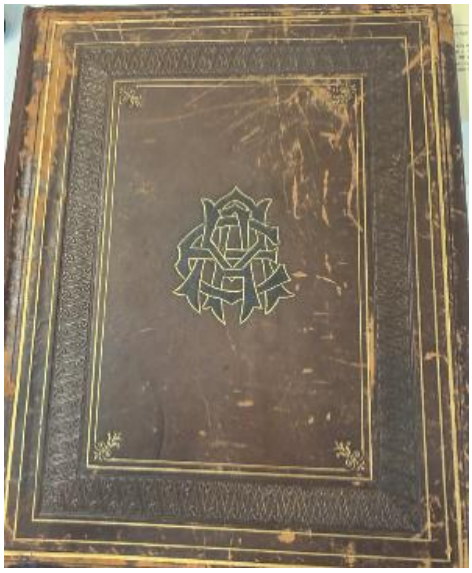


From T. Eckleston's Report on the Arithmetic I gather that a large number of boys who manifested some knowledge of the methods of Arithmetic were extremely inaccurate in practice: and in order to attain greater accuracy T. Eckleston recommends that in the forthcoming examination no marks be given for sums that are not perfectly accurate. For the same purpose it is also recommended that the boys should be excluded from answering questions in the subjects where the range of Class work is small with the view of encouraging them to concentrate their attention on the special work of their own class.

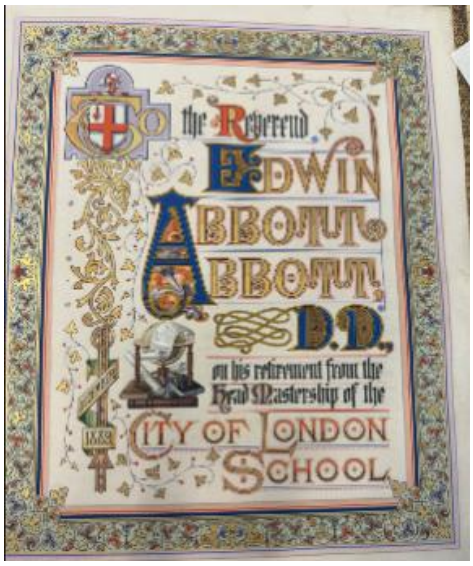


3) I should like marks to be registered for Arithmetic and Latin not less than twice a week for each subject (but of course, as much more often as may seem desirable) unless there are special reasons against it.

4) Please see that with every written exercise whether done in school or not contains the words "Marks for neatness ——— " on it, in order to remind the writer of the necessity of neatness: and I should like marks for neatness to be given for every exercise



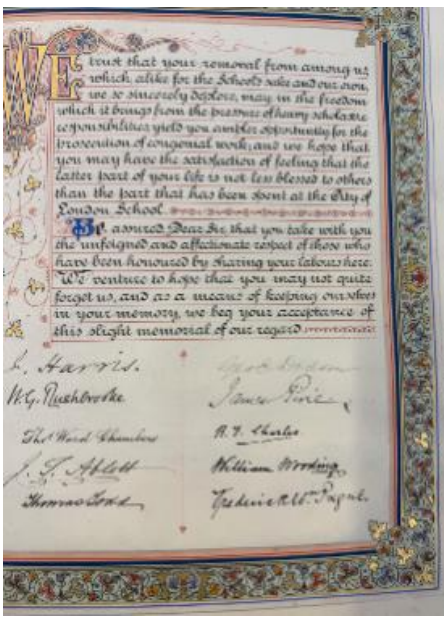
Figs 31-34: this startlingly beautiful book was given to Abbott upon his retirement from CLS. It is in amazing condition (I was scared to hold it) and is a profound tribute to how the man was perceived.



To the Reverend EDWIN ABBOTT ABBOTT, D.D., on his retirement from the Head Mastership of the CITY OF LONDON SCHOOL



We your Colleagues and Assistants at the City of London School, desire to express our deep regret at the near prospect of the termination of your Head Mastership. Of the brilliant success which has attended your many years of labour here, it is not for us to speak: its record stands on the long list of your distinguished pupils and in the reputation of the School. To us your retirement is the loss of a leader of whom we were proud and in whom we had learned to place our trust. We wish to record our admiration for your character, for your public spirit, for your devotion to the cause we all have at heart, and for your sense of duty - which no personal vanity, no desire for personal advantage has ever warped, and with this we would gratefully acknowledge the courtesy bearing, the ready sympathy in time of trouble, the unfailing kindness at all times, whereby you have so greatly added to our happiness here.



We trust that your removal from among us, which, alike for the School's sake and our own, we so sincerely deplore, may in the freedom which it brings from the pressure of many scholastic responsibilities yield you ampler opportunity for the prosecution of congenial work; and we hope that you may have the satisfaction of feeling that the latter part of your life is not less blessed to others than the part that has been spent at the City of London School.

Be assured, Dear Sir, that you take with you the unfeigned and affectionate respect of those who have been honoured by sharing your labours here. We venture to hope that you may not quite forget us, and as a means of keeping ourselves in your memory, we beg your acceptance of this slight memorial of our regard.

L. Harris. — Geo. Lindsay

W.G. Rushbrooke — Simon Price

Thos. Ward Chambers — R.T. Charles

J.S. Abbott — William Worsley

Thomas Ford — Frederick W. Pagel

Figs 35 & 36 courtesy of the library of the University of St Andrews

35 Animated versions of "*Flatland*" have led to some wonderful art.

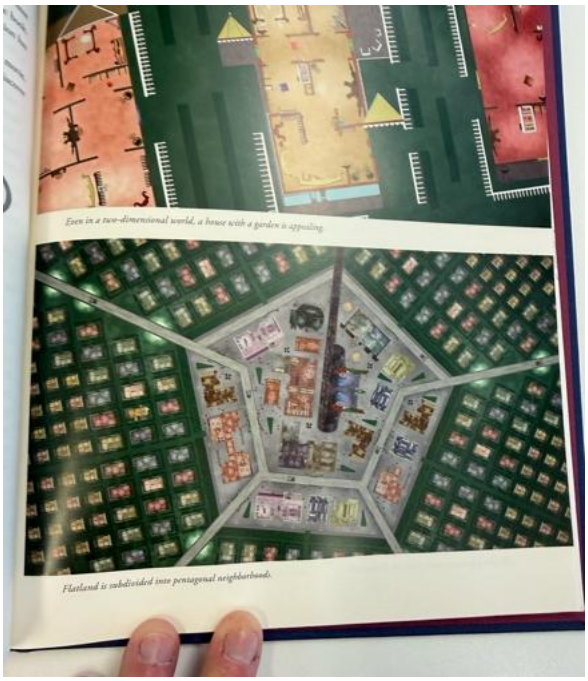


Fig 36: From Abbot's book on Alexander Pope.

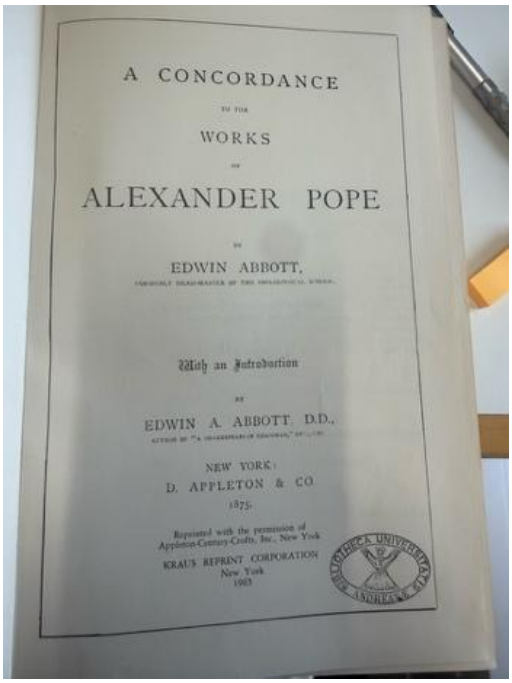
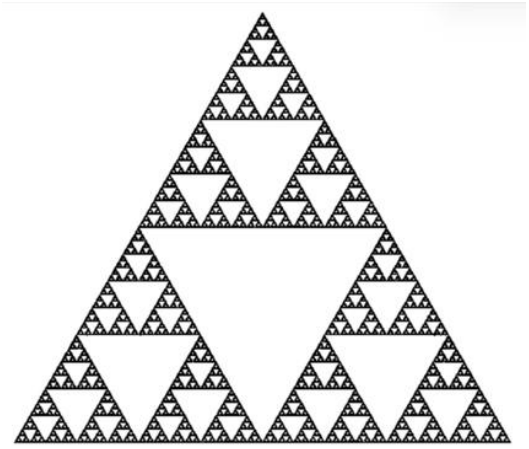


Fig 37: A Sierpinski Gasket, created by drawing an inverted equilateral triangle inside every upward facing one, has neither length nor area, and dimensionality around 1.6.



Conclusion

Abbott stared into the world that Galton outlined and anticipated some of the moral and human costs of the axioms that Galton seemed not even to consider, but would come to pass with frightening haste in the 20th century (Galton would have been appalled at the subsequent horror committed in the name of his own science). They had the same school in their past, the same university as Alma Mater and the same genius for breadth of knowledge and creativity of logical pursuit but, in what Galton would surely fail to appreciate, the same input led to widely different output.

Abbott could find space for reconciling his faith with the uncertainty of an unknowable world, in which Science and Mathematics require as much imagination as any other field. Yet Galton, a man without religious faith, could not perceive any perspective that differed from the certainty of his own convictions.

Might they have met? There is no known record of it happening, but the world of Victorian Science was not that enormous, and both men spent many years towards the end of the nineteenth century prominent around London in numerous ways. The Royal Society offered me the chance to cross-reference every handwritten record of visitors over the period where Galton was Vice-President, but there were hundreds of scrolls, little chance of success and I was in the middle of a day-trip to London that included 22,000 steps and a temperature of 34 ◦ C, so I declined.

Besides - I rather like the idea of not knowing for sure.

It does seem likely that they would have crossed paths at at least one point. Perhaps one afternoon in 1896, around the corner from the Royal Society at the Athenaeum Club (figs 17,18), then a house for gentlemen whose intellectual interests were prominent.

In a library, perhaps. Over tea.

I wonder what they might have talked about?



AI image by Gemini

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Fig 38: Souvenirs





