CHALLENGES INTHE DEVELOPMENT OF REGIONAL MATHEMATICS CURRICULUM STANDARDS: THE CASE OF SOUTHEAST ASIA MINISTERS OF EDUCATION ORGANISATION (SEAMEO)

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This case study illustrated the roles of agents inthe development of the ASEAN regional curriculum standards, particularly the challenges and elaborations to consolidate different perspectives of diverse background in three phases: Firstly, the mathematics curriculum of ASEAN countries were compared and mapped to find the minimum essential contents. The comparison of topics and gradesshowedno intersecting common curriculum between the countries. Secondly, the union of the mappingsfor contents was benchmarked with curriculum standards of developed countries. However, this did not match well with the 21st-century curriculum reform issues. Thirdly, the 21st-century curriculum framework was established emphasising on values and thinking skillswith collaboration oflocal and global agents to finalize the curriculum standards.Comparison of curriculums with other countries isa necessary step toknow the current status of each country, even withmethodological limitations.The 21st-century mathematics curriculum can be realized with the perspective of the process of mathematisation to distinguish the conceptual differences.

INTRODUCTION

There are several efforts for curriculum integration to sharecurriculum standards for the establishment of quality education and securinghuman capitalmobility. Common Core States Standards in the USA is an effort from the state to federal level. Regionally, the Bologna process is established to strengthen the quality assurance of higher education in the European countries.Likewise, Asia Pacific Economic Cooperation (APEC, 2017) is also seeking about integrated efforts to be projected until 2030.In the case of the Association of Southeast Asian Nations (ASEAN) Community, Southeast Asia Ministers of Education Organization (SEAMEO) established Education Agenda #7 *"Adopting a 21st Century Curriculum*" up to 2035 to integrate regional curriculum standards. What are the necessary activities and challenges for curriculum integration?This paper illustrated the challengesin developing the Southeast Asia Basic Education Standards (SEA-BES) in Mathematics under this objective.

RESEARCH QUESTIONS AND METHODOLOGY

Based on the research objective and discussion document of theme E, the role of agents for designing and developing curriculum was chosen. This research illustratedthe role of agents and the challenges in designing and developing the SEA-BES in Mathematics.There are four questions to be answered in relation to the roles of the agents: Q1. How the agents set the format of the standard document?Q2. How was the content of teaching chosen?Q3. What are the principles applied in choosing the contents and writing the standards? Q4. What issues and challenges encountered among the agents were solved? Through answering those research questions, the four foci ofE1to E4 posed in theme E will be answered.

The curriculum development project of SEA-BES in mathematics up to 9th grade was initiated since 2014 and completed in 2017. The project was managed by SEAMEO RECSAM (Regional Education

Centre for Science and Mathematics) under the mandate of the SEAMEO Secretariat. The outcome of the project, which is the proposed curriculum standards, can serve as a platform for curriculum development and assessment of each member country and professional development of teachers imbued with ASEAN ideals in building the ASEAN Community.

Many agents participated and contributedin this project. The SEAMEOSecretariat (2 persons) provided the information regarding related issues of educations and directions were set as in the SEAMEO 7 priority areas. RECSAM director and the specialists (4 persons) were responsible to plan the activities and engaged in the integration of the comparedcurriculum amongASEAN countries.The results on the spreadsheet showed the map for comparison, and subsequently the writing of the standard documents. RECSAM consultant (1 person) suggested the curriculum reform movements of various countries, the formats of writing the standards,informed the content knowledge for teaching and discussed the aspects that werelacking. The RECSAM collaborators, who were leading teachers, teacher educators and professors (30 persons) in Malaysia were involved in the mapping for comparison, developing the initial draft of the standards and checking the proposed document. The curriculum specialistswere government officials in every SEAMEO countries (11 persons) provided the information of their curriculum, critiques of the draft with a comparison to their curriculum standards and provided suggestions for improvement. The international I-experts (8 persons), contributed ideas about on-going curriculum reforms, roles of technology in the reform, inquiry-based and critical thinking as the trend of teaching, and professional development. The Japanese J-experts (7 persons) explained the reform movements, roles of textbooks in Japan and teaching of proof. In the analysis of activitiesand the roles of the agents, only the underlined names were used in the writing. However, contributor's names'was quoted and acknowledgedon the website of SEA-BES.

RECSAM and the consultant wereauthors of this article. The data for discussionin this article were as the following: RECSAM and the consultant retained every edition of their working using MS-words, Excel and e-mails and official reports of the meeting could be seen on the web. These data sequenced by the timeline werethe data for analysis. Analysis of data was done by the following steps: Firstly, based on the timeline, the challenges faced by RECSAM, the consultant, and other agents were specified. Secondly, from the specified challenge, the three phases of the project were clarified throughthe contributions of collaborators, specialists, the consultant and experts. Personal information of the agents waswithheld in the writing. Based on this context,the three phases of the project in relation to the research questionsand the specified foci of E1 to E4 in the themeE were elaborated.

First phase: Comparison of curriculum standards and the mapping

RECSAM initiated the proposal to SEAMEO Secretariat for developing the SEA-BES curriculum standards in 2014 which was aligned to the SEAMEO 7 priority areas.With the consent, the SEA-BES was developed as a part of the 21st-century curriculum with minimum essential contents.Regional meetings were then held to carry out the comparison of curricula from the 11 SEAMEO member countriesand addressed the issues of minimum essentials. Due to the constraints that most curricula were not translated into English, only curriculum of six countries submitted in English were used for review and comparison based on the mathematics terminologies usedin one of the countries. Specialists fromall the 11 member countries were invited to provide commentaries during the second phase.

	Year 1	Year 2
Domain		
1. NUMBER & OPERATION		
1.1 COUNT, READ AND WRITE, NUMBER TO 20.	Counting orally to 20 and back by reciting zero, one, two, three..	COUNTING, READING AND WRITING, NUMBER TO 1000.
Count Numbers	Giving a reasonable estimate of up to 20 object	Counting numbers in steps of 100 UP TO 1000
Read and write numbers	Reading and writing numbers from 0 to 20 in numerals	Counting in steps of 1 between 100s to 1000.
Counting by progression	Writing number symbols and number names up to 20	Count numbers in steps of 10s and 50s up to 1000.
Recognize zero	Recognising zero, its meaning, and its symbol	Representing numbers up to 1000 in different representation such as concrete, oval and symboloc
Compare and order numbers	Comparing and ordering numbers from 0 to 20.	Reading and writing numbers up to 1000 in numerals and in words
Math symbols	Using words such as more, less, greater, smaller, fewer, the same as, as many as.	Recognizing and representing place values of 3-digit numbers using models and expanded notation
Arrange numbers	Arranging a set of numbers within 20 according to size	Comparing and ordering numbers within 1000
Skip count	Skip counting and recognizing simple number patterns.	Skip counting and recognizing simple number patterns
Ordinal and Cardinal	Using ordinal numbers up to 10th (first, second, third, …, tenth) to describe the position of an object in a row of objects or the order of a set of events.	Using ordinal number up to 30th.

Figure 1. Mapping of Brunei Curriculum (a Part)

Topics	Year 1	Year 2
Domain 1:		
1. Numbers and Number Sense		
1.1 Number Notation	Visualizing and representing numbers from 0 to 100 using a variety of materials.	
1.2Count objects	Counting the number of objects in a given set by ones and tens.	
1.3Compose and Decompose Objects	Composing and Decomposing a given number. e.g. 5 is 5 and 0, 4 and 1, 3 and 2, 2 and 3, 1 and 4, 0 and 5	
1.4Representing objects by numerals		visualizing and representing numbers from 0-1000 with emphasis on numbers 101 – 1 000 using a variety of materials.
1.5Grouping Objects		grouping objects in ones, tens, and hundreds.
1.6Numbers Visualization		
1.7 Place value -whole number	visualizing and giving the place value and value of a digit in one- and two-digit numbers.	giving the place value and finds the value of a digit in three-digit numbers.
1.8 Cardinal and Ordinal Numbers: Visualization	Recognizing Cardinal and ordinal Numbers from 0 to 100	
1.9Cardinal and ordinal numbers	identifying the 1st , 2nd, 3rd, up to 10th object in a given set from a given point of reference.	

Figure 2. Mapping of Philippines Curriculum (a part)

Primary Mathematics							Country: Malaysia					
	pic Progressi						Learning Objectives					
Topics	1	2	3	4	5	6	BRUNEI	SINGAPORE	PHILIPPINES	MALAYSIA	CAMBODIA	THAILAND
Domain 1: NUMBERS AND OPERATIONS												
1. Read , write count	/						/	/	/	/	/	/
2. Skip count	/						/			/		/
3. Mathematics symbols	/						/	/	/	/		/
4. Arrange, compare numbers	/						/	/	/	/		/
5. Ordinal cardinal							/	/	/		/	

Figure 3: Mapping in the case of whole numbers for comparison of curriculums

Figure 1 and 2 are samples of the curriculum mapping done by the collaborators based on curriculum of the selected countries. Figure 3 shows an example of a consolidated results. The terminologies in the left column was chosen by RECSAM based on the Malaysian curriculum.The top row shows the countrieswith the intersections showing the grade. In this mapping, the consultant pointed out the weaknesses and inappropriateness of terminologies based on the standards sequence from one country such as Malaysia because other countries may practise differently. For example, cardinal and ordinal number is the basic knowledge of number concept. However, Malaysiadid not use these terminologies in their curriculum document. There wereindeed, several missing terminologies in the first RECSAM mapping. Some of thesewere related tothe cultural-language dimension: In the Malaysian curriculum standards, shape and figure were not distinguished in Malay. On the other hand, some standards in other countries distinguished shape and figure distinctly. Based on these points highlighted, RECSAM revised their screening by adding new terminologies, in the case of 'shape' which was used in other countries. However, the newly added terminologies, 'shape', emerged at the end of the first list of terminologies, whereas the cardinal and ordinal number in Figure 1, 2, and 3emerged at the end of line. The second map lost the linkage amongst terminologies. The first map was based on the terminologies of one country showingthe comparison between that one country and other countries. The second map shows the differences clearly but did not succeed to show it inthe map at a glance. For example, 'shape' is usually taught before 'figure'. However, 'shape' as a terminology appeared later.

The differences clarified by the second map enable theinclusionof terminologies into domains and overcome the differences of content teaching. For example, one country specified that 'money' was included in the domain of numbers while some other countries specified money asa measurement. In another case, some countries never teach geometry with proving until the 9th grade. Under the domain

of geometry, angles were related to calculation of geometry, however it was a part of measurement in others. It was found that thereweremore orientation of calculation in the content of mathematics and on contrary, explanation and reasoning was not enhanced relatively. Such differences were clearly seen through the maps (It will be discussed in Second Phase).

Based on those maps, RECSAM attempted to show the curriculum standards with the minimum essential contents. Through the mapping, RECSAM expected that the intersections of all terminologies became the minimum essential contents. However, the results of the mapping still showed the difficulty inidentifying the minimum essentials. There were cases where the same terminologies were used, but the teaching grades differ and resulted in terminologies being not shareable. There was a country that initiated division from the first grade while another country initiated this from the fourth grade. This implied that all SEAMEO countries should initiate the teaching of division from the fourth gradeif the common curriculum standards were defined by the minimum essential contents sharable in ASEAN countries.Based on this particular example, RECSAM would considerinitiating division only at the fourth grade. The above discussion was made among RECSAM and the consultant. Due to thediscrepancy of grading, RECSAM finally decided to change the grading to three key stages: Key stage 1 (grade 1-3), Key stage 2 (grade 4-6) and Key stage 3 (grade 7-9).

Second phase: Benchmarking based on outcomes of the mapping

The Secretariat recommended RECSAM to produce the 21st-century curriculum. SEAMEO Priority No. 7 states that 'Pursuing a radical reform through systematic analysis of knowledge, skills, and values need to effectively respond to changing global contexts, particularly to the ever-increasing complexity of the Southeast Asian economic, socio-cultural, and political environment, developing teacher imbued with ASEAN ideals in building ASEAN community'

Topics DOMAIN 1 - NUMBERS AND OPERATIONS_ALGEBRA	subtopic	KS	Countr
L. Whole numbers up to 10000	Whole numbers and Operations		
	Cardinal and Ordinal numbers (1-1 correspondence, larger or smaller,	1	S
	Composition and Decomposition of Numbers)		
	Denominations of numbers as for the quantity (cups, plates, RM, Rp, TB, SD	2	M
	cents, Converts between single denominations and multiple denominations)		
	Understanding and using the Based-10 place value system with model (units	1	M
	cube, tenth bar, hundred square, thousand cube, 0-9 digits, places)		
	Various ways of counting (e.g., Count all, Count on, ascending, descending ..	1	B
	Various units for counting (e.g., Count by 10's, count by 100's, multiplication	2	B
	by 2, multiplications by 5, multiplication by 10's, 100's, 60mins, 20RM, 16oz..)		
	Integers on the Number Line	2	P
	Compare Integers to other Numbers	2	P
	Arrange Integers	2	P
	Compare and Order numbers 1 - 1000; 1000 - 100,000		
	Denominations of numbers as for the quantity (cups, plates, RM, Rp, TB, SD		
	Converts between single denomination and multiple denominations		

Figure 4: A sample of benchmark edited based on collaborator's report for the domain of Numbers and Operation, Algebra. S means Singapore, M means Malaysia, B means Brunei and P means Philippines, KS means number of key stage

RECSAM was seeking ways on how to utilize the maps to formulate curriculum standards that fits the ASEAN countries and challenged to meet the needs of statement No. 7. RECSAM began to draft the curriculum standards for every key stage in relation to the mapsof all the standards of thesixcountries and attempted to quote all countries standards to produce a meaningful documentas the bases for the benchmarking (Figure 4).

RECSAM set the same domains across all three key stages such as 'Numbers and Operations, Algebra'. The collaborators decided the topic names such as 'Numbers up to 10000' based on

curriculum documents of the ASEAN rising countries or choosingmore advanced contents in other cases.. RECSAM and the collaborators used the whole map instead of the intersections of mapping for the selection of contents. During the criteria selection on this benchmarking, the consultant guided and provided important information such as meanings of competency (OECD, 2005), and several curriculum standards to RECSAM for clarifying the 21st-century curriculum and the current world curriculum reform movement, which also included Sustainable Development Goals by UNESCO and STEM. RECSAM also provided the curriculum standards of advance countries as reference to the collaborators. These included the NCTM standards (2000), Common Core State Standards (2010), Australia Curriculum Standards (2009) and Japan Curriculum Standards (2012) and the new English edition, curriculum standards of Malaysia and Cambodia in ASEAN countries. The contributions of the collaborators were found to be biasedto their own national curriculum in terms of content selection and description (Figure 4).This was overcomeby RECSAM in consolidating their contributions for benchmarking through discussion among RECSAM and the consultant with the perspectives of curriculum standards in advance countries.

Topic	Sub Topic	Learning Standard
Introducing Whole numbers up to 10,000	Use Cardinal and Ordinal numbers	1. Counting on objects using Cardinal and Ordinal numbers (1-10) correspondence, larger or smaller. 2. Selecting object appropriately using cardinal and ordinal numbers. 3. Ordering cardinal and ordinal numbers collaboratively.
	Apply Correspondence	1. Counting on objects using model or diagram. 2. Comparing numbers using model or diagram. 3. Matching correctly numbers with diagram given.
	Interpret Numbers	1.Counting numbers as for the quantity (cups, plates, marbles, etc) 2.Naming numbers as for the quantity (cups, plates, marbles, etc) 3. Writing numbers as for the quantity (cups, plates, marbles, etc) accurately.

Figure 5: A Partof summarisededition for regional meeting of curriculum specialists from ASEAN

At the regional ASEAN curriculum specialist meeting, the document inFigure 5 was proposed and discussed about the appropriateness of the content mapping for every key stage based on the explanation of RECSAM. The curriculum specialists provided the feedback and shared the difficulties to set the regional standards. Additionally, the consultant also sharedthe fundamental concerns of a 21st-century curriculum for embedding the necessary competencies.The first concernwas'What wasto be benchmarked?'At that juncture, RECSAM proposed (Figure 5) to select the final expected achievement for the topic name up to the 3rd grade in Key Stage 1. If the topic name 'Whole Number up to 10000' is given in Key Stage 1, the competency such as 'Number up to 120' is embedded and need not be described. However, such a way of writing the benchmark wasnot suitable to developthe necessaryprocess skills. For example, counting objects, inthe early first grade, the first object for counting, direction for counting, and the last object for counting were necessary. It is not the counting by the base ten system such as 10 of 100, 10 of 1000 and so on. In that case as in Figure 5, most of the process skills for learning and doing could not be shownunder the limitation of writing "up to 10000": we never count by onesup to such large numbers.

The second problem is the choice of terminologies. For example, in Geometry: Shape, Figures, and Plane Figures are different terminologies for specific objects in the curriculum. The Plane Figures extend the sides, otherwise, there will be no discussion on the equality of area with the same height,and ex-circles can be constructed by extending the sides of a triangle. Plane Figures are the object of proof in geometry. Some countries never teach Plane Figures which deprivesthe learning opportunities for explanation (proving). Explanations with critique areusually done by examples and counterexamples.If Shape, Figure, and Plane Figuresare distinguished, in discussion for redefining the meaning of terminologies, critiques are possible to be initiated even from Key stage 1. Amending

the sequence to develop thinking mathematically is possible by distinguishing the conceptual differences with various terminologies. The third problem is the usage of "domain".Keeping the domain names across the key stages enhanced the compartments while "strands" enhancedthe connectivity of different concepts.It is not necessary to keep the same names for strandsand standards beyond the key stages because atevery stage, the concept of numbersis extended and reorganized in appropriate manners.

For solving those problems, specialists, RECSAM and the consultant neededto consolidate the description of the regional curriculum standards and a further (third) meeting was set.

Third phase: Formulating the framework and finalising the document

In the thirdmeeting, RECSAM and the consultant revised the draft of the standards based on the outcomes ofthe previous meeting (see, Figure 6). Before the third meeting, the draft document was sent to all specialists in every ASEAN country with questionnaires, such as:1.Meaningof the national curriculum in your country. There were diversities on the meaning of national standards,includingthe assessment standards, textbooks and every daylesson plans.The diversities itself had produceddifficultiesfor sharing; 2. Structure or format of the national curriculum document with terminology for formatting curricula such as standards, learning outcome, and teaching and learning activities. The format of the standards was the major problem for a common consensus; 3. Diagram for explaining aims of the national mathematics curriculum standards for 21st century; 4. Explaining some examples of their national standards from their aims and diagrams; 5. Commentary about the tentative format of the RECSAM standards (Figure 6); 6. Commentaries to the RECSAM standards for feedback, such as how far or close to your national curriculum, and what arethe challenges for youto overcomethediscrepancy.

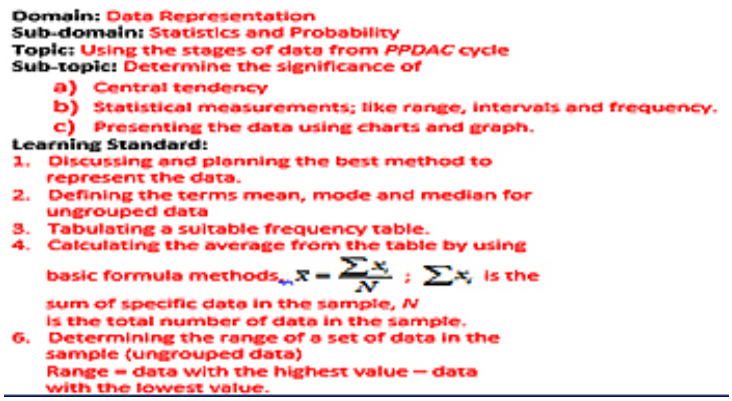
Domain: Data Representation
Sub-domain: Statistics and Probability
Topic: Using the stages of data from *PPDAC* cycle
Sub-topic: Determine the significance of
a) Central tendency
b) Statistical measurements; like range, intervals and frequency.
c) Presenting the data using charts and graph.
Learning Standard:
1. Discussing and planning the best method to represent the data.
2. Defining the terms mean, mode and median for ungrouped data
3. Tabulating a suitable frequency table.
4. Calculating the average from the table by using basic formula methods, $\bar{x} = \frac{\sum x_i}{N}$; $\sum x_i$ is the sum of specific data in the sample, N is the total number of data in the sample.
6. Determining the range of a set of data in the sample (ungrouped data)
Range = data with the highest value – data with the lowest value.

Figure 6:Sample format proposed from RECSAM for the third meeting

Third meeting was carriedout with additional presentations from I-experts and J-experts for consolidating the standards from the international perspectives. In relation to the first and third problems on phase two, I-experts provided information on the followingitems: Common Core States Standards in the USA, Exploration with Technology, Reform of Curriculum for Open-Ended Approach, Curriculum Development with Collaborative Enquiry, Verb- based Curriculum Numeracy, Critical Thinking, Curiosity, Possible Challenges in Thailand, and Professional Development. In relation to all three problems in the second phase, J-experts provided the information on the following items: Ongoing Reform of Junior High School, Proof and Proving for Developing Critical Thinking on Geometry on Joint Project with the UK. Those inputs of the experts were to clarify the aims,

objectives, roles and contents of the standards. For example, some specialists who recognised geometry as measurement were also able to recognise the calculation of angles as a form of proof in geometry.

Atthe meeting, the specialists presented their answers for the questionnaires andgave theircommentaries.RECSAM and the specialists learned various frameworks from each other such as the diagrams in Figure 7. Against theRECSAM standards description,the specialists gave positive commentariesand provided the comparisons of their content standards highlighting thedifferences and theircapacities in handling challenges that emerged. Based on the discussion, RECSAM and specialists chose the three rectangular-framework as in Figure 8,consisting of components like Mathematical Values, Attitudes and Habits for Human Character; Mathematical Thinking and Process,and Contents.For embedding every countries' aims such as in Figure 7.For allowing the possible interpretation of sentence in the standards on the context of every country, the four hierarchies format instead of the five hierarchies in Figure 6 were shared and set the way of writing by using verbs and adjectivesto clarify the process-humanity strands in the content and showing the conceptual differences and connectivity between standards within the same strands and between different stages.

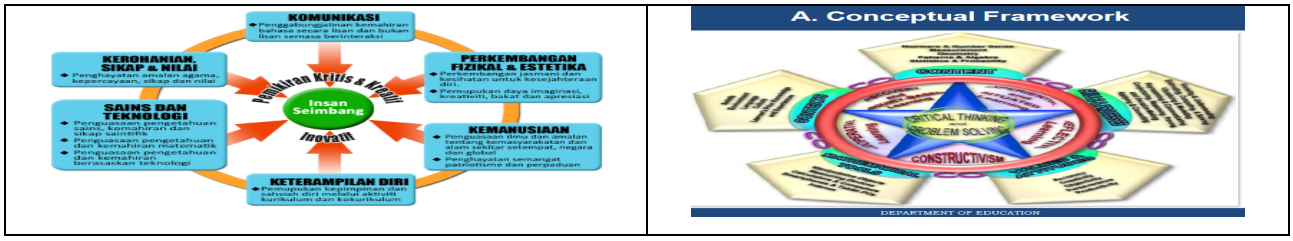

Figure 7: Malaysian Diagram (left) and Philippine Diagram (right)

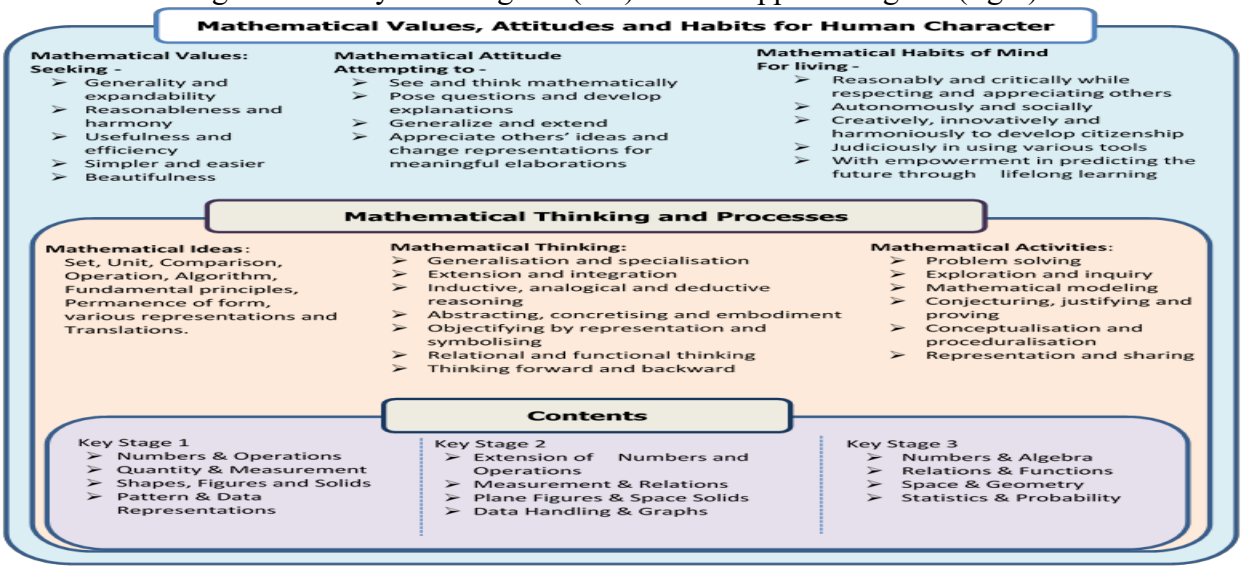

Figure 8: SEA-BES Common Core Regional Learning Standards in Mathematics Framework for the 21st Century

CONCLUSION

In the analysis of the roles of agents, this report concludes the following answers to the research questions. About Q1, RECSAM changed the bases for formatting the standard from the map based on terminologies under the minimum essential contents to describe the process and humanity for the 21st-century curriculum with contributionsfromother agents at every stage. About Q2, contents were

initially chosen from the intersection of the maps, and later from the whole map for benchmarking, and further included the process-humanity for 21st-century curriculum in Figure 8. About Q3, the first hypothesis for writing the standards by mapping was based on the mathematics terminology which can be divided into the consistent domain names. The second hypothesis for writing standards focus on distinguished conceptual differenceswhich enabledthe process-humanity strand based on the mathematisation which was also symbolised by the different strand names in different key stages in Figure 8. About Q4, there were challenges and elaborations among the different agentsresulting frombias for their own national standards. The inputs from I-experts, J-experts and experts from non-ASEAN member countryfor the 21st century curriculum were able to set international perspectives and overcome biases.

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