RGC Ref. No.:
UGC/FDS16/H06/15
(please insert ref. above)

RESEARCH GRANTS COUNCIL
COMPETITIVE RESEARCH FUNDING SCHEMES FOR THE LOCAL SELF-FINANCING DEGREE SECTOR

FACULTY DEVELOPMENT SCHEME (FDS)

Completion Report
(*for completed projects only*)

Submission Deadlines:
1. *The unspent balance, if applicable, and auditor's report: within **six** months of the approved project completion date.*
2. *Completion report: within **twelve** months of the approved project completion date.*

Part A: The Project and Investigator(s)

1. Project Title

Teacher knowledge of early childhood teachers in Hong Kong, with a focus on Mathematics in early childhood education

2. Investigator(s) and Academic Department/Units Involved

Research Team	Name / Post	Unit / Department / Institution	Contact Information
Principal Investigator	Dr LAO Kam-ling / Assistant Professor	School of Education and Languages / The Open University of Hong Kong	plao@ouhk.edu.hk 2768 5805
Co-investigator(s)	NA		
Others	NA		

3. Project Duration

	Original	Revised	Date of RGC / Institution Approval *(must be quoted)*
Project Start Date	1 January 2016	NA	
Project Completion Date	31 December 2017	30 April 2018	26 April 2017
Duration (*in month*)	24 months	28 months	26 April 2017
Deadline for Submission of Completion Report	31 December 2018	30 April 2019	26 April 2017

Part B: The Final Report

5. Project Objectives

5.1 Objectives as per original application

1. To identify the knowledge of early childhood teachers necessary for developing children's early mathematical concepts under the influence of technology.
2. To establish a conceptual framework and its components of teacher knowledge necessary for developing children's early mathematical concepts under the influence of technology.
3. To develop an instrument to investigate how the components of the knowledge of early childhood teachers necessary for developing children's early mathematical concepts under the influence of technology related.

5.2 Revised objectives

Date of approval from the RGC: N.A.

Reasons for the change:

5.3 Realisation of the objectives

Identification of knowledge:

The knowledge of early childhood teachers necessary for developing children's early mathematical concepts under the influence of technology (MtEceK) was identified by focus group methods. One expert group (EP) and one focus group (FG) were formed. Purposive sampling was used to solicit collective views. Members of the two groups invited were frontline early childhood practitioners and experts in early childhood education (ECE). Expert group had 6 regular members and 1 affiliated member. Focus group had 5 regular members and 2 affiliated members. Throughout the whole research process, 19 EP and 11 FG individual interviews, 11 EP and 6 FG meetings, as well as 19 EP and 4 FG phone interviews were carried out. Members shared their current practices of organizing early mathematics learning experience to young children. They were asked to deliberate their views and opinions with practical examples. To stimulate discussion, two additional experience sharing sessions were conducted to the expert group by the research team. The topics were related to holistic planning of technology resources and early childhood curricula of other countries. These sharing activities facilitated transfer of professional knowledge among members and accelerated members' participation as a community of practice. To establish a common ground for discussion, MKT framework (Ball et al., 2008) and TPACK framework (Koehler & Mishra, 2008) were introduced as references. For the common understanding on technology, a list of twelve commonly used technologies in supporting instruction and assessment in ECE identified by Hernandez et al.(2015) was also introduced.

Conceptual Framework:

Based on the literature reviews and inputs from the EP and FG members, the project team drafted an initial conceptual framework (MtEceK Framework) and its associated Teachers' Math Task List for the EP and FG members' comment and modification. Focus group members focused on the mathematics-related task list that early childhood teachers involve in actual practices. The expert group mainly focused on the formulation of the theoretical framework. Based on the collective opinions from members, a framework with four strands and a list of 20 teacher tasks were formulated respectively. All the interviews and meetings conducted at that stage were transcribed and coded by two independent coders. Discussions of both expert group and focus group were coded against both the framework and the list. For the Framework, the inter-rater reliability was moderate (Focus group: $\kappa = 0.475$, Expert group : $\kappa = 0.531$). For the Task List, the kappa measures for the focus group and the expert panel were 0.720 and 0.760, both showed substantial agreement (Landis & Koch, 1977). Results of analysis were reported to EP and FG for refinement of the framework and the list.

Instrument development:

With the reference to the literature review, coding analysis and professional inputs from the EP and FG members, 320 items in 25 scenarios were drafted by the project team and commented by the EP and FG members. Modified items were divided into three sets for piloting after the EP and FG members reviewed and endorsed. In the Pilot Test [Feb to March 2017], 107 valid responses were collected. The overall reliability for the 3 item sets were good (α=0.813, 0.886, 0.827 respectively). Those data were further processed and analyzed using Rasch analysis. The overall Person reliability and Item reliability of the 3 sets were 0.59 and 0.83 respectively. Based on the analysis results, including level of difficulty and discrimination index, and professional inputs from the EP and FG members, 63 items in 15 scenarios were selected and further refined for final test. In the Final Test [Sept 2017 to Oct 2017], 103 valid responses were collected. Those data were further processed and analyzed. The Cronbach's alpha, Person reliability and Item reliability of the final test were 0.359, 0.70 and 0.92 respectively. Out of the 63 items, 21 items were selected to compile the final set of instrument. The Cronbach's alpha, Person reliability and Item reliability of the final set of instrument are 0.728, 0.66 and 0.94 respectively.

5.4 Summary of objectives addressed to date

Objectives *(as per 5.1/5.2 above)*	Addressed *(please tick)*	Percentage achieved *(please estimate)*
1. To identify the knowledge of early childhood teachers necessary for developing children's early mathematical concepts under the influence of technology.	✓	100%
2. To establish a conceptual framework and its components of teacher knowledge necessary for developing children's early mathematical concepts under the influence of technology.	✓	100%
3. To develop an instrument to investigate how the components of the knowledge of early childhood teachers necessary for developing children's early mathematical concepts under the influence of technology related.	✓	100%

6. Research Outcome

6.1 Major findings and research outcome
(Maximum 1 page; please make reference to Part C where necessary)

Though early childhood contexts in Hong Kong vary greatly, it was found there are some common recurrent tasks involved in mathematics-related activities in practices. In this research, a list of twenty mathematics-related teacher tasks was identified (see attachment 5b). It was also found that teachers' pedagogical decisions were informed by their understanding and consideration in four main aspects. In this research, a theoretical framework with four components was established. Corresponding to the framework, an instrument with 21 items covering the four components was developed.

Under the definition of MtEceK as "the knowledge of early childhood teachers necessary for developing children's early mathematical concepts under the influence of technology", the MtEceK Framework is defined as a framework to delineate the body of teacher professional knowledge essential to purposefully develop and organize developmental appropriate learning experiences for 3- to 6-year-old young learners in maximizing their mathematical learning in early childhood education settings under the influence of technology.

The Framework, diagrammatically represented in a form of 4-sided quadrilateral, comprises four strands: Teacher-oriented Knowledge Strand, Student-oriented Knowledge Strand, Milieu Knowledge Strand and Content Knowledge Strand. Teacher-oriented Knowledge Strand' (TKS) describes the knowledge for the orchestration of mathematics teaching and learning in early childhood settings instrumented with emerging technologies with the affordances to transform classroom practices, which is generated through the design, planning, implementation and evaluation of the pre-primary curriculum by the teacher acting in the role of an active reflection practitioner. 'Student-oriented Knowledge Strand' (SKS) describes the teacher's knowledge on the effect that the learner's background, ability, characteristics and parents have on the child's readiness on acquiring some specific mathematical concept(s), which can be used for teachers to organize and maximize the child's exposure to the development of appropriate mathematical experiences that could also be related to emerging technology. 'Milieu Knowledge Strand' (MKS) describes the contextual knowledge on the stage configuration of an integrated mathematics education curriculum in early childhood settings instrumented with emerging technologies. This includes the tangible and intangible factors in the physical and socio-cultural environment, and the emerging contextual development both within and outside the school setting, which has the potential to play a secondary supportive role in early mathematics learning. 'Content Knowledge Strand' (CKS) describes the subject knowledge of the mathematics discipline, its relation with others disciplines and interdisciplinary knowledge that are necessary for teachers to teach in an integrated approach, which assists the teacher in organizing mathematical concepts as an integral part of the children's experiential knowledge (see attachment 1).

Corresponding to the four Knowledge Strands, 320 items in the form of multiple-choice or multiple response items organized in scenarios were developed for piloting. A database with 107 valid responses was generated. It was found that technology-related items in CKS were relatively more difficult for participants than those in TKS and MKS. 63 items were refined and tested again. A database of 103 valid responses was generated. A valid instrument with 21 items covering four Knowledge Strands was compiled. It was found that the correlation between TKS and CKS was the highest. SKS was also significantly correlated with CKS and TKS. However, correlations between MKS and other Knowledge Strands were weak.

6.2 Potential for further development of the research and the proposed course of action *(Maximum half a page)*

In the current item bank, there are enough items that already met the criteria of item quality to form more than one set of instrument for measuring CKS. A lot of items have potential for revision and improvement for further administration so that item sets can be developed for all Knowledge Strand. Further research should be done to investigate the unique nature of MKS.

Since the framework was developed through an intertwined formulation process of conceptualization and contextualization, it is comprehensible and utilizable for early childhood educators and useful for pedagogical decision-making and professional reflection. Further research can be done to apply the usage of framework on teacher education in Hong Kong to investigate decision-making process of student teachers. The framework and instrument can also be further elaborated and adapted in collaboration with researchers from other countries.

7. Layman's Summary

(Describe in layman's language the nature, significance and value of the research project, in no more than 200 words)

The research investigated the nature of knowledge of early childhood teachers necessary for developing children's early mathematical concepts under the influence of technology in Hong Kong. A conceptual framework with four knowledge strands and an instrument with 21 multiple-choice or multiple response items were developed. As an attempting to address the gap across research in mathematics education, early childhood education and teacher knowledge, this study is new in a sense that it embedded the consideration of technology in the framework development process and purposefully anchored the instrument on teachers' classroom practice. It made the resulting framework and the instrument comprehensible and utilizable by practitioners. The framework and the instrument are useful to inform early childhood teachers on their practice in making appropriate pedagogical decision in developing children's early mathematical concepts. The database of teacher knowledge generated by the instrument in this study provides insights on the needs of teacher education.

Part C: Research Output

8. Peer-reviewed journal publication(s) arising directly from this research project

(Please attach a copy of the publication and/or the letter of acceptance if not yet submitted in the previous progress report(s). All listed publications must acknowledge RGC's funding support by quoting the specific grant reference.)

The Latest Status of Publications				Author(s) *(denote the corresponding author with an asterisk*)*	Title and Journal/Book *(with the volume, pages and other necessary publishing details specified)*	Submitted to RGC *(indicate the year ending of the relevant progress report)*	Attached to this report *(Yes or No)*	Acknowledged the support of RGC *(Yes or No)*	Accessible from the institutional repository *(Yes or No)*
Year of publication	Year of Acceptance (For paper accepted but not yet published)	Under Review	Under Preparation (optional)						
		✓		Kam Ling Lao	"Teacher Knowledge Framework for Early Mathematics Education in a Technology-rich Environment Rooted from the Eyes of Practitioners" submitted to the journal "*Educational Media International*"	No	Yes [Attachment 1]	Yes	Yes
			✓	Kam Ling Lao	"An Instrument to Investigate Teacher Knowledge for Early Mathematics Education" to be submitted to the "*International Journal of STEM Education*"	No	No	Yes	Yes
			✓	Kam Ling Lao	"Hong Kong Teachers' Readiness for the Uses of Technology in Kindergartens" to be submitted to the *"Hong Kong Teachers' Centre Journal*"	No	No	Yes	Yes

Recognized international conference(s) in which paper(s) related to this research project was / were delivered *(Please attach a copy of each conference abstract)*

Month / Year / Place	Title	Conference Name	Submitted to RGC *(indicate the year ending of the relevant progress report)*	Attached to this report *(Yes or No)*	Acknowledged the support of RGC *(Yes or No)*	Accessible from the institutional repository *(Yes or No)*
Mar/2016/ Savannah, USA	MtEceK - A Project to Investigate Teacher Knowledge of Early Childhood Teachers in Hong Kong	27th Annual Conference of the Society for Information Technology and Teacher Education (SITE–2016)	Yes	Yes [Attachment 2]	Yes	Yes
Dec/2016/ Thailand	Knowledge for early childhood educators to facilitate children's mathematics learning under the influence of technology	The 21st Asian Technology Conference in Mathematics (ATCM 2016)	Yes	Yes [Attachment 3]	Yes	Yes
Mar/2017/ Austin, USA	Teacher knowledge for early mathematics education in a technology-rich environment - in the eyes of practitioners	28th Annual Conference of the Society for Information Technology and Teacher Education (SITE–2017)	No	Yes [Attachment 4]	Yes	Yes
Jun/2017/ IOpatiji, Croatia	What Are the Mathematics-related Teacher Tasks in Early Childhood Settings?	69th OMEP World Assembly and International Conference	No	Yes [Attachment 5a, 5b]	Yes	Yes
Jan/2018/ Hawaii, USA	Are Our Early Childhood Teachers Ready for Early Mathematics Education?	16th Annual Hawaii International Conference on Education	No	Yes [Attachment 6]	Yes	Yes
Mar/2018/ Washington, USA	Technology-related teacher knowledge for early mathematics education: What are they in the eyes of practitioners? How to measure?	29th Annual Conference of the Society for Information Technology and Teacher Education (SITE–2018)	No	Yes [Attachment 7]	Yes	Yes

9. Whether research experience and new knowledge has transferred /contributed to teaching and learning *(Please elaborate.)*

Yes. A dissemination seminar was conducted on 3 Feb, 2018. It was open for Hong Kong early childhood education practitioners. During the seminar, the Project leader introduced the MtEceK framework, the current usage of technologies for mathematics teaching and learning in HK ECE context as well as some common pitfalls and knowledge gaps in using the technologies in teaching and learning. The dissemination was well received by the participants and some participants showed interested in the instrument developed in the project.

10. Student(s) trained *(Please attach a copy of the title page of the thesis)*

Name	Degree registered for	Date of registration	Date of thesis submission / graduation
NA			

11. Other impact

(e.g. award of patents or prizes, collaboration with other research institutions, technology transfer, teaching enhancement, etc.)

Some items were used for teaching early childhood teacher training programme.

12. Public access of completion report

(Please specify the information, if any, that cannot be provided for public access and give the reasons.)

Information that cannot be provided for public access	Reasons
N.A.	N.A.

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THE LOCAL SELF-FINANCING DEGREE SECTOR

FACULTY DEVELOPMENT SCHEME (FDS)

Completion Report - Attachment
(for completed projects only)

RGC Ref. No.:	UGC/FDS16/H06/15
Principal Investigator:	Dr LAO Kam-ling
Project Title:	Teacher knowledge of early childhood teachers in Hong Kong, with a focus on Mathematics in early childhood education

Statistics on Research Outputs

	Peer-reviewed Journal Publications	Conference Papers	Scholarly Books, Monographs and Chapters	Patents Awarded	Other Research Outputs (Please specify)
No. of outputs arising directly from this research project [or conference]	1	6	0	0	N.A.