INDONESIAN SECONDARY MATHEMATICS TEACHERS' KNOWLEDGE AND CLASSROOM PRACTICE IN THE USE OF ICT

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Presented at
Asian Centre for Mathematics Education
East China Normal University

Syiah Kuala Universit

Introduction

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Education:
B.A (Syiah Kuala University, Indonesia)
M.Ed (James Madison University, United States)
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Works Experience:
Secondary Mathematics Teacher (2 Years)
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Introduction - Indonesia

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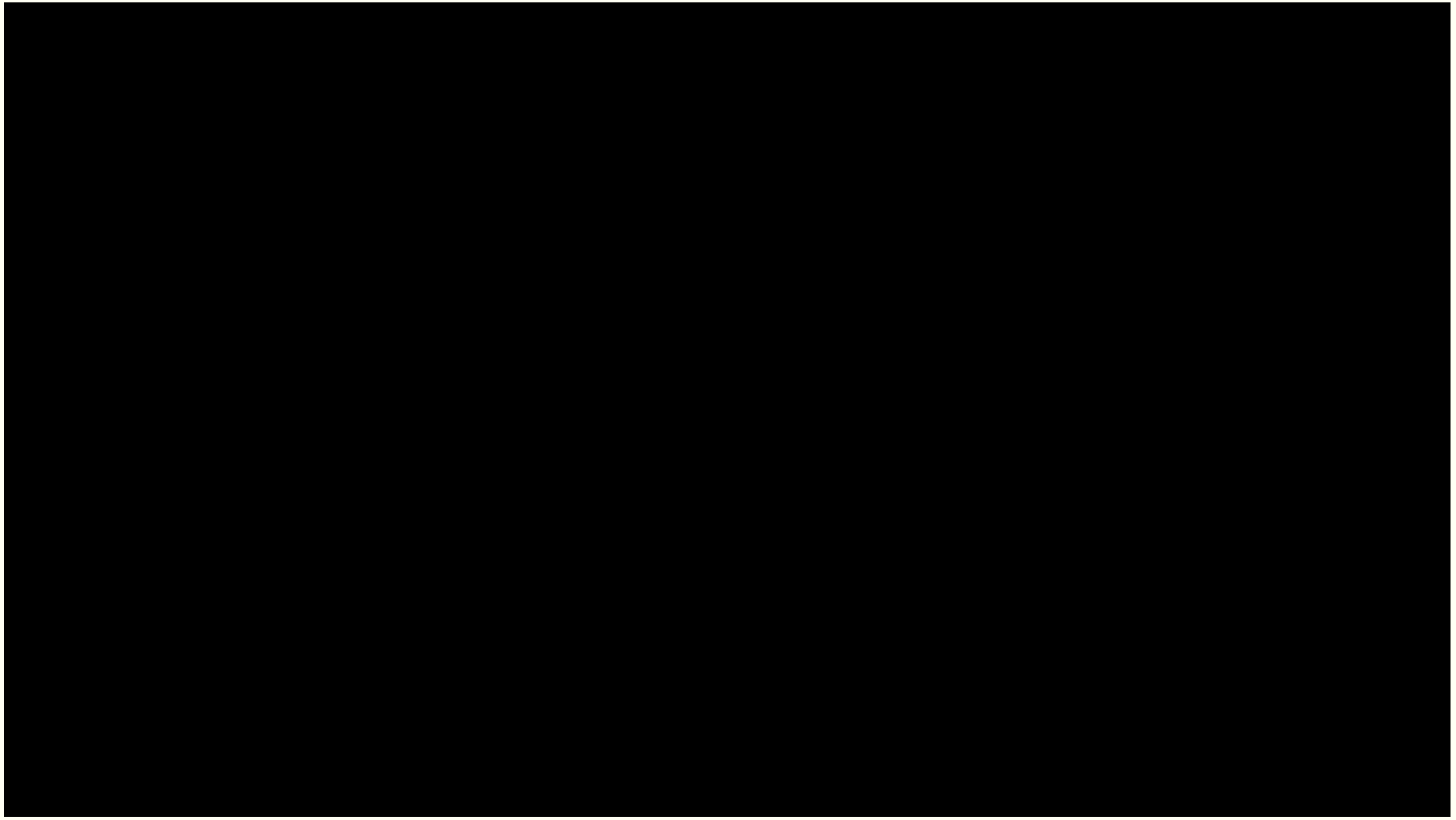

Outline

- Education System, Teachers and Curriculum Reform in Indonesia
- Research Questions
- Theoretical Framework of the Study
- Method
- Teachers' Knowledge in the use of ICT
- Teachers' Classroom Practice in the use of ICT
- Relationship between teachers' knowledge and classroom practices
- Implication and Future Research

Education System in Indonesia

			MoRA	MoRT&HE	MoRA/ MoRT&HE			
		Higher Education	Religious Doctoral Programme(S3)	Doctoral Programme (S3)	Second Professional Programme (SP2)			
			Religious Master Programme (S2)	Master Programme (S2)	First Professional Programme			
			Religious Bachelor Programme (S1)	Bachelor Programme (S1)	Dipl4			
						Dipl3		
							Dipl2	
								Dipl1

Age	Grade	Education Level	MoRA	MoEC	MoRA	MoEC
18	12	Senior Secondary Education	Religious Senior Secondary School	General Senior Secondary School	Religious Vocational School	General Vocational School
17	11					
16	10					

Age	Grade	Education Level		MoRA	MoEC
15	9	Junior Secondary Education	Compulsory Education	Religious Junior Secondary School	General Junior Secondary School
14	8				
13	7				
12	6	Primary Education		Religious Primary School	General Primary School
11	5				
10	4				
9	3				
8	2				
7	1				
6	K2	Early Childhood Education		Religious Kindergarten	General Kindergarten

Teacher and Curriculum Reform in Indonesia

Teacher Reform

In 2005, Indonesian government passed the teacher law aimed at radically reforming national teacher development and administrations.

The 2005 law covers all aspects of teacher's management and development. These are as follows:

- The core principle declares that teaching is a 'profession'.
- Teacher requirements: all teachers must meet a minimum standard of a four-year degree.
- Teachers who have four-year degree are qualified to participate in the teachers' certification programme (6 moths, Subject Specific Pedagogy) ----- double salary
- The reform of pre-service teachers' education programmes.
- A systemic professional teacher development programme

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Teacher and Curriculum Reform in Indonesia

Teacher Reform – Teacher Certification

- Certification comes with serious national expenditure: if the programme is fully implemented it would cost about a quarter of the education budget (Ree & Jaitze, 2016).
- The teachers' certification programme has not led to substantial improvement in students' learning achievements (e.g., Cerdan-Infantes et al., 2013; Ree & Jaitze, 2016)

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Teacher and Curriculum Reform in Indonesia

Teacher Reform

- The 2005 teacher law, then, was elaborated in several ministry regulations
- One of them is Number 16 in the regulation of Minister of Education and Culture in 2007 on standards of teachers' competencies as presented below:

"Pedagogical competence is the ability of a teacher to manage the learning process associated with learners, including the understanding of educational philosophy, the learners, curriculum development, instructional design, ICT integration, and assessment"

Teacher and Curriculum Reform in Indonesia

Curriculum Reform

- The curriculum had undergone many changes in 1947, 1952, 1964, 1968, 1975, 1984, 1999, 2004, 2006 and most recently in 2013

- In1984, the government implemented a curriculum which signalled the first attempt and policy directive to integrate modern technologies into the mathematics teaching and learning in Indonesian classrooms (Mailizar, Manahel, & Fan, 2014).

- The current curriculum emphasises on the use of digital technology in teaching
- The current curriculum emphasises on 4 skills (Communication, Collaboration, Critical thinking, and Creativity)

Research Gap

- Regarding studies on mathematics teachers' knowledge of ICT use in teaching, most of the previous studies have been conducted in developed countries. In contrast, only a few studies have investigated this issue in developing countries, let alone Indonesia.
- Most of the studies on teachers' use of ICT in mathematics teaching rely only on teachers' self-reports of through employing questionnaire surveys
- The previous studies on the relationship between teachers' knowledge and their classroom practices in the use of ICT did not make the distinction between teachers' knowledge of ICT and teachers' knowledge of ICT use in teaching

Research- Context of Indonesia

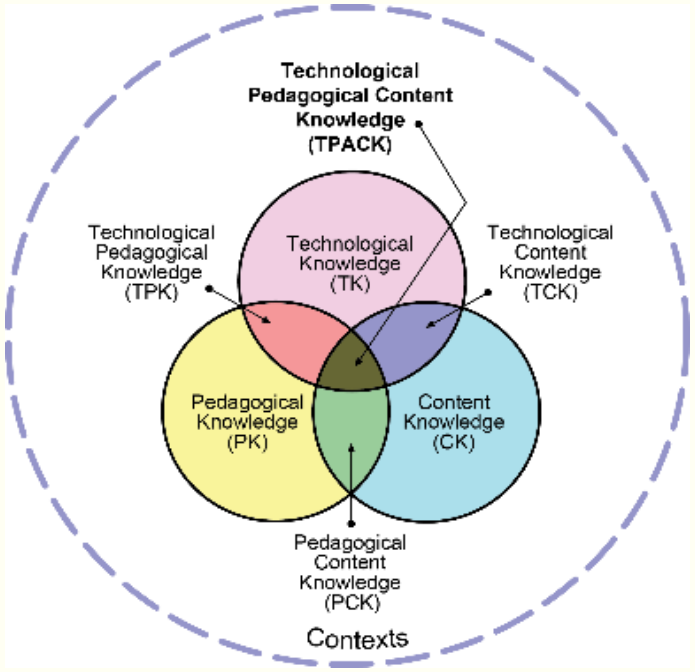
- The previous studies on mathematics teachers' use of ICT did not look at teachers' pedagogical activities when they use ICT
- The previous studies on teachers' knowledge emphasizes on pre-services teachers

Research Questions

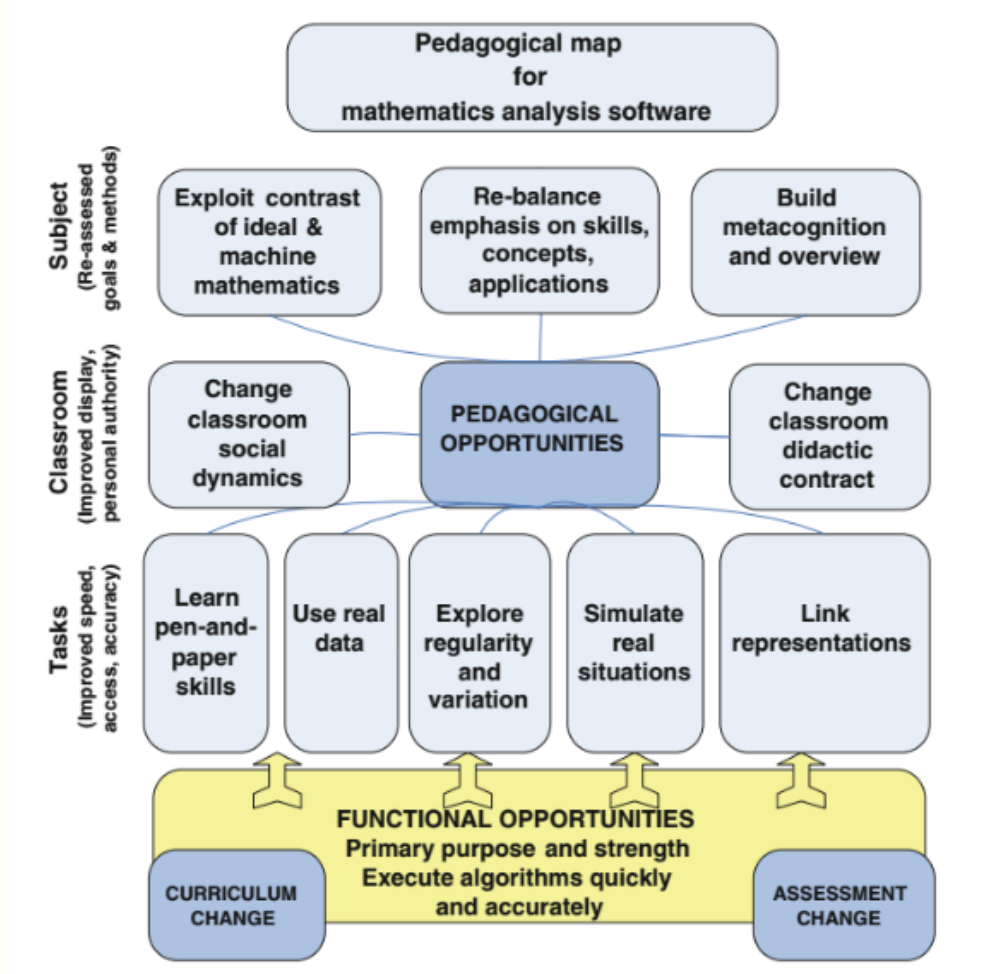
- What knowledge do Indonesian secondary mathematics teachers have about ICT and its use in teaching?
- How do Indonesian secondary mathematics teachers use ICT in their teaching practices?
- What is the relationship between teachers' knowledge and classroom practices in the use of ICT in mathematics teaching?
- What barriers do Indonesian secondary mathematics teachers face in the use of ICT in the classroom?

Conceptual Framework

TPACK (Mishra & Koehler, 2006)



Pedagogical map for MAS(Pierce & Stacey (2010)



Conceptual Framework- Teachers' Knowledge

Construct of Knowledge	Description
Knowledge of ICT	Knowing how to operate hardware as well as knowing of how to use software and the internet without consideration of any mathematical content and teaching approaches
Knowledge of ICT use in teaching	
○ ICT-Content Knowledge	Knowing how to use ICT to represent, communicate, solve and explore mathematical contents, ideas, or problems without consideration of teaching approaches.
○ ICT-Pedagogical Knowledge	Knowing how to use ICT to provide advantages to specific aspects of teaching approaches without reference to subject matter
○ ICT-Pedagogical Content Knowledge	Knowing how to use ICT to teach, represent and facilitate learning of specific content of mathematics with specific teaching approaches to enhance teaching and learning

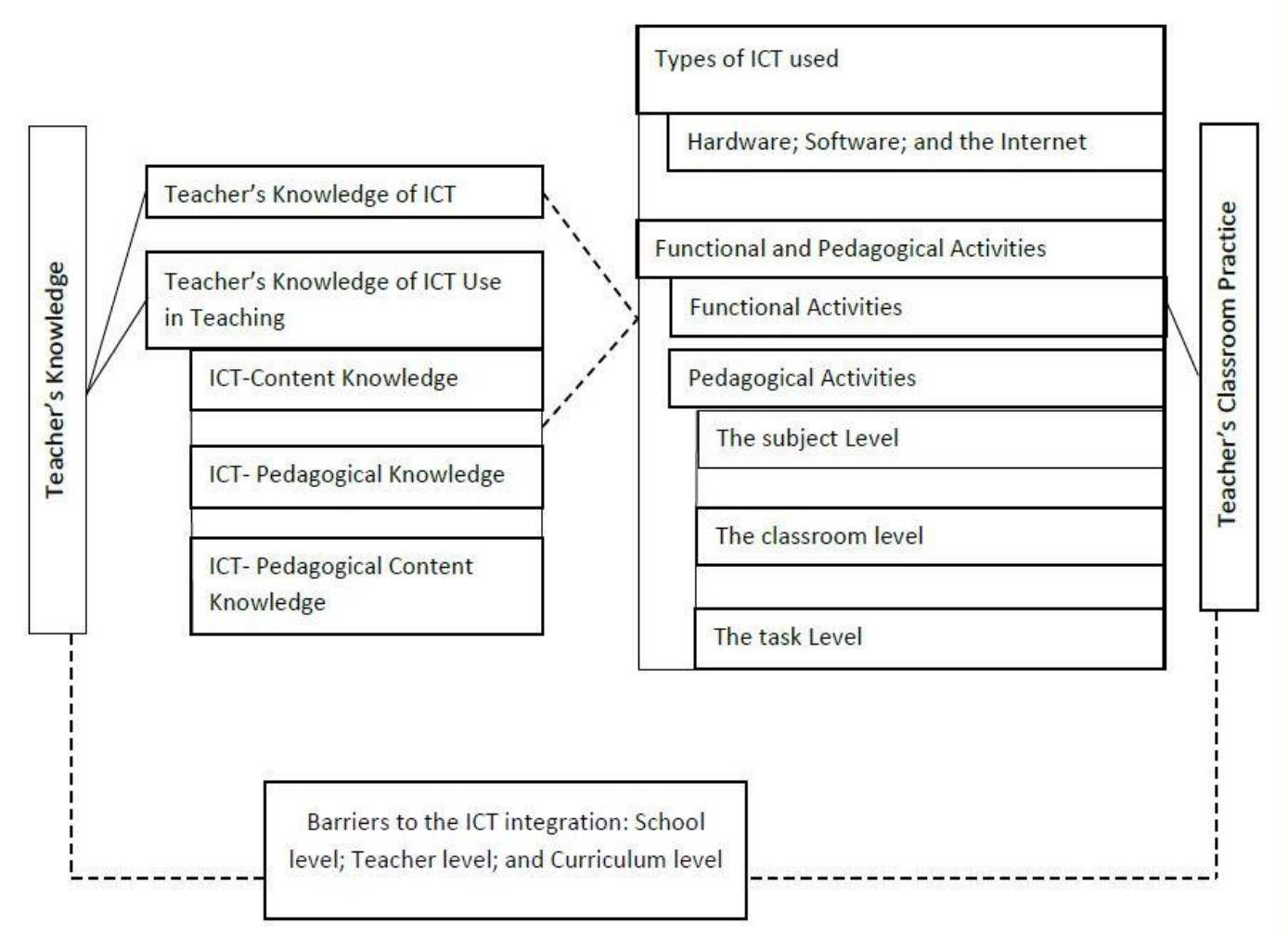
Conceptual Framework- Teachers' Classroom Practices

Type of ICT Used	○ Hardware ○ Software, and ○ Online Resources
Functional and Pedagogical Activities	
○ Functional Activities	○ routine mathematical procedures (e.g. drawing graphs, solving equations, factorising
○ Pedagogical Activities	○ Subject Level ○ Classroom Level ○ Task Level

Conceptual Framework- Teacher Pedagogical Activities at each level (Piece and Stacey's (2010)

Pedagogical Activities	Description
Task Level	
• Learn pen-and paper skills	Using instant 'answers' as feedback in learning processes
• Use real data	Working on real problems involving calculations
• Explore regularity and variation	Strategically varying computations searches for patterns; observing effect of parameters; Use general forms.
• Stimulate real situations	Using dynamic diagrams, dragging and collecting data for analysis. Using technology generated statistical data sets.
• Link Representation	Moving fluidly between geometric, numeric, graphic and symbolic representations.
Classroom Level	
• Changing classroom social dynamic	Teachers facilitate rather than dictate; teachers encourage group work as well as encouraging students to initiate discussion and share their learning with the class
• Changing classroom didactic contract	Teachers allow technology to become a new authority; changing what is expected of students and teachers; Permitting or constraining explosion of available methods
Subject Level	
• Exploiting contrast of ideal and machine mathematics	Teachers deliberately use 'unexpected' error messages, format of expressions, graphical displays as catalysts for rich mathematical discussion
• Rebalancing emphasis on skills, concepts, applications	Teachers adjust goals: spend less time on routine skills, more time on concepts and applications; teacher increase emphasis on mathematical thinking.
• Building metacognition and overview	Teachers give overview as introduction or summation: link concepts through manipulation of symbolic expressions and use of multiple representations.

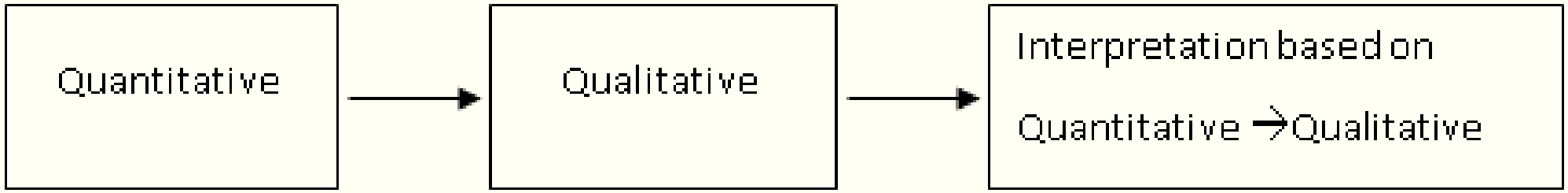
Conceptual Framework



Method

Research Design

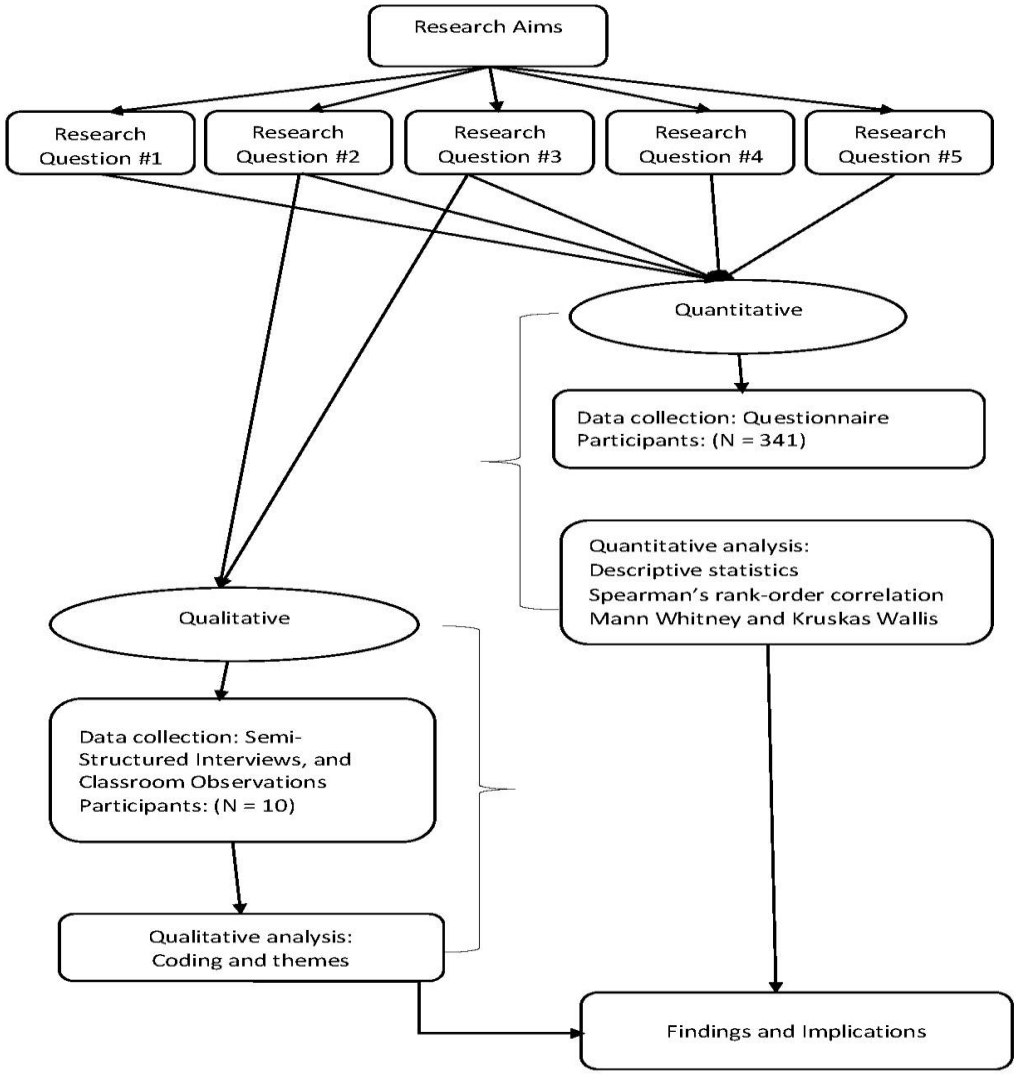
Sequential explanatory research design



Source: from Creswell and Plano-Clark (2007)

Method

Research Design



Method

Participants and Setting

Population

- One of Provinces in Indonesia
- 367 senior secondary schools
- 1,443 mathematics teachers.

Method

Sample (Stratified Random Sampling)

High		Middle		Low	
1	City of Banda Aceh	6	Regency of Aceh Besar	12	Regency of Aceh Selatan
2	City of Lhokseumawe	7	Regency of Aceh Utara	13	Regency of Aceh Jaya
3	Regency of Bireuen	8	Regency of Pidie	14	Regency of Bener Meriah
4	City of Langsa	9	Regency of Aceh Barat	15	Regency of Nagan Raya
5	Regency of Aceh Tengah	10	Regency of Aceh Barat Daya	16	Regency of Aceh Tamiang
		11	Regency of Pidie Jaya		

Method

Quantitative Phase Sample

No	Regencies/Cities	Number of School	Number of Selected School
1	City of Banda Aceh	22	8
2	City of Lhokseumawe	11	4
3	Regency of Bireuen	28	10
4	City of Langsa	9	3
5	Regency of Aceh Tengah	17	6
6	Regency of Aceh Besar	29	10
7	Regency of Aceh Utara	25	9
8	Regency of Pidie	17	6
9	Regency of Aceh Barat	16	6
10	Regency of Aceh Barat Daya	9	3
11	Regency of Pidie Jaya	10	4
12	Regency of Aceh Selatan	17	6
13	Regency of Aceh Jaya	8	3
14	Regency of Bener Meriah	13	5
15	Regency of Nagan Raya	10	4
16	Regency of Aceh Tamiang	16	6

Method

Sample (Quantitative Phase)

In total:

- 93 Schools
- 440 Teachers
- 355 teachers completed and returned the questionnaire
- 14 questionnaires found incomplete, leaving 341 questionnaires for the analysis

Method

Sample (Qualitative Phase)

Participant	Gender	T.Experience	Level Of Education	T.Certificate	Type of School
ID 1	Female	1 Year	Bachelor Degree	No	MoEC
ID 2	Female	2 Years	Bachelor Degree	No	MoEC
ID 3	Female	17 Years	Master Degree	Yes	MoRA
ID 4	Male	10 Years	Master Degree	Yes	MoEC
ID 5	Male	11 Years	Master Degree	Yes	MoEC
ID 6	Female	13 Years	Bachelor	Yes	MoEC
ID 7	Male	20 Years	Bachelor Degree	Yes	MoEC
ID 8	Male	14 Years	Master Degree	Yes	MoEC
ID 9	Male	8 Years	Bachelor Degree	No	MoEC
ID 10	Female	4 Years	Master Degree	No	MoEC

Method

Data Analysis (Quantitative Data)

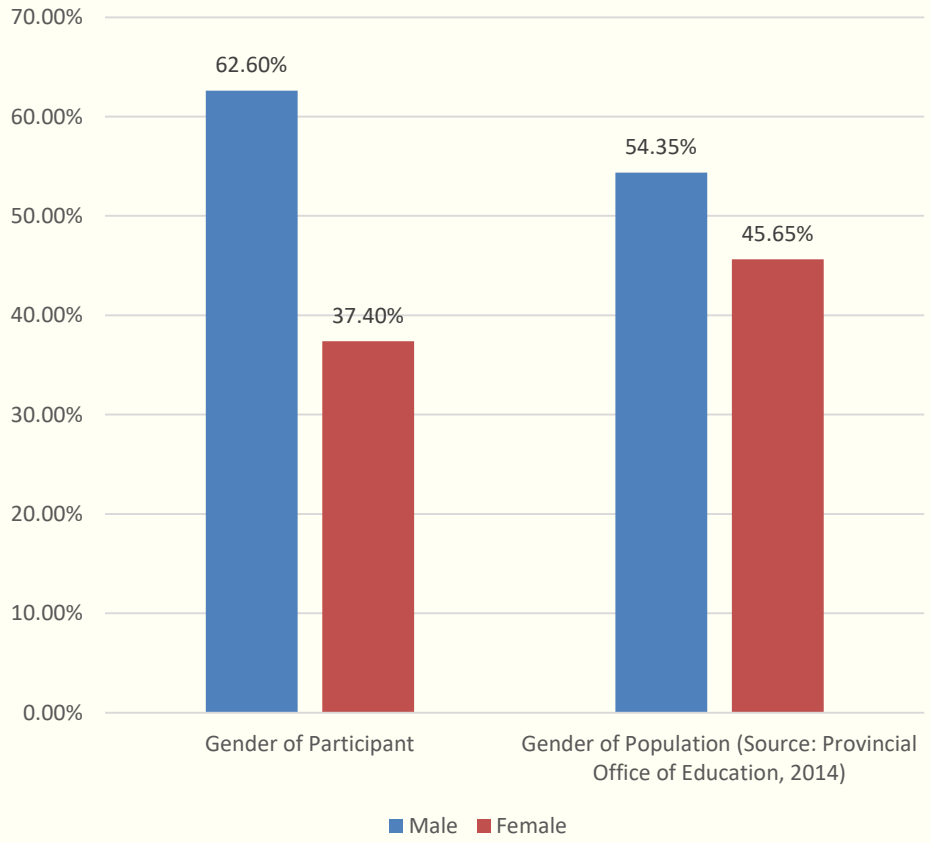
- Descriptive Statistics and Inferential Statistics (Research Question 1, Research Question 2, Research Question 4)
- Inferential Statistics (Research Question 3)

Data Analysis (Qualitative Data)

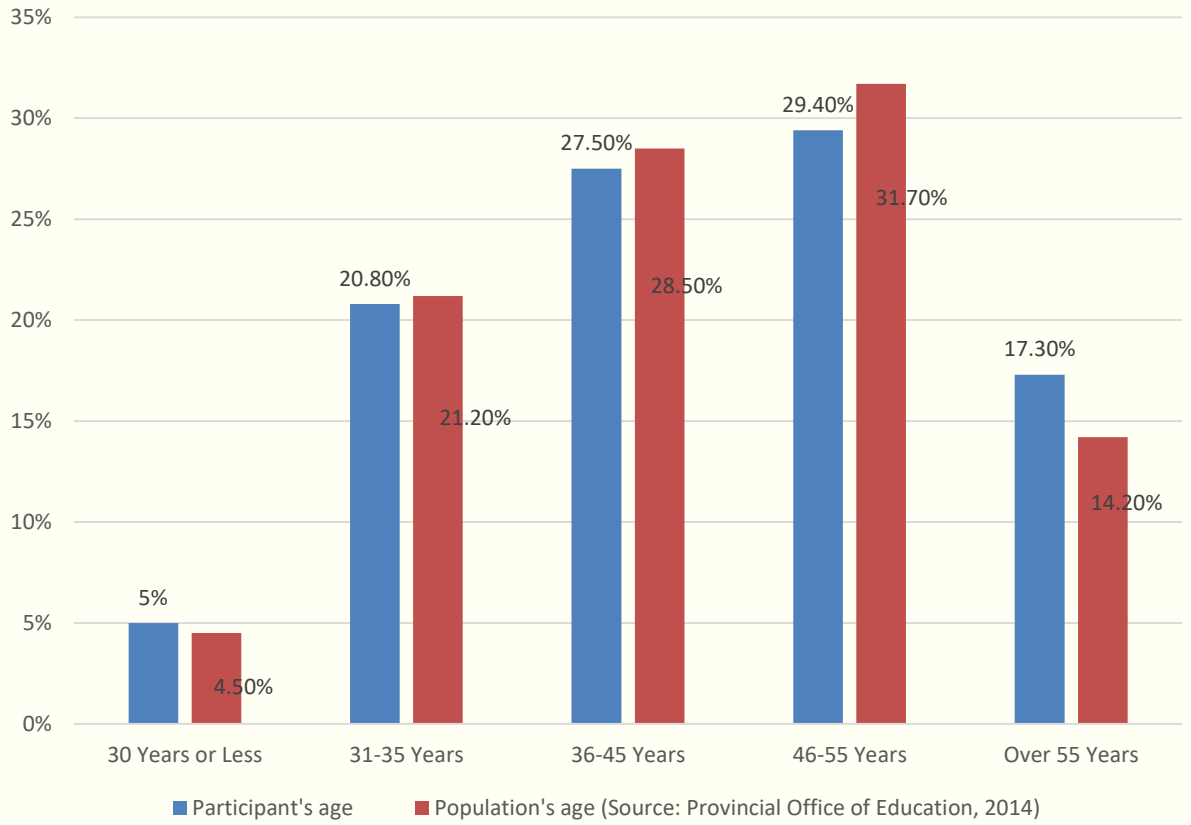
- A deductive qualitative analysis (Research Question 2 and Research Question 4)

Results – Demographic Information

Distribution of the participants according o gender



- Distribution of the participants according to age



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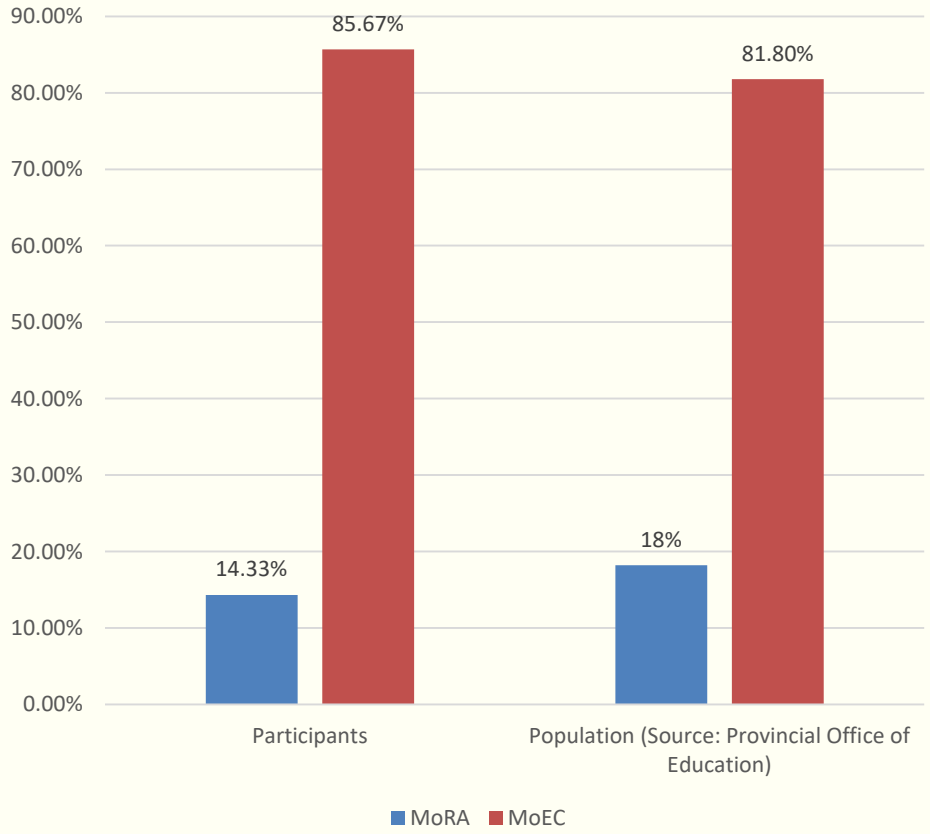
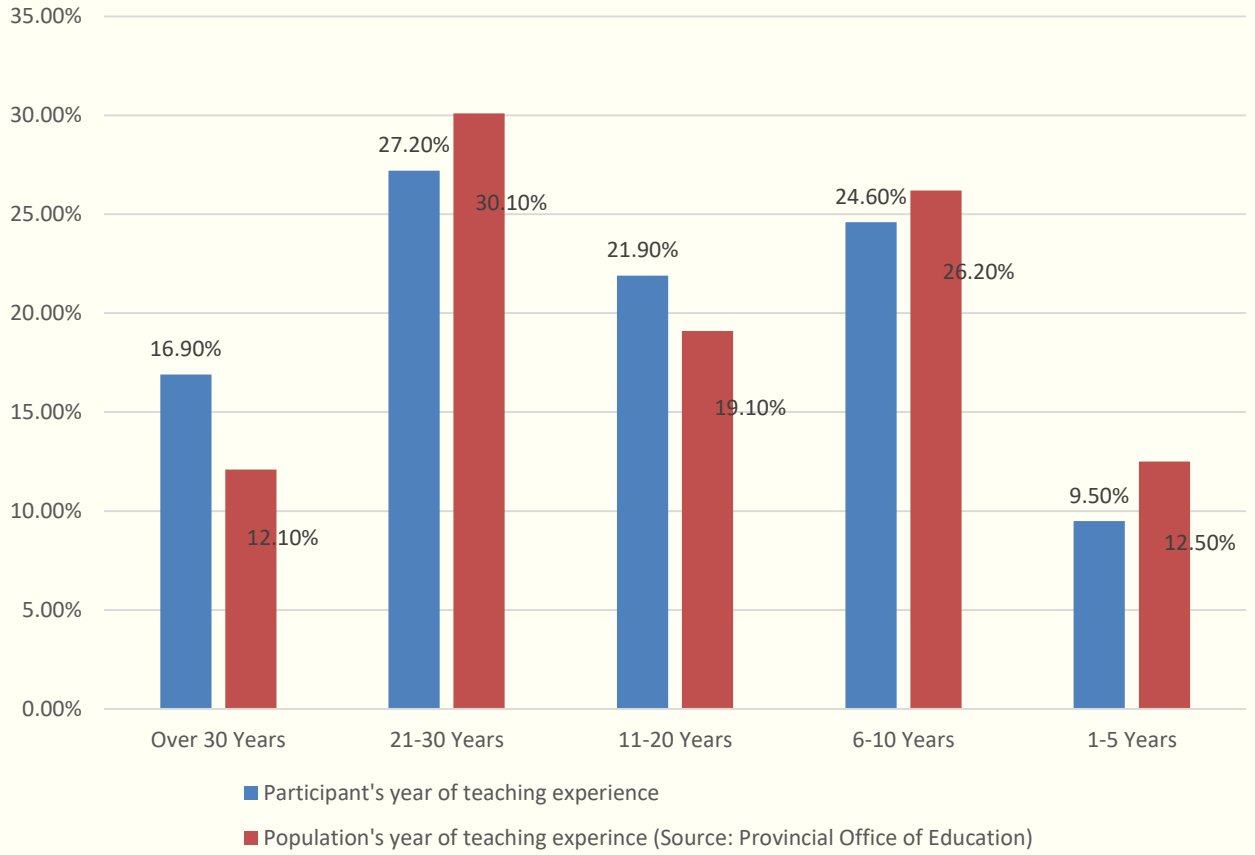
Results – Demographic Information

Distribution of the participants according to types of school



Distribution of the participants according to years of teaching experiences



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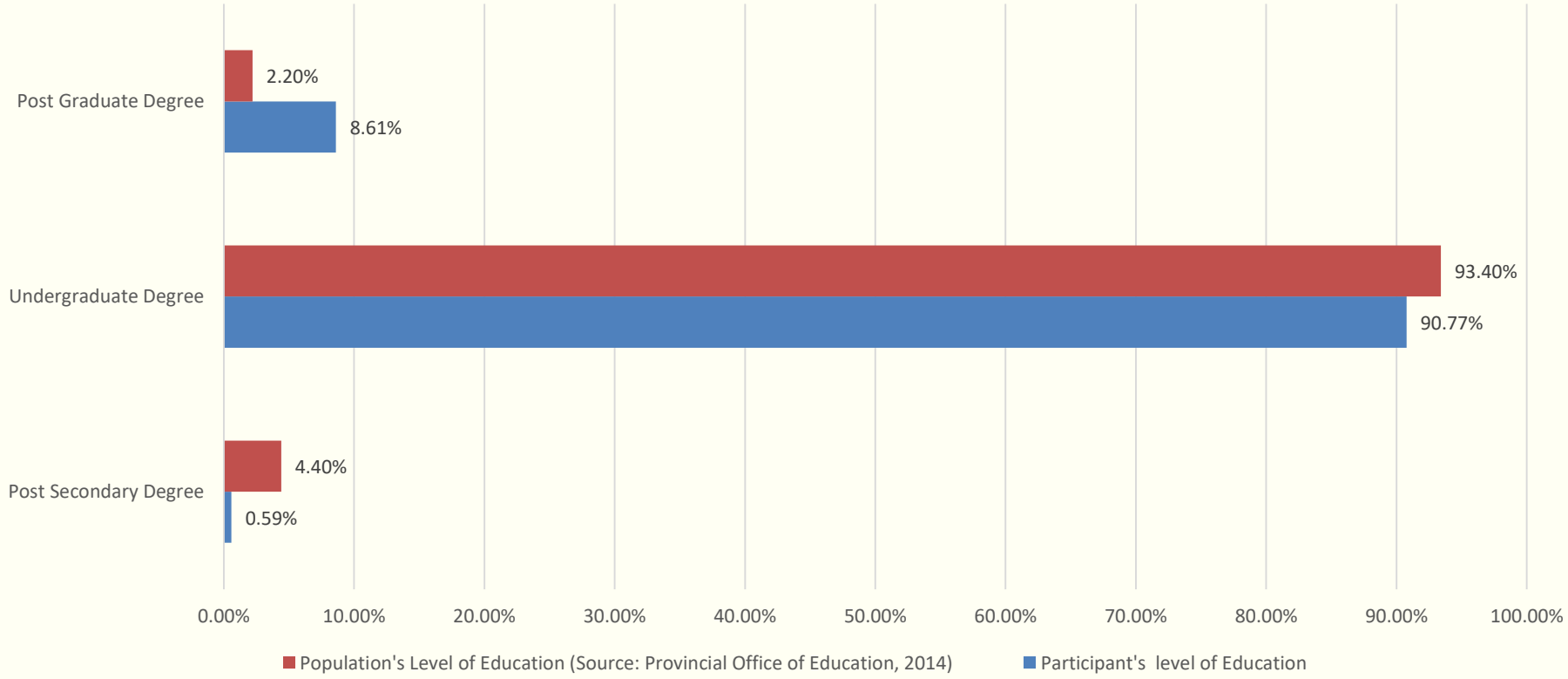
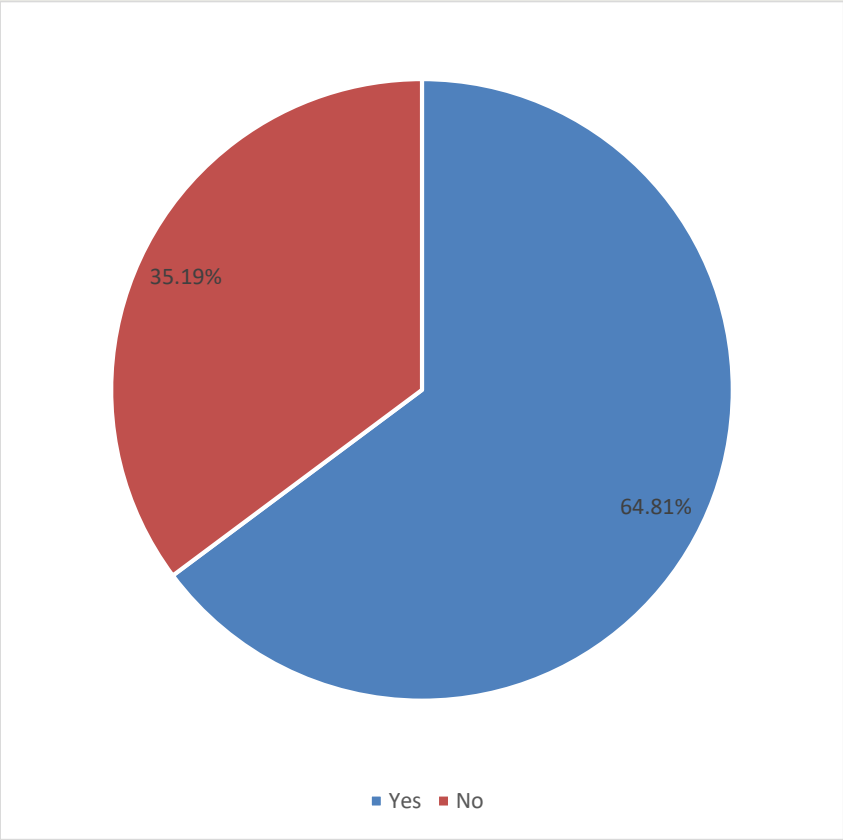
Results – Demographic Information

Distribution of the participants according to the level of education

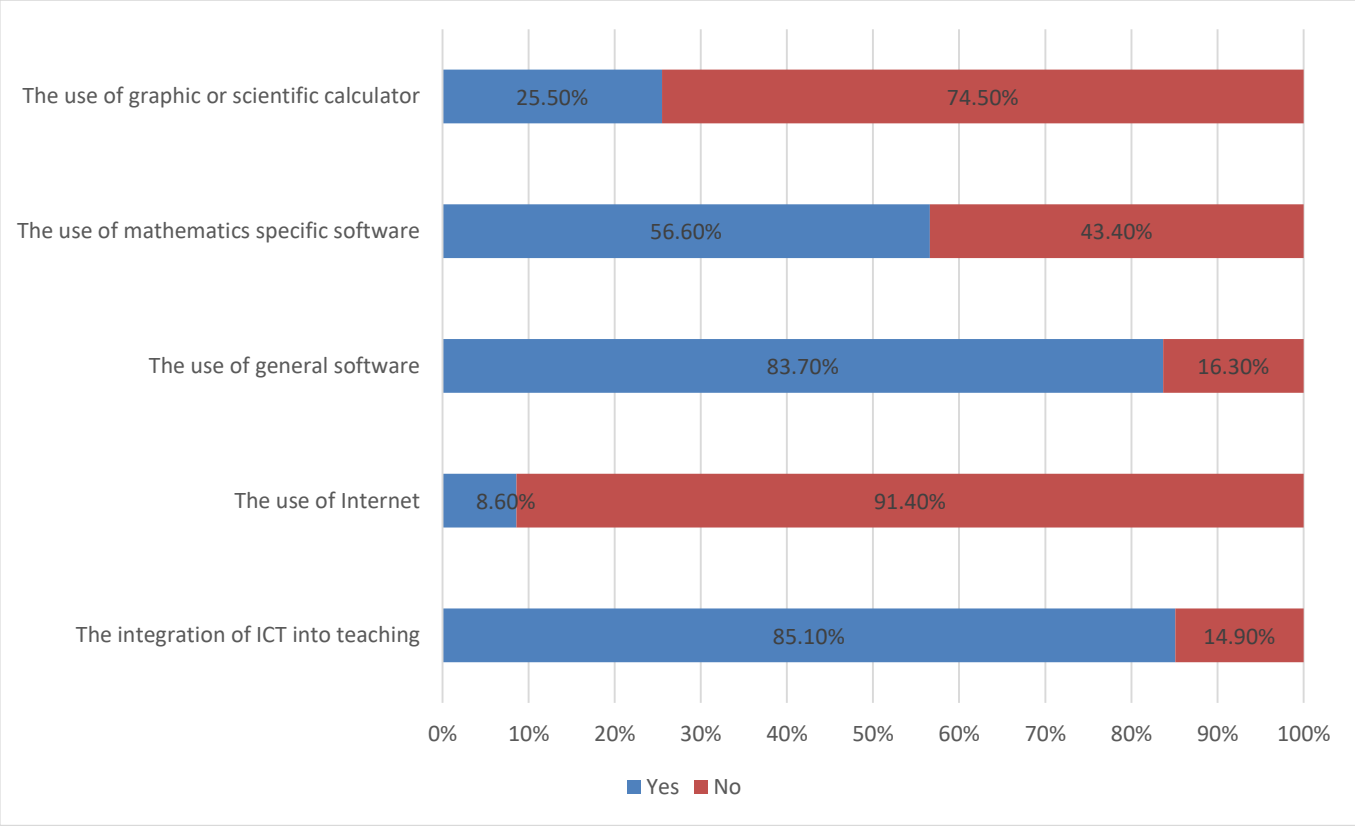


Results – ICT Training Course

Distribution of the participants according to training of ICT



Distribution of the participants according to types of training course



Results – Teachers' Perception of Their Knowledge

Results – Teacher Knowledge of ICT

Knowledge of hardware

Knowledge of hardware	Mean	Standard Deviation
Graphing Calculator	2.57	1.22
Tablet/Mobile Device	3.18	1.04
Computer/Laptop	3.66	0.88
Mean	3.14	

Results- Teacher Knowledge of ICT

Knowledge of general software	Mean	Std. Deviation
Word processor software(e.g., Ms Word)	3.85	0.90
Presentation software (e.g., Ms PowerPoint)	3.54	0.98
Online presentation software (e.g., Prezi)	1.99	0.94
Spreadsheet software (e.g., Ms Excel)	3.48	1.01
Mind mapping software (e.g., Inspiration)	2.04	0.99
Animation software (e.g., Macromedia Flash)	2.17	1.00
Three dimensional visualisation software (e.g., Sketch Up)	1.91	0.92
Mean	2.71	

Results- Teacher Knowledge of ICT

Knowledge of Mathematical software	Mean	Standard Deviation
Computer Algebra System (e.g., Maple and Maxima)	2.09	1.10
Dynamic Geometry Software (e.g., Geometer's Sketchpad and Cabri Geometry)	2.04	1.01
Dynamic Mathematics Software (e.g., GeoGebra and Autograph)	2.32	1.06
Statistical Software (e.g., Tinkerplots and Fathom)	1.87	0.92
Mean	2.07	

Results- Teacher Knowledge of ICT

Knowledge of online tools	Mean	Standard Deviation
Online Learning Resources	2.21	1.18
Learning Management System	2.07	1.06
Mean	2.14	

Results- Teacher Knowledge ICT

A repeated measures ANOVA :

- there was significant differences in teachers level of knowledge of hardware across the items F(1.84, 540.01) = 163.21, p = 0.00.
- there was significant differences in teachers level of knowledge of general software across the items *F*(2.86, 686.55) = 461.36, p = .00.
- there was significant differences in teachers level of knowledge of mathematical software across the items *F*(6.38, 1665.11) = 35.48, p = 0.00.

A paired t-test:

- there was a significant difference in the score for teacher knowledge for online learning resources (M=2.21, SD =1.18) and learning management system (M 2.07, SD =1.06); t (287) =4.15, p= .00.

Results- Teacher Knowledge of ICT use in teaching

ICT-Content Knowledge	Mean	Std. Deviation
a. Use ICT to represent mathematical ideas	3.10	1.03
a. Use ICT to communicate mathematical processes	3.02	1.08
a. Use ICT to solve mathematical problems	2.90	1.10
a. Use ICT to explore mathematical ideas	2.84	1.08
Mean	2.96	

Results- Teacher Knowledge of ICT use in teaching

ICT-Pedagogical Knowledge	Mean	Std. Deviation
Use ICT for direct instruction	3.33	0.93
Use ICT for inquiry-based teaching and learning	3.14	0.94
Use ICT for project-based teaching and learning	2.85	0.95
Use ICT for discovery teaching and learning	2.81	0.91
Use ICT for collaborative teaching and learning	2.72	0.97
Mean	2.97	

Results- Teacher Knowledge of ICT use in teaching

ICT-Pedagogical Content Knowledge	Mean	Std. Deviation
Use ICT to teach topics of mathematics that are better learned when employing specific teaching approaches	3.20	0.90
Use strategies that combine mathematical content, ICT and teaching approaches to support students' understandings as they are learning mathematics	3.10	0.93
Use ICT in teaching that enhances mathematical content and how it taught	3.06	0.97
Use ICT to incorporate authentic tasks in teaching mathematics through project-based learning	2.88	1.08
Use ICT to teach students to develop their mathematics problem solving through inquiry-based learning	2.07	1.06
Mean	2.87	

Results- Teacher Knowledge ICT use in teaching

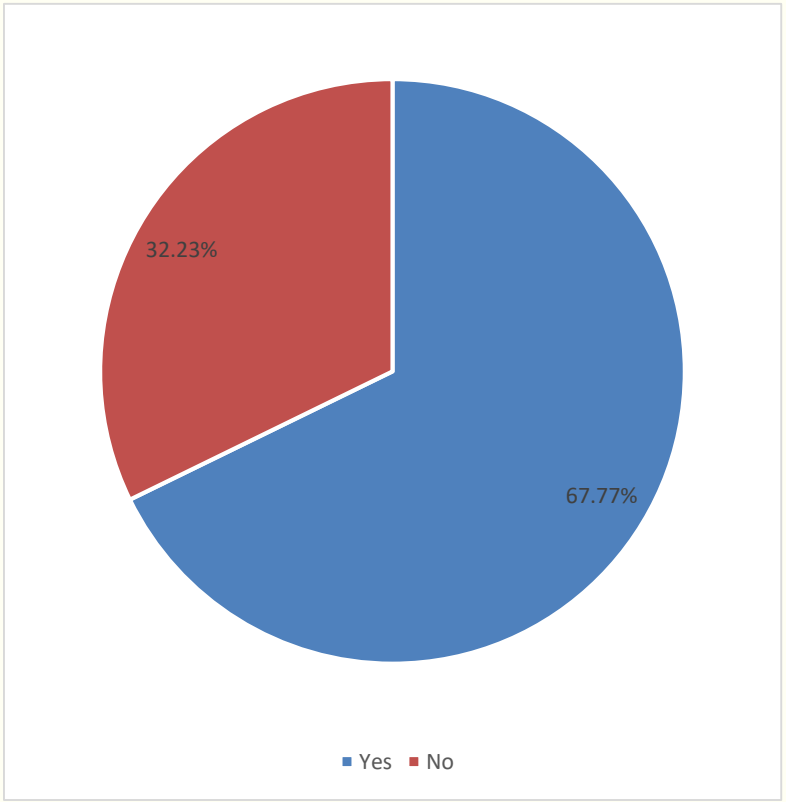
A repeated measures ANOVA :

- The results showed that there was significant differences in teachers level of knowledge of ICT use in teaching across those three categories $F(1.59, 513.85) = 48.9$, $p = .013$.

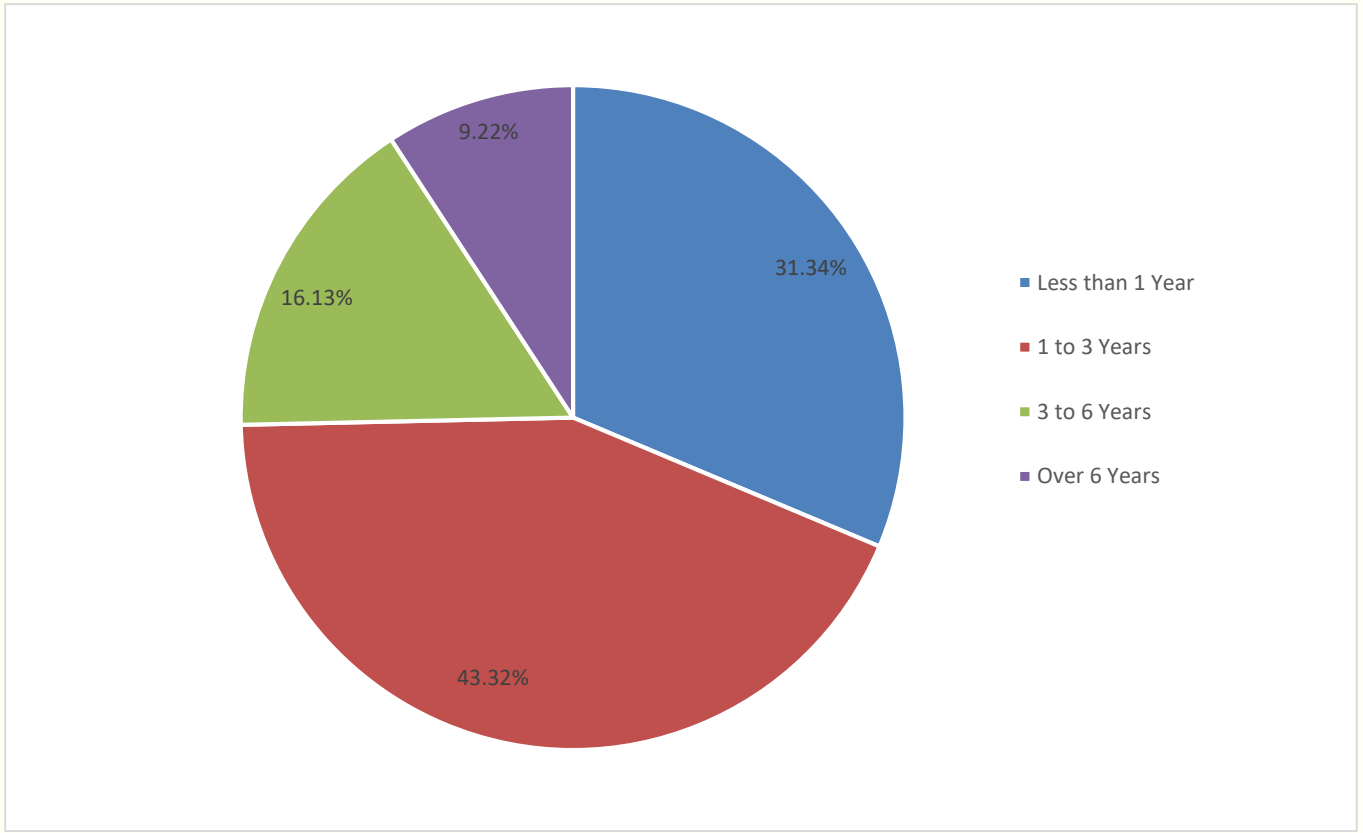
Results – Teachers' Classroom Practices in the Use of ICT

Results-Teachers' Classroom Practice in the Use of ICT

Percentage of the participants who used ICT

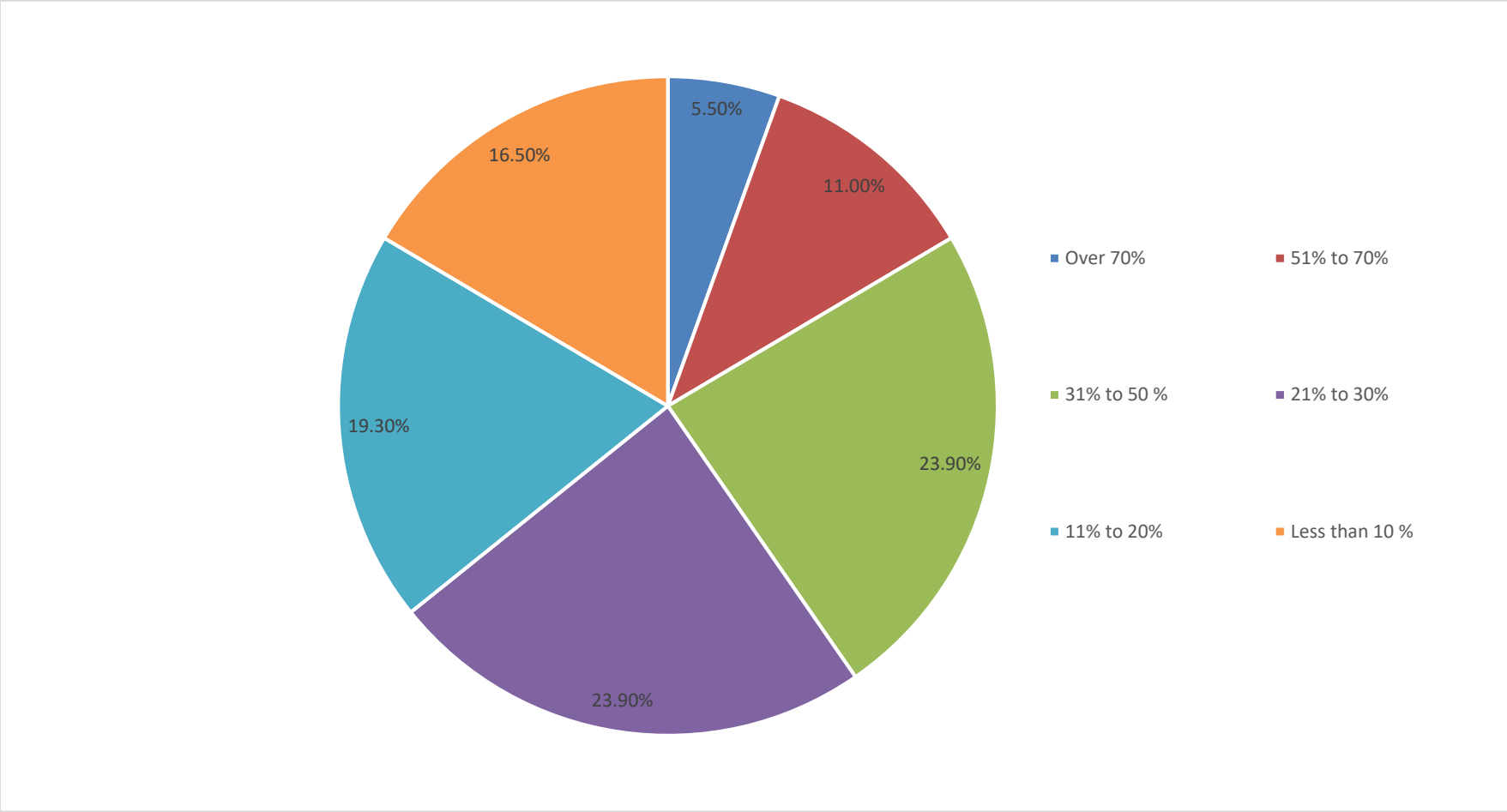


Years of experience in the use of ICT



Results-Teachers' Classroom Practice in the Use of ICT

Years of experience in the use of ICT



Results-Teachers' Classroom Practice in the Use of ICT

Use of Hardware	Mean	Std. Deviation
Tablet/Handheld Device	2.45	.99
Computer/Laptop	3.35	.81
Calculator	2.15	1.16

Results-Teachers' Classroom Practice in the Use of ICT

Use of General Software	Mean	Std. Deviation
Word Processor (e.g., Ms Word)	3.12	1.09
Presentation (e.g., Ms PowerPoint)	3.15	.97
Spreadsheet (e.g., Ms Excel)	2.67	1.06
Mind Mapping (e.g., Inspiration)	1.68	.89
There-Dimensional Visualisation (e.g., Sketchup)	1.60	.80

Results-Teachers' Classroom Practice in the Use of ICT

Mathematical software	Mean	Std. Deviation
Computer Algebra System (e.g., Maple)	1.82	.98
Dynamic Mathematics and Dynamic Geometry Software (e.g., GeoGebra an Autograph)	2.11	1.00
Statistical Software (e.g., Tinkerplot)	1.78	.98

Results-Teachers' Classroom Practice in the Use of ICT

Online Resource	Mean	Std. Deviation
Web-based teaching and learning resources	2.04	1.06
Learning management system	1.80	1.02

Results-Teachers' Classroom Practice in the Use of ICT

A repeated measures ANOVA :

- There was significant differences in teachers use of hardware $F(2, 408) = 132.89$, $p = 0.00$
- There was significant differences in teachers use of general software ($F(3.33, 642.86) = 226.87$, $p = 0.00$)
- There was significant differences in teachers use of mathematical software ($F(1.84, 388.05) = 17.85$, $p = 0.00$) across the items.

A paired t-test:

- The results revealed that there was a significant difference in the score for teacher knowledge for web-based teaching and learning resources ($M=2.04$, $SD =1.06$) and learning management system ($M = 1.80$, $SD =1.02$); $t (205) =4.27$, $p= .00$.

Results-Teachers' Classroom Practice in the Use of ICT

Functional and Pedagogical Activities	Mean	Std. Deviation
• Do arithmetic	3.12	.91
• Draw graphs	3.01	1.03
• Solve equations	2.85	1.16
• Construct diagrams	2.96	1.23
• Do measurements	2.82	1.16
• Create three-dimensional visualisations	2.74	1.22

Results-Teachers' Classroom Practice in the Use of ICT

Classroom Activities		
• Present content of mathematics	2.79	1.11
• Give classroom instructions	2.75	1.10
• Guide student in exploratory and inquiry activities	2.44	1.07
• Assess students' learning	2.34	1.06
• Provide feedback	2.35	1.15
• Provide remedial	2.33	1.13

Results-Teachers' Classroom Practice in the Use of ICT

Teaching Approach		
• Teacher-centred approach	3.02	.90
• Students-centred approach	2.98	.98

Results-Teachers' Classroom Practice in the Use of ICT

Subject		
• Geometry	2.75	.99
• Algebra	2.61	1.01
• Statistics and Probability	2.75	1.03
• Calculus	2.47	1.07
• Trigonometry	2.62	1.03

Results-Teachers' Classroom Practice in the Use of ICT

Task		
• Learn pen-and-paper skills	2.53	1.15
• Use real data	2.57	1.11
• Explore regularity and variation	2.37	1.10
• Simulate real situation	2.40	1.10
• Link representation	2.44	1.08

Results-Teachers' Classroom Practice in the Use of ICT

A repeated measures ANOVA :

- there was significant differences in teachers used of ICT for various functional activities (F(3.35, 713.55.05) = 12.82, p = 0.00)
- there was significant differences teachers used of pedagogical activities (F(4.26, 890.19) = 25.98, p = 0.00)
- there was significant differences in the use of ICT across topics of mathematics (F (3.86, 817.75) = 9.07, p = 0.00) and tasks (F(3.76, 812.99) = 5.20, p = 0.01.).

A paired t-test:

- there was no significant difference in the use of ICT for teacher-centered approach (M=3.02, SD =.90) student-centered approach (M=2.98, SD =.98); t (220) =.66, p= .51.

Results-Teachers' Classroom Practice in the Use of ICT

Participants	Subject Level	Task Level	Classroom Level
Participant 1	Rebalance emphasis on skills, concepts and applications, and build metacognition and overview	Explore regularity and variation, and link representation	Change classroom didactic contract; Change classroom social dynamics
Participant 2	Rebalance emphasis on skills, concepts and applications, and build metacognition and overview	Explore regularity and variation, and link representation	Change classroom social dynamics
Participant 3	-	Learn pen-and- paper skill	-
Participant 4	Rebalance emphasis on skills, concepts, applications	Explore regularity and variation, and link representation	Change classroom didactic contract; Change classroom social dynamics
Participant 5	-	Learn pen–and- paper skill	Change classroom social dynamics
Participant 6	-	Learn pen–and- paper skill	Change classroom social dynamics
Participant 7	-	Link representation	-
Participant 8	Rebalance emphasis on skills, concepts and applications, and build metacognition and overview	Explore regularity and variation, and link representation	Change classroom social dynamics
Participant 9	-	Learn pen–and- paper skill, explore regularity and variation	-
Participant 10	-	Learn pen–and- paper skill	-

Results – Teachers' Barriers to ICT Integration

Results-Teachers' Barrier to the Integration of ICT

School-Level Barriers	Mean	Std. Deviation
do not have access to hardware at school	2.21	1.06
do not have access to software at school	2.34	1.11
school does not have internet connection	1.93	1.13
school's policy does not support the use of ICT	1.64	.77
Textbooks do not incorporate information about the use of ICT	2.45	1.08
School does not provide technical support	2.44	1.11
do not have enough time to prepare ICT-based lessons	2.74	1.01
Mean	2.25	

Results-Teachers' Barrier to the Integration of ICT

Barriers at Curriculum Level	Mean	Std. Deviation
Student's assessment is not in line with the use of ICT	2.63	1.25
Structure of Mathematics' content is not in line with the use of ICT	2.09	.87
Mean	2.36	

Results-Teachers' Barrier to the Integration of ICT

Teacher-Level Barrier	Mean	Std. Deviation
I am not confident to use ICT in the classroom	2.31	.98
I had negative experience with ICT in the past	2.11	.88
I believe that ICT does not enhance learning	1.63	.82
Mean	2.01	

Results – Relationship Between Teachers' Knowledge and Their Classroom Practices in the Use of ICT

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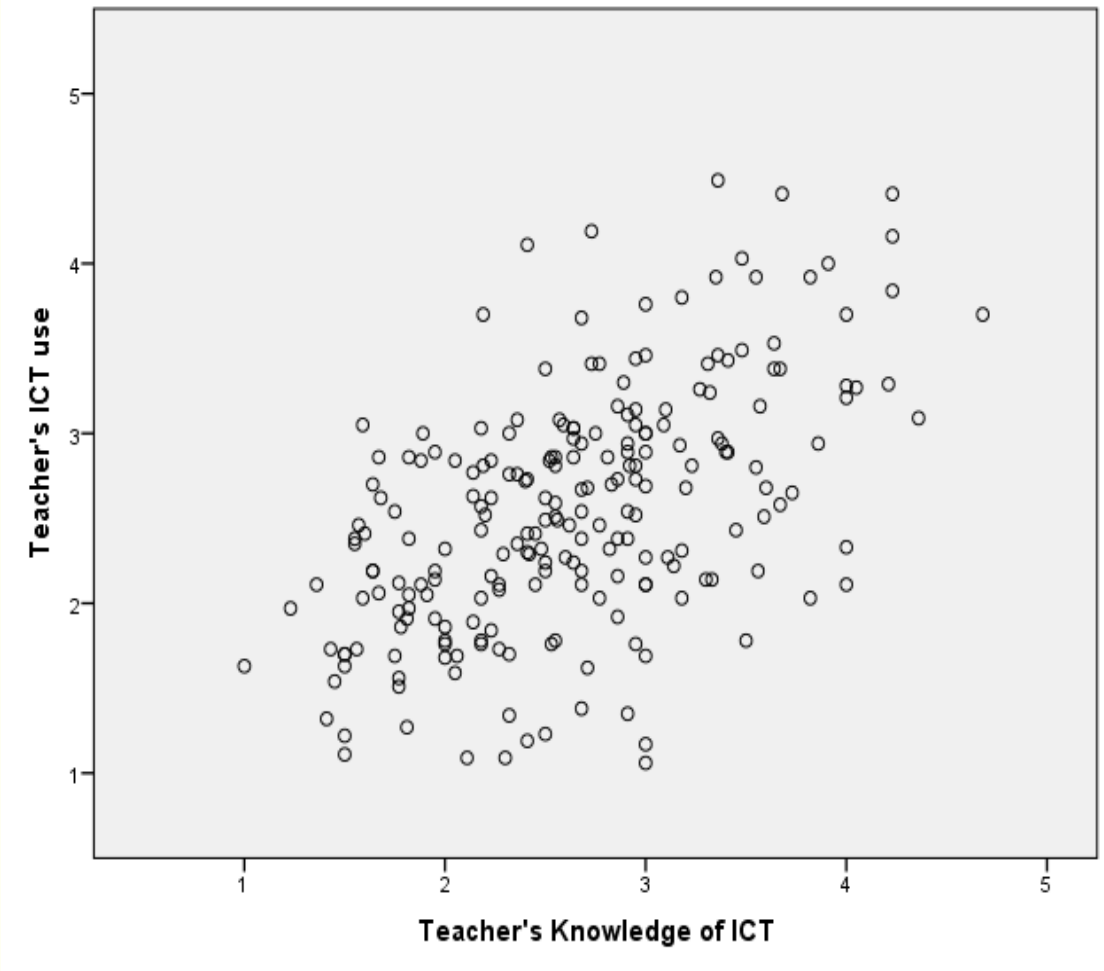

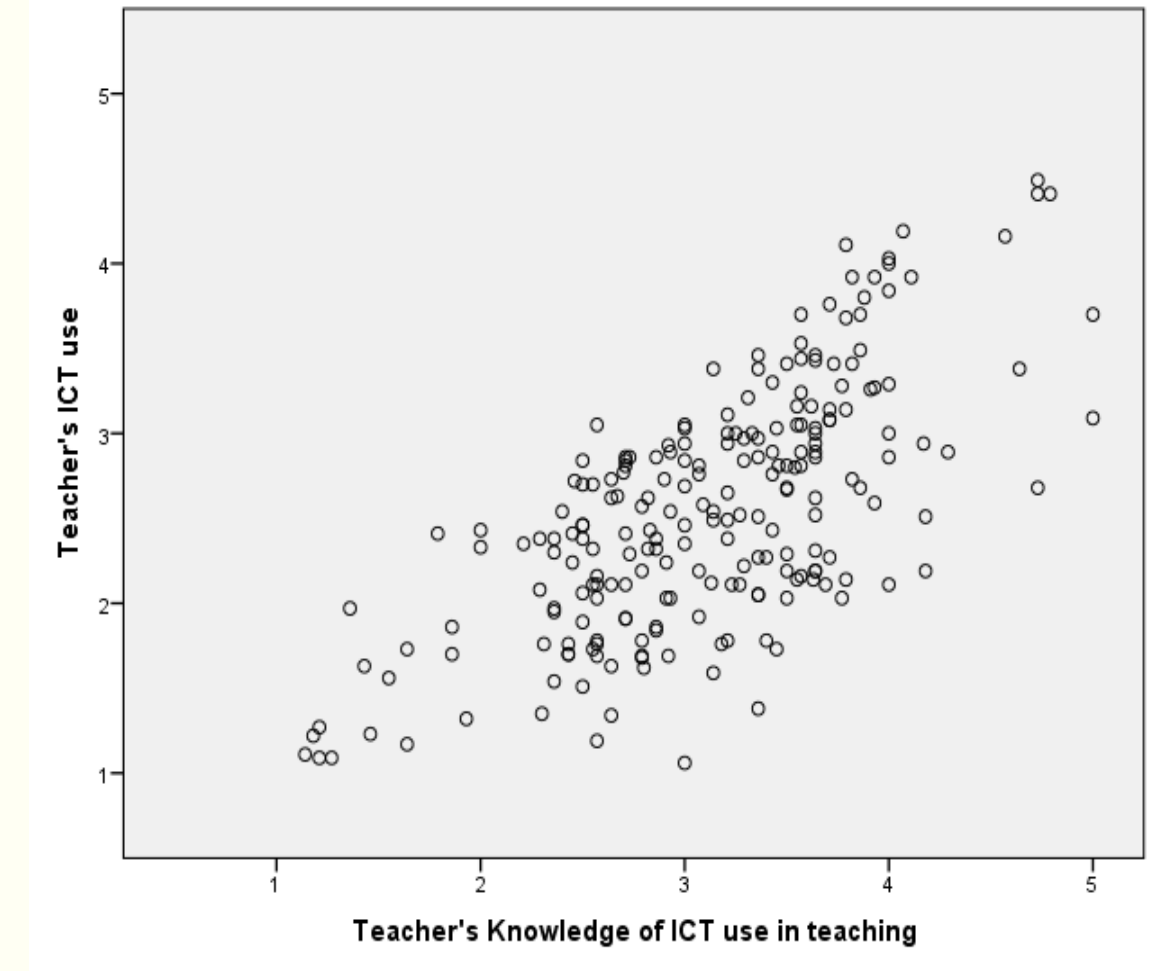

Results- Relationship Between Teachers' Knowledge and Their Classroom Practices in the Use of ICT

Summary of correlation matrix

Variable	ICT use in teaching	Knowledge of ICT	Knowledge of ICT use in teaching
Classroom Practices	1.00		
Knowledge of ICT	.524**	1.00	
Knowledge of ICT use in teaching	.645**	.666**	1.00

Results- Relationship Between Teachers' Knowledge and Their Classroom Practices in the Use of ICT (Observation and Interview)

Parts	Level of Knowledge (Quantitative)		Lesson Observed	Classroom Practices		
	K of ICT	K of ICT use		Classroom Level	Subject Level	Task Level
Rina	4.68 (high)	4.9 (high)	Transformation geometry (Reflection)	Change classroom didactic contract, Change classroom social dynamics	Rebalance emphasis on skills, concepts and applications, and build metacognition and overview	Explore regularity and variation, and link representation
Mir	3.86 (high)	4.17 (high)	Transformation geometry (Reflection)	Change classroom social dynamics	Rebalance emphasis on skills, concepts and applications, and build metacognition and overview	Explore regularity and variation, and link representation
Anton	2.94 (low)	4.27 (high)	Trigonometry (Graph of trigonometric functions)	Change classroom didactic contract, Change classroom social dynamics	Rebalance emphasis on skills, concepts and applications	Explore regularity and variation, and link representation
Hari	2.64 ((low)	3.64 (high)	Transformation Geometry (Reflection)	Change classroom social dynamics	Rebalance emphasis on skills, concepts and applications, and build metacognition and overview	Explore regularity and variation, and link representation
Alfin	3.58 (high)	3.79 (high)	Three-dimensional geometry (the distance between a point and a line segment)	-	-	Learn pen –and- paper skill, explore regularity and variation
Abu	3.63 (high)	3.64 (high)	Differential Calculus	Change classroom social dynamics	-	Learn pen –and- paper skill
Bute	2.18 ((low)	2.91 (low)	Inverse functions	-	-	Learn pen –and- paper skill
Muti	2.15 (low)	2.97 ((low)	Transformation geometry (Translation)	-	-	Learn pen-and- paper skill
Laila	2.18 (low)	3.00 (low)	Transformation Geometry	Change classroom social dynamics	-	Learn pen –and- paper skill
Din	2.23 (low)	2.71 ((low)	Geometry (Circle Equation)	-		Link representation

Conclusion

- To large extent, Indonesian secondary mathematics teachers had insufficient knowledge of both ICT and ICT use in teaching
- The teachers had not yet achieved a high level of ICT use since most of them still used it for an established form of classroom practices.
- The study suggested that both teachers' knowledge of ICT and teachers' knowledge of ICT use in teaching had a positive correlation with teachers' classroom practices using ICT
- It is important to highlight that the relationship between teachers' knowledge of ICT use in teaching and their classroom practices was stronger than the relationship between teachers' knowledge of ICT and their classroom practices
- Along with insufficient knowledge, the teachers also faced other barriers to implementing ICT in the classroom. It revealed that teachers' lack of time to prepare ICT-based lessons was the main barrier

Future Direction

- As the findings of the study showed, integration of ICT has emerged in Indonesia's secondary mathematics classrooms. It needs a further large-scale study to examine impacts of the ICT integration on students' learning experiences and outcomes.
- In relation to teachers' knowledge, the further study needs to employed research instruments that can investigate teachers' actual knowledge through, for example, a task-based interview for specific content on mathematics
- As the finding show Indonesian secondary mathematics teachers, to large extent, do not have sufficient knowledge to integrate ICT in the classroom, it needs further experimental or developmental research to understand how to develop Indonesian secondary mathematics teachers' knowledge in the use of ICT in the classroom.

谢谢

Thank You

Terima Kasih