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EXPLORING THE 21ST CENTURY SKILLS AND SCIENCE TEACHING PEDAGOGY: PROFILES, READINESS, AND BARRIERS

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Abstract. The main objective of this study is to explore the extent of teachers' readiness in anticipating the demands of 21st century skills and science teaching pedagogy practice. A quantitative survey-descriptive method employed in this study. The sample consists of 120 public primary school teachers in Pontianak. A five responses Likert scale questionnaire comprises 37 items was administered. Data were analysed by using descriptive statistical analysis, the independent *t*-test, and the extent of readiness was interpreted according to the interval of the overall average score. Based on data analysis, it is found that the total profile of "never and seldom" teachers' responses is 9.2%, the "often and always" is 20.0%, and "sometimes" is 70.8%. There is no total means score difference between experienced and novice teachers' performance (t = 0.887, p > 0.05). Moreover, the barrier factors the teachers faced in schools could be categorized as professional development, personal, institutional, and technological factor. This study concluded that the readiness of public primary school teachers in Pontianak in implementing the 21st century skills and science teaching pedagogy is an insufficient category. In-service teacher training for ICT integration should be directed toward building teachers' skills and competencies in science pedagogical practices.

Keywords**:** 21st Century Skills; Teachers' Readiness; Science Teaching Pedagogy; Barrier Factors

I. INTRODUCTION

The institution of schooling worldwide faced substantial pressures due to the significant economic, technological, and sociological shifts (Saavedra & Opfer, 2012; Tan et al., 2017) which should be anticipated to evolve and respond to the learning needs and social futures of student lives. Therefore, the purpose of education should not be just to train professional workers or scientists, but also to introduce students to a scientific way of thinking that will make them better citizens (Kwok, 2018). Unfortunately, the education process at all levels of schooling is often seen as abstract and irrelevant to real life. Students are burdened with memorization of facts. A huge amount of students feel that their discipline contents are abstract and cannot relate these materials to the real world. Windschitl (2009) also confirmed that classes often focus on activity rather than sense-making discourse. Besides, teachers rarely press students for explanations, use questioning effectively, and take into account students' prior knowledge.

Teachers must make changes in pedagogy and teaching-learning strategies to align with 21st century learning. Kumar and Chander as cited in Wei & Othman (2017) argued that 21st century pedagogy was (1) problem solving; (2) proficiency in high-level thinking; (3) collaborative; (4) technology; (5) reflection; (6) fostering technological skills, information and media; (7) "Project-based learning" and (8) appraisal as shown in Fig. 1.

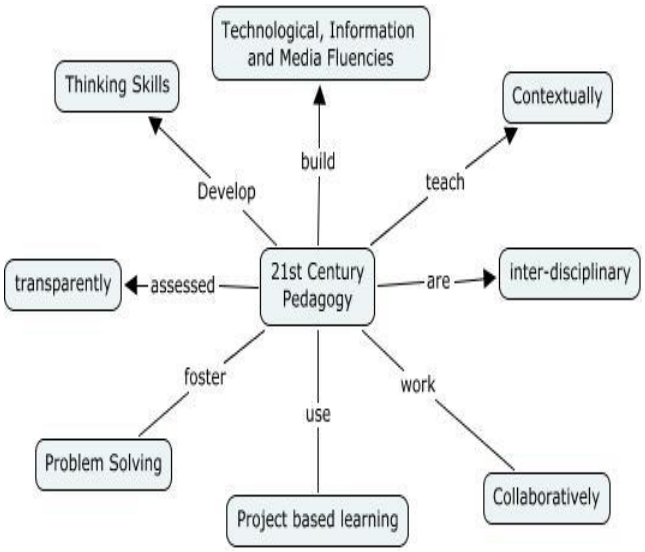

Fig. 1 21st Century Teaching Pedagogy (Kumar and Chander cited in Wei & Othman, 2017)

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Saavedra and Opfer (2012) suggest nine principles to teach 21st century skills and science teaching pedagogy (1) make learning relevant to 'big picture'; (2) teaching with discipline; (3) developing lower and higher thinking skills to encourage understanding in different contexts; (4) encourage the transfer of learning; (5) teach how to learn' or metacognition; (6) correct misunderstanding directly; (7) promoting teamwork; (8) utilizing technology to support learning; and (9) increasing student creativity.

Given the importance of primary teachers having teaching pedagogy 21st century, assessing the readiness teachers have for these skills is at the centre of research. In this context, I referred to Wei & Othman (2017) that confirmed the eight strategies, they are; high order thinking skills, project-based learning, reflection, collaborative skills, authentic assessment, problem-solving, technology, and knowledge construction. It is also based on the rational reasons that various studies show that students are more successful in acquiring new competencies when they intentionally using metacognitive abilities, recognize objectively newly learned concepts, and construct meaningfully that information with the knowledge and skills they already have. The process of relating to new knowledge and accomodating it into the existing conceptual framework will support further learning, and in time will cultivate creativity and originality, develop new cognitive habits, and also improves critical thinking skills (Herring, 2012).

The skills and science teaching pedagogy as mentioned above should be prepared to help students to face the real future needs. Windschitl (2009) argued that preparing teachers competencies in teaching 21st century skills will require many years of coherent teaching, reflection, and continuous professional development experiences that build on one another. The efforts to promote such teaching will require redesigning of many interrelated components of the education system. Tilaar (1999) reminded that if there is an educational policy and effort to improve Indonesian educational quality, those endeavours should be as microscale improvement-based-classrooms that mainly involved teachers, especially in the primary schools. He also argued that educational improvement depends on what teachers do and think.

A primary school teacher is the first formal education influence on young children, making their role pivotal to the development of learning and teaching (Fitzgerald, Dawson, & Hackling, 2013). Research of in-service primary teachers has shown that many feel uncomfortable teaching science or that they are not prepared to teach it due to low self-efficacyin science (Bergman & Morphew, 2015). Research has shown that teachers with low efficacy may avoid teaching science (Velthuis, Fisser, & Pieters, 2014) or using unengaging and didactic approaches (Avery & Meyer, 2012).

Wei & Othman (2017) investigated the practice of 21st century teaching and learning in the five primary schools involved 92 teachers in Kuching, Sarawak. They concluded that the overall average scores of the practice of 21st century teaching and learning of teachers are 3.22 insufficient category. Atik-Kara and Kurum (2007) have researched Turkish elementary school preservice teachers' views and perceptions of 21st teaching pedagogy skills, as mentioned life long learning (LLL) skills. They found the preservice teachers do not have enough knowledge or awareness of LLL. The study found that there are significant differences between male and female candidate teachers' perceptions regarding LLL (Demirel, Sadi, & Dağyar, 2016).

Studies of expertise in implementing teaching pedagogy mostly took the form of novice-expert teacher comparisons. The study conducted by Shohani et al. (2015), for instance, that involved 18 novice and 18 experienced English teachers in Iran using teacher's questionnaire of Likert scale, found that self-efficacy for classroom management have differed, but not in their efficacy for personal teaching and external influences. Based on his study, Firman (2008) concluded; (1) in their teaching, novice and experiences have similar target concepts following chemistry curriculum content; (2) Novice teachers tend to employ more knowledge transmission modes in teaching in which explicit knowledge is told directly to the students; and (3) Novice teachers utilize limited and poor illustrations and analogies after telling the explicit knowledge. As a whole, classes are more passive and deductive. It has been established that experienced teachers differ from novice teachers in their knowledge, skills, and beliefs (Fitzgerald, Dawson, & Hackling, 2013). Therefore, it may be concluded that they also differ from novice teachers in their professional development needs.

Although many educators agreed on the issues essential to improving the teacher teaching quality, however, until now in Indonesia especially in Pontianak, there are only a few empirical studies that assess the elementary teachers' practice to cultivate 21st century students skills and science teaching pedagogy. Further investigations to deeply explore the problems related to teachers' status (experienced and novice) have also never conducted. Besides, the (factors) barriers that enable the teachers to cultivate students' skills compliance with their future needs are far from investigating.

The main problem in this study "What is the extent of readiness of public primary school teachers in Pontianak in implementing the 21st century skills and science teaching pedagogy practice in their teaching-learning processes?". The research questions in this study as follows: (1) What is profiles of teachers' response toward the aspects of the 21st century science teaching pedagogy practice?; (2) Is there a difference in the performance of science teaching pedagogy practice between experienced and novice teacher?; and (3) What are the barriers the teachers faced in implementing the 21st century science teaching pedagogy practice?. The main objective of this study is to explore the extent of teachers' readiness in anticipating the demands of 21st century skills and science teaching pedagogy practice.

II. METHODOLOGY

This study was conducted quantitatively in survey-descriptive method (Creswell, 2008) and surveyed using the questionnaire in public primary schools. The population of this study was a total number of 1,197 teachers that are currently serving in the public primary schools in Pontianak

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District. Random selection was used to select 120 teachers who participated in this study. The questionnaire in this study is modified from the questionnaire developed by Wei and Othman (2017) by adding supporting factors and barriers teachers faced in their daily practice of teaching-learning processes. The questionnaire comprises 37 items aimed at gathering information on the construct in 21st century teaching and learning practices in primary schools consist of (1) high-level thinking skills, (2) project-based learning, (3) reflection, (4) collaborative skills, (5) reflection, (6) project-based learning, (7) assessments, (8) problem solving, and (9) construction of knowledge. This questionnaire uses the Likert Scale which has 5 scales i.e from 1 to 5 to measure teaching and learning in the 21st century. The scale of the scale is like the scale of 1 representing *'Tidak Pernah (TP)*: never', 2 representing *'Jarang (JR)*: seldom', 3 representing *'Kadang-Kadang (KD)*: sometimes', 4 representing *'Sering (SR)*: often' and 5 representing *'Selalu (SL)*: always'. The Cronbach Alpha coefficient reliability of the questionnaire was 0.6. The blueprint of the questionnaire is shown in Table I.

TABLE I
THE ASPECTS OF THE CONSTRUCT OF 21ST SCIENCE TEACHING PEDAGOGY AND THEIR CRONBACH ALPHA RELIABILITY COEFFICIENTS

Aspects	Items	Number of Items	Coeff.of Reliability
High level thinking skills (HOTs)	1, 2, 3, 4, 5	5	.66
Project-based learning	6, 7, 8, 9	4	.77
Reflection	10, 11, 12, 13	4	.73
Collaborative skills	14, 15, 16, 17	5	.74
Assessments	19, 20, 21, 22, 23, 24	6	.69
Problem solving	25, 26, 27, 28,29	5	.61
Technology	30, 31, 32 ,33	5	.66
Construction of skills	34, 35, 36, 37	4	.67
Total		**37**	**.69**

Descriptive statistical analysis is used to make frequency, mean, percentage and standard deviation of teachers' teaching and learning practices. The independent *t*-test is used to determine the significant difference in terms of veteran (serving time more than 10 years) versus novice teacher (serving time less than 10 years). The extent of readiness was interpreted according to the interval of the overall average score i.e low, sufficient, and high category as shown in Table II.

TABLE II
THE EXTENT OF READINESS OF 21ST CENTURY SCIENCE PEDAGOGY PRACTICE

Mean Score Interval	The Extent of Readiness
1.00 – 2.33	Low
2.34 – 3.67	Sufficient
3.68 – 5.00	High

III. RESULTS AND DISCUSSION

A. *Results*

1) *Profiles of Teachers Responses to the Aspects of 21st Century Skills and Science Teaching Pedagogy Practice*

Profiles of teachers' responses to the aspects of 21st century skills and science teaching pedagogy practice are depicted respectively in Table III until X as shown in Table III.

TABLE III
PROFILES OF TEACHERS' RESPONSES ON THE ASPECT OF HIGHER ORDER THINKING SKILLS (HOTS)

No	Higher Order Thinking Skills (HOTS)	TP (%)	JR (%)	KD (%)	SR (%)	SL (%)
1	Plan to use high-level thinking skills when interacting with students in science class	5 (4,2)	10 (8.3)	75 (63.5)	16 (13.3)	14 (11,7)
2	Use high questions when interacting in science class	8 (6.7)	10 (8.3)	69 (57.5)	25 (20.8)	8 (6.7)
3	Guide students to answer high-level questions	10 (8.3)	10 (8.3)	46 (38,3)	41 (34.2)	13 (10.8)
4	Use tools/media that can stimulate HOTS	7 (5.8)	15 (12.5)	36 (30.0)	52 (43.3)	10 (8.3)
5	Teach high-level thinking skills in science class	8 (6.7)	9 (7.5)	47 (39.2)	46 (38.3)	10 (8.3)

Note: *TP = Never; JR= Seldom; KD = Sometimes; SR = Often; SL = Always*

From Table III, it is found that the profile of teachers' performances according to their responses toward the aspect of Higher Order Thinking Skills (HOTS) regarding the "never and seldom" responses (average is 9.2%) is less than the percentages of "often and always" (average is 23.5%).

From Table IV, it is found that the profile of teachers' performances according to their responses toward the aspect of Problem Based Learning regarding the "never and seldom" responses (average is 11.4%) is less than the percentages of "often and always" (average is 15%).

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TABLE IV
PROFILES OF TEACHERS' RESPONSES ON THE ASPECT OF PROBLEM-BASED LEARNING (PBL)

No	Problem Based Learning	TP (%)	JR (%)	KD (%)	SR (%)	SL (%)
6	Provide assignments based on PBL to students	8 (6.7)	12 (12.0)	51 (42.5)	23 (19.2)	8 (6.7)
7	Encourage students to work together on projects	9 (7.5)	11 (9.2)	72 (60.0)	18 (15.0)	10 (8.3)
8	Ensure students' tasks use multi-disciplinary approaches and skills (some lessons)	6 (5.0)	11 (9.2)	73 (60.8)	25 (20.8)	5 (4.2)
9	Encourage students to apply the right technology when implementing PBL	11 (9.2)	23 (19.2)	55 (45.8)	16 (13.3)	15 (12.5)

Note: *TP = Never; JR= Seldom; KD = Sometimes; SR = Often; SL = Always*

From Table V, it is found that the profile of teachers' performances according to their responses toward the aspect of Reflection regarding the "never and seldom" responses (average is 13.5%) is less than the percentages of "often and always" (average is 14.4%).

TABLE V
PROFILES OF TEACHERS' RESPONSES ON THE ASPECT OF REFLECTION

No	Reflection	TP (%)	JR (%)	KD (%)	SR (%)	SL (%)
10	Guide students to write reflections correctly and effectively to improve learning	15 (12.5)	23 (19.2)	59 (49.2)	18 (15.0)	5 (4.2)
11	Encourage students to make self-reflection after teaching and learning sessions	18 (15.0)	10 (8.3)	63 (52.5)	17 (14.2)	10 (8.3)
12	Get feedback from colleagues in teaching and learning sessions	6 (5.0)	11 (9.2)	63 (52.5)	25 (20.8)	15 (12.5)
13	Write feedback from peers	8 (6.7)	17 (14.2)	70 (58.3)	16 (13.3)	9 (7.5)

Note: *TP = Never; JR= Seldom; KD = Sometimes; SR = Often; SL = Always*

From Table VI, it is found that the profile of teachers' performances according to their responses toward the aspect of Collaborative Skills regarding the "never and seldom" responses (average is 11.9%) is less than the percentages of "often and always" (average is 21.0%).

TABLE VI
PROFILES OF TEACHERS' RESPONSES ON THE ASPECT OF COLLABORATIVE SKILLS

No	Collaborative Skills	TP (%)	JR (%)	KD (%)	SR (%)	SL (%)
14	Collaborate with colleagues to develop professional learning groups	4 (3.3)	15 (12.5)	54 (45.0)	28 (23.3)	19 (15.8)
15	Encourage students to use various social media to interact	10 (8.3)	19 (15.8)	61 (50.8)	21 (17.5)	9 (7.5)
16	Apply Lesson Study to increase professionalism in teaching	11 (9.2)	21 (17.5)	43 (35.8)	35 (29.2)	10 (8.3)
17	Use effective communication skills	4 (3.3)	11 (9.2)	59 (49.2)	33 (27.5)	13 (10.8)

Note: *TP = Never; JR= Seldom; KD = Sometimes; SR = Often; SL = Always*

From Table VII, it is found that the profile of teachers' performances according to their responses toward the aspect of Assessment regarding the "never and seldom" responses (average is 9.9%) is less than the percentages of "often and always" (average is 21,4%).

From Table VIII, it is found that the profile of teachers' performances according to their responses toward the aspect of Problem Solving regarding the "never and seldom" responses (average is 9.0%) is less than the percentages of "often and always" (average is 21.3%).

From Table IX, it is found that the profile of teachers' performances according to their responses toward the aspect of Technology regarding the "never and seldom" responses (average is 8.8%) is less than the percentages of "often and always" (average is 21,4%).

From Table X, it is found that the profile of teachers' performances according to their responses toward the aspect of Construction of Skills regarding the "never and seldom" responses (average is 11.6%) is less than the percentages of "often and always" (average is 22.1%).

From Table III until Table X, it is found that the profiles of teachers' responses to the entire (eight) aspects of the 21st century skills and science teaching pedagogy practice regarding the "never and seldom" responses is 9.2%, the "often and always" response is 20.0%, and the rest "sometimes" response is 70.8%. It means that most public elementary school teachers in Pontianak District had

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sometimes employed the 21st century skills and science teaching pedagogy practice in their classrooms.

TABLE VII
PROFILES OF TEACHERS' RESPONSES ON THE ASPECT OF ASSESSMENT

No	Assessment	TP (%)	JR (%)	KD (%)	SR (%)	SL (%)
18	Use a collaborative approach in the teaching and learning process	8 (6.7)	10 (8.3)	69 (57.5)	25 (20.8)	8 (6.7)
19	Make judgments based on student work results (authentic assessment)	10 (8.3)	8 (6.7)	70 (58.3)	22 (18.3)	10 (8.3)
20	Focus on assessment based on high-level thinking	9 (7.5)	17 (14.2)	50 (41.2)	41 (34.2)	3 (2.5)
21	Encourage students to judge themselves	7 (5.8)	15 (12.5)	36 (30.0)	52 43.3)	10 (8.3)
22	Encourage students to conduct peer assessments	5 (4.2)	10 (8.3)	75 (62.5)	16 (13.3)	14 (11.7)
23	Assess the abilities or achievements of students	5 (4.2)	15 (12.5)	56 (46.6)	32 (26.6)	12 (10)
24	Provide direct feedback on student work	10 (8.3)	10 (8.3)	46 (38.3)	41 (34.2)	13 (10.8)

Note: *TP = Never; JR= Seldom; KD = Sometimes; SR = Often; SL = Always*

TABLE VIII
PROFILES OF TEACHERS' RESPONSES ON THE ASPECT OF PROBLEM-SOLVING

No	Problem-Solving	TP (%)	JR (%)	KD (%)	SR (%)	SL (%)
25	Practice teaching through a problem-solving approach	4 (3.3)	11 (9.2)	70 (58.3)	21 (17.3)	14 (11.7)
26	Link topics taught with everyday life problems	5 (4.2)	15 (12.5)	59 (49.2)	35 (29.2)	8 (6.7)
27	Encourage/invite students to use various problem solving strategies	9 (7.5)	11 (9.2)	56 (46.6)	34 (28.3)	10 (8.3)
28	Ensure that the problems given are related to daily life	6 (5.0)	17 (14.2)	35 (29.2)	50 (42.6)	12 (10.0)
29	Use science teaching methods that use ICT, are not always traditional	7 (5.8)	15 (12.5)	46 (38.3)	43 (35.8)	9 (5.8)

Note: *TP = Never; JR= Seldom; KD = Sometimes; SR = Often; SL = Always*

TABLE IX
PROFILES OF TEACHERS' RESPONSES ON THE ASPECT OF TECHNOLOGY

No	Technology	TP (%)	JR (%)	KD (%)	SR (%)	SL (%)
30	Encourage students to use appropriate techno-logy to prepare for learning/training	6 (5.0)	9 (7.5)	65 (54.2)	30 (25.0)	10 (8.3)
31	Encourage students to use social media to interact	10 (8.3)	8 (6.7)	70 (58.3)	22 (18.3)	10 (8.3)
32	Use software that is suitable and easy to use while interacting	5 (4.2)	15 (12.5)	56 (46.6)	32 (26.6)	12 (10)
33	Use online learning, such as; e-books, e-videos, e-learning	7 (5.8)	12 (10)	46 (38.3)	44 (36.6)	11 (9.2)

Note: *TP = Never; JR= Seldom; KD = Sometimes; SR = Often; SL = Always*

TABLE X
PROFILES OF TEACHERS' RESPONSES ON THE ASPECT OF CONSTRUCTION OF SKILLS

No	Construction of Skills	TP (%)	JR (%)	KD (%)	SR (%)	SL (%)
34	Familiarize students with information-based skills (from Journals, TV, Internet, etc.)	10 (8.3)	15 (12.5)	65 (54.2)	22 (18.3)	8 (6.7)
35	Familiarize students with using media-based skills and learning aids	10 (8.3)	12 (10.0)	59 (49.2)	31 (25.8)	8 (6.7)
36	Familiarize students with technology-based skills (e.g. tools/machines)	9 (7.5)	17 (14.2)	50 (41.2)	41 (34.2)	3 (2.5)
37	Get students to use reflection-based skills to improve teachers and themselves	7 (5.8)	13 (10.8)	36 (30.0)	54 (45.0)	10 (8.3)

Note: *TP = Never; JR= Seldom; KD = Sometimes; SR = Often; SL = Always*

Furthermore, based on the teachers' responses on the Likert Scale as depicted in Table III until X, it is also found that means of teachers' performance on 21st century science

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teaching pedagogy practices and its interpretation as shown in Table XI.

TABLE XI
MEANS OF TEACHERS' PERFORMANCE ON 21ST CENTURY SCIENCE TEACHING PEDAGOGY PRACTICES

Aspects	Mean	SD	Interpretation
High Order Thinking Skill	3.37	.84	Sufficient
Problem-Based Project	3.50	.78	Sufficient
Reflection	3.46	.82	Sufficient
Collaborative Skills	3.75	.69	High
Assessment	4.03	.58	High
Problem Solving	4.06	.68	High
Technology	3.15	1.10	Sufficient
Construction of Skills	3.40	.88	Sufficient
Total	**3.58**	**.57**	**Sufficient**

Based on Table XI, it also found that the overall performance means scores of 21st century skills and teaching pedagogy practice in science learning is 3.58 insufficient category.

2) The Difference between Experienced and Novice Teachers' Practice of 21st Century Science Teaching Pedagogy Practice

The difference in performance means scores of 21st century skills and teaching pedagogy practice in science learning between experienced and novice teachers are shown in Table XII.

TABLE XII
MEANS SCORE OF TEACHERS' PERFORMANCES

Aspects	Means		M.D	*t*	Sig.
	Exp	Nov			
High Order Thinking Skill	3.54	3.20	.34	1.828	.070
Problem-Based Project	3.32	3.69	-.37	-2.177	.031*
Reflection	3.45	3.46	-.01	-.071	.944
Collaborative Skills	3.82	3.68	.14	.865	.389
Assessment	4.01	4.05	-.04	-.321	.749
Problem Solving	4.10	4.03	.07	.483	.630
Technology	3.38	2.94	.44	1.787	.076
Construction of Skills	3.16	3.64	-.48	1.809	.073
Total	**3.64**	**3.53**	**.11**	**.887**	**.377**

Note: *Exp = Experienced;Nov = Novice ;MD =Mean Difference*
** Significant at 0.05 level*

Based on Table XII, the research findings as follows:

a. There is no significant difference between experienced and novice teachers' performance of 21st skills and science teaching pedagogy practice regarding the aspect of high order thinking skills ($p > .05$).
b. There is a significant difference between experienced and novice teachers' performance of 21st skills and science teaching pedagogy practice regarding the aspect of the problem-based project ($p < .05$).
c. There is no significant difference between experienced and novice teachers' performance of 21st skills and science teaching pedagogy practice regarding the aspect of reflection ($p > .05$).
d. There is no significant difference between experienced and novice teachers' performance of 21st skills and science teaching pedagogy practice regarding the aspect of collaborative skills ($p > .05$).
e. There is no significant difference between experienced and novice teachers' performance of 21st skills and science teaching pedagogy practice regarding the aspect of assessment ($p > .05$).
f. There is no significant difference between experienced and novice teachers' performance of 21st skills and science teaching pedagogy practice regarding the aspect of problem-solving ($p > .05$).
g. There is no significant difference between experienced and novice teachers' performance of 21st skills and science teaching pedagogy practice regarding the aspect of technology ($p > .05$).
h. There is no significant difference between experienced and novice teachers' performance of 21st skills and science teaching pedagogy practice regarding the aspect of knowledge/skills construction ($p > .05$).
i. It is concluded that there is no significant difference between experienced and novice teachers' performance of 21st skills and science teaching pedagogy practice ($p > .05$).

3) The Barriers in Implementing Students' Skills of 21st Century Science Teaching Pedagogy Practice

Based on teachers' responses to the research questionnaire. the several dominant factors regarded by most elementary school teachers in Pontianak as barriers in cultivating the students' skills in the 21st century in the classroom science teaching pedagogy in this study are:

a. Most (more than 70%) of teachers declared that they had seldom participated in the continuous professional development training, especially in cultivating students skills for anticipating the 21st century.
b. Most (more than 60%) of teachers stated honestly that they don't comprehensively know or comprehend what and how to promote student's skills for anticipating the 21st century in their teaching-learning process.
c. All (100%) of teachers in public elementary schools in Pontianak has a compulsory workload are more than 24 hours a week. Most teachers have to earn some money to support family-economical demands after teaching in their schools.
d. Most (more than 50%) of teachers argued that higher-order thinking skills are not appropriate to develop to elementary school students in the lower classes. especially for first. second and third-grade students.
e. Most (more than 90%) of elementary school teachers in Pontianak are limited technological resources i.e. LCD, computer, science laboratory. Besides, environmental factors such as availability of electricity and classroom settings as other factors determining the technology uptake by teachers.

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f. Most (more than 50%) of teachers, especially veteran teachers, could not operate well the programs available on the computers. They lack the use of ICT to support their tasks and learning in schools.

B. Discussion

This study concluded that the readiness of public primary school teachers in Pontianak in implementing the 21st century skills and science teaching pedagogy practice is an insufficient category. The finding is consistent with Wei & Othman (2017) study that revealed the overall average scores the practice of 21st century teaching and learning in the five primary schools involved 92 teachers in Kuching. Sarawak is 3.22 (insufficient category).

In compliance with teachers' readiness in implementing educational innovations, Rogan and Mosha (DeSimone et al., 2002) argued that the effectiveness of the teacher depends on her competence (academically and pedagogically), efficiency (ability, workload, and commitment), teaching and learning resources and methods, and support from education administrators and supervisors. Teacher professional development programs seem to provide opportunities for teachers to look for new roles, develop new instructional techniques, and improve themselves both as educators and as individuals. In Gender's (Yadov, 2011) view, professional development includes formal experiences such as attending workshops, participating in professional meetings, and mentoring and informal experiences such as reading professional publications, watching television documentaries related to an academic discipline.

Garba, Byabazaire, and Busthami (2015) confirmed that six skills should be cultivated by teachers in schools for anticipating the twenty-first century. First, critical thinking skills and the ability to solve problems. The point is critical thinking is to apply rational, high thinking activities, which include analyzing activities, synthesizing, regarding problems and their solutions, concluding and evaluating. Or in short, think about solving problems to get better. Second, the skills to cooperate and communicate well. The purpose of communication is that we can interact with all human beings in this world.

Third, skills of creative thinking and developing imagination. Teachers must be able to lure students to think creatively in all fields in the world of education. Every student has different abilities. the teacher must be able to grow every creativity of all students. It has high creativity and Imagination that will succeed and dominate the world today. Fourth, ability or skill to be able to understand and use information from various sources to be displayed on the internet or often known as digital literacy. Based on UNESCO records, digital literacy is the ability to access news sources and critically evaluate and create information through digital technology. Through digital literacy. a person cannot only operate technological equipment but also must have other abilities. Fifth, competence or ability to develop or assess the potential of students or often known as student leadership and personal development. The teacher must be able to understand the potential of each student and develop that potential. Every child has different potential, the teacher must be able to increase self-confidence in students in developing their potential. Sixth, the skills to become citizens who are good or often known as citizenship. The progress of technology and information in the 21st century will reduce nationalist feelings. Therefore. the teacher must give the doctrine to students to be good citizens by contributing to building the country to participate in the welfare of society. If a country is in crisis, many problems will arise.

According to Saavedra and Opfer (2012), the 21st century skills and pedagogy in the science of learning can be distilled into nine points that can address new learning needs, are: (1) Make the curriculum relevant. To be effective, any curriculum must be relevant to students' lives; (2) Teach through the disciplines. Learning through disciplines entails learning not only the knowledge of the discipline but also the skills associated with the production of knowledge within the discipline. Through disciplinary curriculum and instruction students should learn why the discipline is important, how experts create new knowledge, and how they communicate about it; (3) Simultaneously develop lower and higher-order thinking skills. Lower-order exercises are fairly common in existing curricula, while higher-order thinking activities are much less common. Higher-level thinking tends to be difficult for students because it requires them not only to understand the relationship between different variables (lower-order thinking) but also how to apply—or transfer—that understanding to a new, uncharted context (higher-order thinking); (4) Encourage transfer of learning. Students must apply the skills and knowledge they gain in one discipline to another. They must also apply what they learn in school to other areas of their lives. This application—or transfer—can be challenging for students (and for adults as well); (5) Teach students to learn how to learn. There is a limit to the skills, attitudes, and dispositions that students can learn through formal schooling. Therefore, educating them for the 21st century requires teaching them how to learn on their own. To do so, students need to be aware of how they learn. Teachers can develop students' metacognitive capacity by encouraging them to explicitly examine how they think, it is also important for students to develop positive mental models about how we learn, the limits of our learning. and indications of failure; (6) Address misunderstandings directly. Learners have many misunderstandings about how the world works, and they hold onto these misconceptions until they have the opportunity to build alternative explanations based on experience. To overcome misconceptions, learners of any age need to actively construct new understandings; (7) Promote teamwork as a process and outcome. Students can discuss concepts in pairs or groups and share what they understand with the rest of the class. They can develop arguments and debate them; (8) Make full use of technology to support learning. Technology offers the potential to provide students with new ways to develop their problem solving, critical thinking, and communication skills, transfer them to different contexts, reflect on their thinking and that

of their peers, practice addressing their misunderstandings, and collaborate with peers—all on topics relevant to their lives and using engaging tools; (9) Foster students' creativity. Like intelligence and learning capacity, creativity is not a fixed characteristic that people either have or do not have. Rather, it is incremental, such that students can learn to be more creative. In contrast to the common misconception that the way to develop creativity is through uncontrolled. Creative development requires structure and intentionality from both teachers and students and can be learned through the disciplines.

The second question of the study attempted to analyze the differences between novice and experienced teachers' in cultivating the 21st century students' skills and science teaching pedagogy practice. This study found that there is no significant difference between experienced and novice teachers' performance of the aspects explored in this study of 21st skills and science teaching pedagogy practice, except in the aspect of "problem-based project learning".

Novice teachers are defined as those with little or no mastery teaching pedagogy experience. However, there is no determination of the status novice or experienced teacher in terms of years of teaching experience (Gatbonton, as cited Mahmoudi and Özkana, 2015). In this study, the author refers to a teacher who serves less than 10 (ten) years of teaching experience as a novice and more as an experienced teacher.

Studies of expertise in teaching mostly took the form of novice-expert comparisons. Firman (2008), for instance, concluded: (1) in their teaching. novice and experiences have similar target concepts following chemistry curriculum content; (2) Novice teachers tend to employ more knowledge transmission modes in teaching in which explicit knowledge is told directly to the students.; and (3) Novice teachers utilize limited and poor illustrations and analogies after telling the explicit knowledge. As a whole, classes are more passive and deductive; (4) Expert teachers tend to employ transformation modes in teaching, in which concrete representations are exposed to provide a concrete basis for the students to construct their knowledge on their own. Classes are more active and inductive; (5) Expert teachers utilize demonstrations. Lab activities, pictorial and verbal analogies and illustrations more intensively to make content knowledge understandable for the students. The survey conducted by Melnick and Meister (2008) concluded that there is no difference in academic preparation and time management between novice and experienced teacher. But they differ in classroom management and parent interaction.

Shohani et al. (2015) described 13 differences between the way novice and expert teachers can be interpreted as behaviours and the cognitive thought processes that underlie each one as follows: (1) While planning, expert teachers consistently connect curriculum with goals. Experts were found to plan long-term and (were) cognizant of the relationship between daily objectives and the overall curriculum, while novices tended to focus on short-term planning; (2) Experts teach with their gut and trust their "teacher voice". Novices were found to mentally script each section of their lesson, from the questions posed to students to the examples that could be used as concept reinforcements. Experts were found to plan more strategies to teach a specific skill than novices and to implement their lesson largely unrehearsed before the instructional period; (3) Novices plan activities that take a significant amount of time. Experts make more transitions among teaching activities than did novices; (4) Experts have perfected student questioning and informal assessment. Experts were more efficient in probing for student understandings than novice; (5) Experts implement lessons with the built-in and expected structure. Experts made greater use of guided and monitored practice routines to increase student comprehension as compared with novices; (6) Novice teachers have yet to develop analogies or examples. Experts were able to employ a variety of alternative explanations whereas this ability (was) unattainable by novices; (7) Expert teachers assess lessons at the individual level. Experts focused on individual student achievement and adapted their lesson accordingly while novices primarily used the interest level of the class as the cue for altering a lesson; (8) When reflecting, novice teachers assess lessons based on their behaviour and performance. The expert teacher was concerned with individual student understanding and achievement while novices were egocentric, and predominantly reflected primarily on their teaching behaviours; (9) Novice teachers have not yet mastered their management techniques. Experts are more likely to identify and subsequently solve management problems in the classroom using external controls (e.g. change seating assignments) whereas the novice teacher tends to be unaware or in some instances, ignore classroom disruptions; (10) Expert teaches are more astute in their teaching environment. Expert teachers were able to articulate in greater detail and accuracy as to events occurring in the classroom whereas novices, in contrast, generically described the same occurrences; (11) Expert teachers have eyes in the back of their head. Expert teachers are capable of scanning an entire room simultaneously to better understand how classroom events are unfolding while novices and advanced beginners tend to focus their attention on only one area of the room; (12) Novice teachers believe that learning is correlated with their performance and behaviour rather than the student. Expert teachers tend to focus on student learning and achievement when asked to recall and reflect upon a teaching lesson by elaborating on the organization and management of the lesson, emphasizing both student and teacher behaviours. Novices, in contrast, placed greater weight on their performance, specifically to student misbehaviours encountered rather than the effectiveness of the learning environment; (13) Expert teachers understand that the key to learning is connecting content to prior knowledge. Expert teachers tend to use multiple strategies to assess students' mental schemas before introducing new information. This new content is then linked with prior knowledge and the assessment of student understanding occurs throughout the entire instructional period. Novices were found to teach in a manner where these important connections between prior and new knowledge are

not emphasized and where flexibility and adaptability are less prevalent within the classroom environment as compared to experts.

Richards and Farrell (2005) as cited by Mahmoudi and Özkana (2015) also distinguished experienced teachers from novice teachers according to some characteristics that they share. They say that experienced teachers have: (1) a rich and elaborate knowledge base; (2) ability to integrate and use different kinds of knowledge; (3) ability to make intuitive judgments based on experience, desire to investigate and solve a wide range of teaching problems; (4) a deeper understanding of students' needs and student learning; (5) awareness of instructional objectives to support teaching; (6) better understanding and use of language learning strategies; (7) greater awareness of the learning context; (8) greater fluidity and automaticity in teaching.

The third question of the study attempted to explore the factors regarded by most elementary school teachers in Pontianak as barriers in cultivating the students' skills in the 21st century in the classroom science teaching pedagogy practice. According to DeSimone et al. (2002), factors that could affect a teacher in implementing teaching pedagogy practice could be categorized as (1) professional development factors; (2) personal factors; (3) institutional factors; and (4) technological factors. These factors will be referred to in this investigation.

First, Professional development factors. During the training program, preservice and in service, the teachers' received values, theories of learning, model of teaching, professional development programs, and the opportunity for managing effective learning. Training design factors which include the incorporation of the learning principles, the sequence of training materials and the job relevance of the training content, level of satisfaction with the knowledge, skills and abilities have a strong influence on the interest of the teachers to implement the science teaching pedagogy in the classroom. For a successful professional development program, teachers need to be involved in determining their learning needs and participate in school-based learning opportunities, continuously supported, information-rich, and facilitating theoretical understanding and collaborative problem-solving.

Second, Personal factors. These are all factors related to the individual teacher, such as knowledge and skills. Beliefs, time availability and engagement in the use of technology in teaching. Some of them, for instance, argued that higher-order thinking skills are not appropriate to develop to elementary school students in the lower classes, especially for first, second, and third-grade students. Limited time due to the high workload of teaching including administrative tasks is also regarded as barrier factors. All teachers in public elementary schools in Pontianak has a compulsory workload are more than 24 hours a week. Meantime, more than 50% of teachers are veteran teachers who cannot operate computers.

Third, Institutional factors. The system of the school consists of administration through motivation; rewards, incentives and financial support to teachers, support from peers, participation in decision making, and availability of technological tools are factors that influenced the teachers' practice in the 21st century teaching pedagogy. Most (more than 75%) elementary school teachers in Pontianak are limited technological resources. Besides, environmental factors such as availability of electricity and classroom settings as other factors determining the technology uptake by teachers. Fourth, Technological factors. Two technological factors that affect continuous use of technology are: ease of use and effectiveness, ease of use refers to the convenience, adequacy, reliability, and user friendly of the technology, whereas effectiveness refers to the likelihood of the long tangible benefits for the institution, improved learning and communication. Related to the two factors, most teachers, especially veteran teachers, could not operate well the program available on the computers. They lack the use of technology to support their learning.

IV. Conclusions

This study concluded that the readiness of public primary school teachers in Pontianak in implementing the 21st century skills and science teaching pedagogy is an insufficient category. The profile of teachers' responses towards the aspects of science teaching pedagogy practice is in vary. However, experienced and novice teachers' performance of the practice is not significantly different. Besides, the barrier factors could be categorized as professional development, personal, institutional, and technological factor. In-service teacher training for ICT integration has to be directed toward building teachers skills and competence in applying the science teaching pedagogy. Further researchers can consider undertaking new studies that can help in building a new approach for in-service teacher training.

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