ON A POSSIBILITY OF CREATING OR TRANSLATING MATHEMATICS TERMINOLOGIES

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The purpose of this paper is to suggest a method of creating or translating mathematics terminologies.

Nowadays, many peoples in non-industrialized areas are trying to speak and write mathematics in their own languages to build up their own mathematics education. One of the difficulties in those trials may be that they occasionally don't have exactly corresponding words to Western mathematics terminologies. Such a difficulty follows about any cultural exchanges generally.

My suggestion to tide over such a difficulty is that we should refer to terminologies from various cultures. For, in my observation, Western mathematics terminologies are often inappropriate for beginners of mathematics learning even in the Western culture. In addition, some mathematics terminologies in non-Western cultures seem to be better in the expression of their concepts than those of Western's. If my observation is true, it seems efficient for people in non-industrial areas to refer those words from various cultures in creating or translating mathematics terminologies fitting to their own culture. As an example to examine the efficiency of the suggestion, I give rough comparative tables of some elementary mathematics terminologies between those of Western's and of East Asia's in the following. If the suggestion is accepted as efficient, we need more complete and precise comparative linguistic study on mathematics terminologies between various cultures'.

In East Asia, elementary mathematics terminologies are all most same following to those of Chinese. At least between China and Japan, their main differences are in reading. So, in the cells of terminologies in East Asia of the following tables, I put down those words in Chinese Characters, and their Japanese readings in the brackets [ ] in Roman letters, and their meaning in English following to them.

Remark 1. As the reader look at the following tables, s/he may find that East Asian mathematics terminologies themselves sound like their definitions. I think that's because Chinese characters are ideographical, i.e. they represent their meaning of themselves.

0. Number

	Western (English)	East Asian (Japanese)
0	number	数 [su] number

1. Numerals

In East Asia, people use the scale of notation of base 10 and units "ju (10)," "hyaku (100)," "sen (1000)," "man (10000)," "oku (10^8=100000000)," etc. We can give a comparative table of small numbers and a large number as follows:

	Western (Indian-Arabic)	East Asian (Japanese)
1-0	0	零 [rei]
1-1	1	一 [ichi]
1-2	2	二 [ni]
1-3	3	三 [san]
1-4	4	四 [shi] or [yon]
1-5	5	五 [go]
1-6	6	六 [roku]
1-7	7	七 [sichi] or [nana]
1-8	8	八 [hachi]
1-9	9	九 [kyu] or [ku]
1-10	10	十 [ju]
	11	十一 [ju-ichi] 10+1 (cf. 1-1)

	12	十二 [ju-ni] 10+2 (cf. 1-2)
	13	十三 [ju-san] 10+3 (cf. 1-3)
	14	十四 [ju-shi] or [ju-yon] (cf. 1-4)
	15	十五 [ju-go] 10+5 (cf. 1-5)
	16	十六 [ju-roku] 10+6 (cf.1-6)
	17	十七 [ju-shichi] or [ju-nana] 10+7 (cf. 1-7)
	18	十八 [ju-hachi] 10+8 (cf. 1-8)
	19	十九 [ju-kyu] or [ju-ku] 10+9 (cf. 1-9)
	20	二十 [ni-ju] 2×10
	21	二十一 [ni-ju-ichi] 2×10＋１
	100	百 [hyaku]
	542	五百四十二 [go-hyaku-yon-ju-ni] 5×100+4×10+2

Remark 2. We, East Asian people, now use Indian-Arabic numerals to write numbers and read them in classic style as above. The reason why we put down East Asian classic numerals is to show a part of their number system. It helps reader's understanding in the followings as well.

2. Terminologies in Arithmetic

	Western (English)	East Asian (Japanese)
2-1	arithmetic	算術 [san-jutsu] 算=bars to count, 術=art or skill

2-2	add	加 [kuwaeru]
2-3	sum	和 [wa]
2-4	subtract	引 [hiku] remove
2-5	difference	差 [sa]
2-6	multiply	掛 [kakeru] multiply
2-7	product	積 [seki] product
2-8	divide	割 [waru]
2-9	quotient	商 [sho]
2-10	remainder	余 [amari]
2-11	factor	約数 [yaku-su] or 因数 [in-su] 約=shortening or simplifying, 数=number (cf. 0), 因=cause or source, 数=number (cf. 0)
2-12	multiple	倍数 [bai-su] 倍=doubled or multiplied, 数=number (cf. 0)
2-13	prime number	素数 [so-su] 素=source, 数=number (cf. 0)
2-14	factorization	素因数分解 [so-in-su-bun-kai] 素因数=prime factor (cf. 2-11 and 2-13), 分=divide 解=resolve
2-15	cancellation	約分 [yaku-bun] 約=shortening or simplifying, 分=abbreviation of 分数=fraction (cf. 3-3)

2-16	ratio	比 [hi] or 割合[wari-ai] 割=divided, 合=adjustment
2-17	rate	率 [ritsu]
2-18	portion	比例 [hi-rei] 比=ratio (cf. 2-16), 例=lined up
2-19	inverse portion	反比例 [han-hirei] 反=anti or inverse, 比例=portion (cf. 2-18)

3. Classes of Numbers

	Western (English)	East Asian (Japanese)
3-1	natural number	自然数 [shizen-su] 自然=natural, 数=number (cf. 0)
3-2	integer	整数 [sei-su] 整=neat, 数=number (cf. 0)
3-3	fraction	分数 [bun-su] 分=divide or divided, 数=number (cf. 0)
3-4	2/3	三分の二 [san-bun-no-ni] 2 of divided 3 parts, 三=3 (1-3), 分=divided (cf. 3-3), の=of, 二=2 (cf. 1-2)
3-5	decimal	小数 [sho-su] 小=small, 数=number (cf. 0)
3-6	0.2	二割 [ni-wari] 二=2 (cf. 1-2), 割=1/10 (cf. 2-8)

3-7	0.03	三分 [san-bu] 三=3 (cf. 1-3), 分=1/100 (cf. 3-3)
3-8	0.004	四厘 [yon-rin] 四=4 (cf. 1-4), 厘=1/1000
3-9	positive number	正数 [sei-su] 正=right, 数=number (cf. 0)
3-10	negative number	負数 [hu-su] 負=lost, 数=number (cf. 0)
3-11	rational number	有理数 [yu-ri-su] 有=having, 理=ratio (cf. 2-16), 数=number (cf. 0)
3-12	irrational	無理数 [mu-ri-su] 無=not having, 理=ratio (cf. 2-16 & 3-11), 数=number (cf. 0)
3-13	real number	実数 [jistu-su] 実=real, 数=number (cf. 0)

4. Terminologies in Algebra

	Western (English)	East Asian (Japanese)
4-1	Algebra	代数 [dai-su] 代=representing, 数=number (cf. 0)
4-2	Square	平方 [heiho] or 二乗 [ji-jo] 平=flat or plane, 方=rectangular, 自乗 [ji-jo] 自=self, 乗=multiplied, or

		二=2 (cf. 2), 乗=multiplied
4-3	cube	立方 [rippou] or 三乗 [san-jo] 立=solid or cubic, 方=rectangular solid (cf. 4-2), 三=3 (cf. 1-3), jo=multiplied (cf. 4-2)
4-4	n-th power	n 乗 [enu-jo] 乗=multiplied (cf. 4-2), or n 巾 [enu-beki] 巾=power
4-5	square root	平方根 [heiho-kon] 平方=square (cf. 4-2), 根=root
4-6	cube root	立方根 [rippo-kon] 立方=cube (cf. 4-3), 根=root (cf. 4-4), or 三乗根 [san-jo-kon] 三乗=cube (cf. 4-3), 根=root (cf. 4-4)
4-7	n-th root	n 乗根[unu-jo-kon] 乗=multiplied (cf. 4-2), 根=root (4-5)
4-8	base	底 [tei] base
4-9	exponent	指数 [si-su] 指=index, 数=number (cf. 0)
4-10	expression	式 [siki] 式=form
4-11	variable	変数 [hen-su] 変=varying, 数=number (cf. 0)
4-12	monomial	単項式[tan-ko-siki] 単=single, 項=term, 式=form (cf. 4-10)

4-13	polynomial	多項式 [ta-ko-siki] 多=many, 項=term (cf. 4-12), 式=form (cf. 4-10)
4-14	linear expression	一次式 [ichi-ji-siki] 一=one (cf. 1-1), 次=degree, 式=form (cf. 4-10)
4-15	quadratic expression	二次式 [ni-ji-siki] 二=2, 次=degree (cf. 4-14), 式=form (cf. 4-10)
4-16	coefficient	係数 [kei-su] 係=leaning (?), 数=number (cf. 0)
4-17	substitution	代入 [dai-nyu] 代=altenative or representative(cf. 4-1), 入=putting into
4-18	formula	公式 [ko-siki] 公=equally holding, 式=form (cf. 4-10)
4-20	factorization	因数分解 [insu-bunkai] 因数=factor (cf. 2-11), 分解=resolution or decomposition (cf. 2-14)
4-21	equality	等式 [to-siki] 等=equal, 式=form (4-10)
4-22	inequality	不等式 [hu-to-siki] 不=not, 等式=equality (cf. 4-20)
4-23	equation	方程式 [ho-tei-siki] 方=adjusted, 程=degree or extent, 式=form (cf. 4-12)
4-24	solution, root	解 [kai] solution, or 根 [kon] root

4-25	discriminant	判別式 [hanbetsu-siki] 判=judging, 別=difference, 式=form (cf. 4-12)
4-26	simultaneous equation	連立方程式 [ren-ritu-ho-tei-siki] 連=lie in a row or co-, 立=standing, 方程式=equation (cf. 4-23)
4-27	elimination	消去 [sho-kyo] sho=erase, kyo=throw away

5. Terminologies in Geometry

	Western (English)	East Asian (Japanese)
5-1	geometry	幾何 [ki-ka] 幾=how (long etc.), 何=what
5-2	point	点 [ten]
5-3	line	線 [sen] line (including curve)
5-4	straight line	直線 [choku-sen] 直=direct, 線=line (cf.)
5-5	curve	曲線 [kyoku-sen] 曲=bent or curved, 線=line (cf. 5-3)
5-6	plane	平面 [heimen] 平=flat (cf. 4-2), 面=surface (cf. 5-7)
5-7	surface	面 [surface] (cf. 5-6)
5-8	perpendicular	垂直[sui-choku] 垂=hanging, 直=direct or upright
5-9	parallel	平行 [hei-ko] or 並行 [hei-ko]

		平=flat or lining in rows (cf. 5-6), 行=going 並行 [hei-ko] 並=lined up, 行=going
5-10	angle	角 [kaku] originated from corner, horn, or pointed
5-11	right angle	直角[choku-kaku] 直=direct or upright, 角=angle (cf. 5-10)
5-12	degree	度 [do]
5-13	radian	弧度 [ko-do] 弧=arc (cf. 5-46), 度=degree (cf. 12)
5-14	figure	図形 [zu-kei] 図=figure, 形=shape
5-15	polygon	多角形[ta-kaku-kei] or 多辺形 [ta-hen-kei] 多=many (cf. 4-13), 角=angle (cf. 5-10), 辺=side (cf. 5-17), 形=shape (cf. 5-14),
5-16	regular polygon	正多角形 [sei-ta-kaku-kei] 正=regular or right (cf. 3-9), 多角形=polygon (cf. 5-15)
5-17	side	辺 [hen] side line
5-18	vertex	頂点 [cho-ten] 頂=top, 点=point (cf. 5-2)
5-19	diagonal	対角線 [tai-kaku-sen] 対=confronting, 角=angle (cf. 5-10), 線=line (cf. 5-3)

5-20	perimeter	周長 [shu-cho] 周=surrounding (cf. 5-41), 長=length
5-21	triangle	三角形[san-kaku-kei] 三=3 (cf. 1-3), 角=angle (cf. 5-10), 形=shape (cf. 5-14)
5-22	isosceles triangle	二等辺三角形 [ni-to-hen-san-kakku-kei] 二=2 (cf. 1-2), 等=equal (cf. 4-21), 辺=side line (cf. 5-17), 三角形=triangle (cf. 5-21)
5-23	equilateral triangle	正三角形 [sei-san-kaku-kei] 正=regular or right (cf. 3-9 and 5-16), 三角形=triangle (cf. 5-21)
5-24	right triangle	直角三角形 [choku-kaku-san-kaku-kei] 直角=right angle (cf. 5-11), 三角形=triangle (cf. 5-21)
5-25	Pythagorean theorem	三平方定理 [san-heiho-teiri] 三=3, 平方=square (cf. 4-2 and 5-25), 定理=theorem
5-26	quadrilateral	四角形 [shi-kaku-kei] 四辺形 [shi-hen-kei] 四=4 (cf. 1-4), 角=angle (5-12), 辺=side (cf. 5-17), 形=shape (cf. 5-14)
5-27	square	正方形 [sei-ho-kei] 正=regular or right (cf. 3-9 and 5-16), 方=rectangular (cf. 4-2), 形=shape (cf. 5-14)

5-28	rectangle	長方形 [cho-ho-kei] 長=long, 方=rectangular (cf. 4-2 and 5-27), 形=shape (cf. 5-14)
5-29	rhombus	菱形 [hisi-gata] 菱=caltrop, 形=shape (cf. 5-14)
5-30	parallelogram	平行四辺形 [hei-ko-shi-hen-kei] 平行=flat or lining in rows (cf. 5-9), 四辺形=quadrilateral (cf. 5-26)
5-31	trapezium, trapezoid	台形 [dai-kie] 台=table, 形=shape (cf. 5-14)
5-32	pentagon	五角形 [go-kaku-kei] 五=5 (cf. 1-5), 角=angle (cf. 5-10), 形=shape (cf. 5-14)
5-33	hexagon	六角形 [roku-kaku-kei] 六=6 (cf. 1-6), 角=angle (cf. 5-10), 形=shape (cf. 5-14)
5-34	heptagon	[nana-kaku-kei] 七=7 (cf. 1-7), 角=angle (cf. 5-10), 形=shape (cf. 5-14)
5-35	octagon	八角形 [hachi-kaku-kei] 八=8 (cf. 1-8), 角=angle (cf. 5-10), 形=shape (cf. 5-14)
5-36	nonagon	九角形[kyu-kaku-kei] 九=9 (cf. 1-9), 角=angle (cf. 5-10), 形=shape (cf. 5-14)
5-37	decagon	十角形 [ju-kaku-kei] 十=10 (cf. 1-10), 角=angle (cf. 5-10), 形=shape (cf. 5-14)
5-38	dodecagon	十二角形 [juni-kaku-kei] 十二=12 (cf. 1-12),

		角=angle (cf. 5-10), 形=shape (cf. 5-14)
5-39	circle	円 [en]
5-40	center	中心 [chu-shin] 中=inner (cf. 5-36), shin=center
5-41	circle circumference	円周 [en-shu] 円=circle (cf. 5-39), 周=surrounding (cf. 5-20)
5-42	diameter	直径 [choku-kei] 直=direct (cf. 5-4), 径=path
5-43	radius	半径 [han-kei] 半=half, 径=path (cf. 5-42)
5-44	chord	弦 [gen]
5-46	arc	弧 [ko] (cf. 5-13)
5-47	$\pi = 3.14\cdots$	円周率 [en-shu-ritsu] 円=circle (cf. 5-39), 周=surrounding (cf. 5-41), 率=ratio (cf. 2-17)
5-48	central angle	中心角[chushin-kaku] 中心=center (cf. 5-40), 角=angle (cf. 5-10)
5-49	inscribed angle	円周角 [en-shu-kaku] 円周=circle circumference (cf. 5-41), 角=angle (cf. 5-10)
5-50	tangent	接線 [setsu-sen] 接=contact, 線=line (cf. 5-3)
5-51	point of contact	接点 [setsu-ten] 接=contact (cf. 5-50), 点=point (cf. 5-2)
5-52	sector	扇形 [ogi-gata] 扇=folding fan, 形=shape (cf. 5-14)

5-53	inscribe	内接 [nai-setsu] 内=inner (cf. 5-40), 接=contact (cf. 5-50)
5-54	circumscribe	外接 [gai-setsu] 外=outer, 接=contact (cf. 5-50)
5-55	congruence	合同 [go-do] 合=fit or suit or adjust (cf. 2-16), 同=same
5-56	similarity	相似 [so-ji] 相=mutual, 似=similarity

6. Terminologies in Analytic Geometry

	Western (English)	East Asian (Japanese)
6-1	analytic geometry	解析幾何 [kai-seki-ki-ka] 解=resolve , 析=detailed investigation, 幾何=geometry (cf. 5-1)
6-2	number line	数直線 [su-choku-sen] 数=number (cf. 0), 直線=straight line (cf. 5-4)
6-3	coordinate	座標 [za-hyo] 座=place to sit or constellation, 標=mark
6-4	coordinate axis	座標軸 [za-hyo-jiku] 座標=coordinate (cf. 6-3), 軸=axis
6-5	origin	[gen-ten] 原=original, 点=point (cf. 5-2)
6-7	dimension	次元 [ji-gen] 次=order, frequency or degree,

		元=genesis or base or source
6-8	function	関数 [kan-su] 関=related, 数=number (cf. 0)
6-9	domain	定義域 [tei-gi-iki] 定=determine, 義=meaning, 域=range (cf. 6-10)
6-10	range	値域 [chi-iki] 値=value, 域=range (cf. 6-10)
6-11	graph	グラフ [gurahu] グラフ=Japanese reading of graph written in katakana letters
6-12	linear function	一次関数 [ichi-ji-kansu] 一次=linear (cf. 4-14), 関数=function (cf. 6-8)
6-13	quadratic function	二次関数 [ni-ji-kan-su] 二次=quadratic (cf. 4-15), 関数=function (cf. 6-8)
6-14	parabola	放物線 [ho-butsu-sen] 放=throw or shoot, 物=material, 線=line (cf. 5-3)
6-15	ellipse	楕円 [da-en] 楕=flattened, 円=circle (cf. 5-39)
6-16	hyperbola	双曲線 [so-kyoku-sen] 双=bi, 曲=bent (cf. 5-5), 線=line (cf. -3)
6-17	exponential function	指数関数 [si-su-kan-su] 指=index, 数=number (cf. 0), 関数=function (cf. 6-8)
6-18	logarithmic function	対数関数[tai-su-kan-su]

		対=corresponding (cf. 5-19), 数=number (cf. 0), 関数=function (cf. 6-8)
6-19	trigonometric function	三角関数 [san-kaku-kan-su] 三角=triangle (cf. 5-21), 関数=function (cf. 6-8)
6-20	sine function	正弦関数[sei-gen-kan-su] 正=regular or right (cf. 3-9 and 5-16), 弦=chord (cf. 5-44), 関数=function (cf. 6-8)
6-21	cosine function	余弦関数[yo-gen-kan-su] 余=complementary (cf. 2-10), 弦=chord (cf. 5-44), 関数=function (cf. 6-8)
6-22	tangent function	正接関数[sei-setsu-kan-su] 正=regular or right (cf. 3-9 and 5-16), 接=contact (cf. 5-50), 関数=function (cf. 6-8)
6-23	amplitude	振幅 [shin-huku] 振=oscilation, 幅=width
6-24	period	周期 [shu-ki] 周=round (cf. 5-41), 期=time
6-25	frequency	振動数 [shin-do-su] 振=oscillation (cf. 6-23), 動=motion, 数=number (cf. 0)

7. Terminologies in Differential Calculus

	Western (English)	East Asian (Japanese)
7-1	differential calculus	微積分 [bi-seki-bun] shortening of 微分 and 積分 (cf. 7-10 and 7-17)
7-2	(number) sequence	数列 [su-retsu] 数=number (cf. 0), 列=row, column or lined up
7-3	finite	有限 [yu-gen] 有=having (cf. 3-11), 限=bound or limit
7-4	infinite	無限 [mu-gen] 無=not having (3-12), 限=bound or limit (cf. 7-3)
7-5	converge	収束 [shu-soku] 収=consolidate, 束=bundle
7-6	diverge	発散 [hatsu-san] 発=spring out, 散=scatter
7-7	limit	極限 [kyoku-gen] 極=extreme, 限=bound or limit (cf. cf. 7-3)
7-8	series	級数[kyu-su] 級=classified or ordered line up, 数=number (cf. 0)
7-9	continuous	連続 [ren-zoku] 連=connected, 続=continued or followed
7-10	differential	微分 [bi-bun] 微=micro, 分=division (cf. 3-3)

7-11	derivative	微分係数 [bi-bun-kei-su] 微分=differential (cf. 7-10), 係数=coefficient (cf. 4-16)
7-12	derived function	導関数 [do-kan-su] 導=derived, 関数=function (cf. 6-8))
7-13	maximal	極大 [kyoku-dai] 極=extreme (cf. 7-7), 大=large
7-14	minimal	極小 [kyoku-syo] 極=extreme (cf. 7-7), 小=small
7-15	maximum	最大 [sai-dai] 最=most, 大=large (cf. 7-13)
7-16	minimum	最小 [sai-sho] 最=most, 小=small (cf. 7-14)
7-17	integral	[seki-bun] (seki=pile up, bun=division)

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I am not sure whether the suggestion in the first page of this paper is efficient. But, I got the idea stated in the suggestion stimulated by the multicultural view in [1] and [2], where the authors emphasized contributions to the development of mathematics by peoples in various cultures and appreciation for those endeavors. To make up the above comparative tables of mathematics terminologies between those of Western's and of East Asia's, I referred the glossary tables in a Japanese-English dictionary for elementary mathematics terminologies [3]. I'd like to express my sincere gratitude to all of these authors.

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