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Research Article

IN-SERVICE SCIENCE TEACHERS' SELF EFFICACY IN TEACHING SCIENTIFIC INQUIRY: A CASE IN SRI LANKA

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ABSTRACT

As a part of larger study aimed at investigating predictors of science teacher self-efficacy for teaching scientific inquiry in the classroom, this study has three objectives (a) describe teachers' extant practices of constructive alignment in teaching scientific inquiry ;(b) investigate the teachers' perceived self-efficacy in teaching scientific inquiry and (c) examine the impact of teachers' perceived self-efficacy on practices of constructive alignment in teaching scientific inquiry. A questionnaire was used for data collection from 193 science teachers at state schools in a larger urban school district in Sri Lanka. A General Linear Model (GLM) Univariate analysis using SPSS 21.00 programme was used for data analysis. Fact findings revealed that the enactment of scientific inquiry was satisfactory among the respondents, however, it looks more towards "scripted approach to inquiry in terms of learning outcomes, teaching learning activities and assessment tasks of scientific inquiry. The teachers' perceived self- efficacy in student engagement was lower than that of classroom management and instructional strategies associated with inquiry-based teaching. It also reported only area of certification for teaching science, teacher self-efficacy in student engagement and self-efficacy in instructional strategies were significant predictors of perceived use of scientific inquiry. No statistically significant differences in use rates of scientific inquiry were found either by gender or education level. The implications and suggestions for future research are also included.

INTRODUCTION

There is an increasing consensus that science teaching should be based on an inquiry learning approach with a focus on developing understanding about scientific inquiry instead of only focusing on the traditional subject matter (Anderson, 2007; Ledermen *et al*., 2014; Mant *et al*., 2007; Slavin *et al*.,2014). Learning and teaching science as inquiry requires not only grasping scientific information, but also developing fundamental understandings and abilities to conduct scientific inquiry (NRC, 1996, 2000). According to recent meta analyzes (Furtak *et al*., 2012; Lazonder & Harmen, 2016), it is evident on the effectiveness of inquiry learning in contrast to a traditional teacher- centered deductive approach. In the past three decades, several initiatives have been taken to reform the teaching and learning of science in Sri Lankan schools on this valuable instructional approach (Athurupana *et al*., 2011). Despite such reforms, researchers noted that enactment of scientific inquiry in most of Sri Lankan classrooms at all levels are much less, instead, characterized by expository methods (Helen, 1987; Karandawala, 2004; Karunasena, 1994; Seneviratne, 2009; 2014). This finding is also in line with previous studies in non Sri Lankan context(Capps & Crawford, 2013a) Among the many factors simultaneously affecting this gap, science teacher's receptivity to inquiry based instruction is predominant which is in turn closely associated with teacher self-efficacy. Teacher self-efficacy is teachers' own beliefs of their abilities to teach to reach desired educational outcomes (Shaalvik & Shaalvik, 2007).

Teacher efficacy is a powerful predictor of teacher's instructional behavior, especially in scientific inquiry as teaching with inquiry is a relatively complex and demanding activity. It is critical to understand the predictors that can potentially enhance self-efficacy of practicing science teachers. Thus, the careful consideration of teacher self-efficacy may be particularly important for programs or interventions intended to enhance or change science teaching practices. Teacher self-

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efficacy in terms of student engagement, classroom management and instructional strategies have been specifically focused in many studies recently.

Several studies have illustrated a relationship between science teachers' self-efficacy and teachers' enactment of scientific inquiry in the classroom (Appleton, 2007; Narayan & Lamp, 2010; Slim *et al*., 2017; Tschannen-Moran & Hoy, 2001; Voet& de Wever, 2017; Weiss *et al*., 2003). Thus, teacher self-efficacy with regard to its determinants have been the focus of many studies as it has significant implications especially in enabling teachers to engage in reform oriented instructional practices such as be inquiry-based teaching. Yet, its applications in Sri Lankan schools is lacking, more importantly in science education context.

The aim of this study is to investigate science teachers' self-efficacy towards extant practices in teaching scientific inquiry. It also attempts to examine the association among teachers 'demographic factors (gender, education level, area of certification) perceived self-efficacy and perceived practices of constructive alignment in teaching scientific inquiry.

The connection between beliefs, learning, and teaching performance can be captured by the psychological construct of self-efficacy (Bandura, 1977). Evidences across studies have consistently shown that an individual's perceived self-efficacy contributes significantly to the level of his or her motivation and performance accomplishments (Bandura, 1977;1997).This cross sectional study of how science teacher enact the constructive alignment in teaching scientific inquiry and also self–efficacy beliefs towards such enactment of scientific inquiry is of great important in reorienting teacher education programmes for teaching scientific inquiry integrating self-efficacy sources. This study will contribute to the body of knowledge on teacher self–efficacy by tracking individuals from their in–service education through consecutive years of teaching. Additionally, this study investigates the changes in the three domains of self -efficacy (student engagement, instructional strategies, and classroom management) as identified by Tschannen–Moran and Woolfolk Hoy (2001).Such fact findings would be of important in reorienting the form and structure of the professional development efforts.

MATERIALS AND METHODS

Objectives

The purpose of the current cross-sectional study was to determine the impact of teachers' perceived self-efficacy on the actual practice of scientific inquiry in science teaching in the classroom. The following research objectives guided the study:

1. Describe teachers' extant practices of in teaching scientific inquiry by gender, education level and area of certification
2. Investigate the teachers' perceived self-efficacy in teaching scientific inquiry by gender, education level and area of certification
3. Examine the association among teachers' gender, education level, area of certification, perceived self-efficacy and practices in teaching scientific inquiry

Thus, the hypothesis tested out in the study was as follows:

H1: Science teachers' extant practices of in teaching scientific inquiry differs by gender, education level and area of certification

H2: Science teachers' perceived self-efficacy for enactment of scientific inquiry differs by gender, education level and area of certification

H3: There is an association among teachers' gender, education level, area of certification, perceived self-efficacy and practices in teaching scientific inquiry.

Participants

A stratified random sample of 193 science teachers participated in this study. The in-service science teachers comprised of 38 males (19.7%) and 155 females (80.3%) from state schools in Colombo South and Borella divisions of Colombo district of Sri Lanka. By education level, the sample represented 53 degree holders (27.5%) and 140 were non degree holders which is of 72.5 percent. With regards to area of certification of the respondents,71(36.8%) teachers with National Diploma in Education, 81 teachers with postgraduate qualifications and 41(21.2%) represented in the sample.

Instrumentation

The researcher utilized the Teachers' Sense of Efficacy Scale or TSES (Tschannen–Moran *et al*., 1998; Tschannen–Moran & Woolfolk Hoy, 2001) to assess the teacher self–efficacy of the science teachers. The instrument asked participants to rate their capabilities; "How much can you. . ." utilizing the following anchored scale: 1 = Nothing, 2 = Very Little, 3 = Some Influence, 4 = Quite a Bit, 5 = A Great Deal. The TSES has been extensively utilized, and subjected to factor analysis procedures to assess construct validity (Tschannen–Moran & Woolfolk Hoy, 2001). The present study utilized the amended long summated rating scale (20 items) consisting of three distinct domains so that Efficacy for instructional strategies (7 items), efficacy for classroom management (7 items), and efficacy for student engagement (6 items). The published reliabilities for each domain were 0.83, 0.87 and 0.81 respectively. Adhering to the ethics which assured the self-esteem and self-respect of the subjects, the pilot tested survey instrument was administered personally just once, over a period of one month.

In order to measure the perceived usage level of scientific inquiry, the instrument was directly adapted from the National Survey of Science and Mathematics Education Science Questionnaire Horizon Research Inc. (2000). The initial instrument consisted of 6 elements related to ILOs of scientific inquiry, 14 elements of scientific inquiry activities and 11 elements of assessment tasks for scientific inquiry. The instrument asked participants to rate their usage level: "About how often you emphasize in your science classroom to bring about….." and self-reported responses were measured on a five point likert scale of 1 to 5 where 1 = Never used, 2=Rarely (a few times a year), 3= Sometimes (once or twice a term), 4= Frequently (once or twice a week). 5=Very frequently (almost in all science classes). Once pilot tested number of elements of learning activities were 6 out of 14, while other remained unchanged. The instrument produced a total score for level of use of constructive alignment in teaching scientific inquiry.

A General Linear Model (GLM) Univariate analysis using SPSS 21.00 programme was used for descriptive statistics and association among teacher self-efficacy, gender, education level, area of certification and usage level of scientific inquiry and effect size using Partial Eta Squared.

RESULTS

Extant practices in teaching scientific inquiry

The respondents' demographic profile and the fact findings related to extant practices in teaching scientific inquiry by in-service science teachers are presented in Table 1.

Table 1 Descriptive statistics for respondent's profile

Variable	Frequency	Percentage	Mean ± SD
Gender			
Male	38	19.7%	
Female	155	80.3%	
Education level			
Degree holders	53	27.5%	
Non-degree holders	140	72.5%	
Area of certification			
Diploma /Teacher training	71	36.8%	
Postgraduate qualifications	81	42.0%	
Not professionally qualified	41	21.2%	
Education Zone			
Colombo North	23	12.0%	
Colombo Central	24	12.4%	
Colombo South	83	43.0%	
Borella	63	32.6%	
School Type			
1AB	129	66.8%	
1C	40	20.8%	
Type 2	24	12.4%	
Overall usage of scientific inquiry			3.70 ± 0.51
Usage of Learning outcomes of scientific inquiry			3.70 ± 0.68
Usage of Learning activities of scientific inquiry			3.67 ± 0.60
Usage of Assessment tasks of scientific inquiry			3.74 ± 0.57

As shown in Table 1, gender wise and education level wise the science teachers are not equally distributed so as 19.7% were males and 80.3% of females. Similarly, the percentage of degree holders was 27.5% while that of non- degree holders was 72.5%.When area of certification concerned, the sample consisted of 71(36.8%) science teachers(36.8%) qualified with either a teacher training or national Diploma while the percentage of them with postgraduate qualifications was 42%. It is noteworthy to state there were 41(21.2 %) teachers without any professional qualifications. The majority (66.8%) was from 1 AB schools while those of type 1 C and type 2 were 20.7% and 12.4% respectively.

The mean perceived usage level of scientific inquiry was 3.70 ± 0.51. Component wise the mean usage of learning outcomes, teaching learning activities and assessment tasks of scientific inquiry were 3.70 ± 0.68, 3.67 ± 0.60, and 3.74 ± 0.57 respectively. Descriptive statistics for each factor under learning outcomes, teaching learning activities and assessment tasks of scientific inquiry are shown in Table 2.

Out of the six learning outcomes of scientific inquiry, the highest perceived level reported for student engagement with a scientifically oriented question, while the lowest level was for student planning investigations to gather evidences in response to questions. Perceived usage level of other learning outcomes seems at a satisfactory level.

Among the teaching learning activities of scientific inquiry, majority use teacher dominated activities such as engaging students to watch a science demonstration on scientific investigations and engaging students to follow specific instructions in an activity or investigation. The results also reported a bit higher level of use of recording, representing and /or analyzing data. 'Yet' it indicated low level of use of guided or open ended inquiry related student centered activities.

Among the assessment tasks used by majority of respondents, observing student and asking questions as they work individually or in small groups, Using assessments embedded in class activities (text book/Teacher Instructional manuals) predominantly short answer questions on scientific investigations are prominent. It further revealed that they frequently review student home work on scientific investigations. However, assessment using student portfolios or long term science projects on scientific investigations reported a very low level of use by science teachers.

Table 2 Descriptive statistics for each factor under learning outcomes, teaching learning activities and assessment tasks of scientific inquiry

Components of scientific inquiry	n	Factors	Mean ± SD
Learning outcomes	193	LO1-Student engages with a scientifically oriented question	3.85 ±0 .81
		L02-Student plans investigations to gather evidences in response to questions	3.54 ±0 .86
		LO3-Student develops and evaluates explanations, predictions using evidence to address scientifically	3.77 ±0 .82
		LO4-Student formulates conclusions and/or explanations from evidence to address scientifically oriented questions	3.74 ±0 .86
		LO5-Student evaluates conclusions and/or explanations in light of alternative conclusions / explanations	3.65 ±0 .94
		LO6-Student communicates and justifies the proposed conclusions and/or explanation	3.66 ±0 .88
Learning activities	193	LA1-Engage students to watch a science demonstration on scientific investigations	3.81 ±0 .79
		LA2-Engage students to follow specific instructions in an activity or investigation	3.94 ±0 .78
		LA3-Record, represent and /or analyze data	3.77 ±0 .77
		LA4-Ask students to supply evidence to support claims/conclusions	3.67 ±0 .75
		LA5-Ask students to explain concepts/findings to one another	3.46 ±0 .85
		LA6-Make formal presentations on scientific findings to the rest of the class	3.34 ±0 .96
Assessment tasks	193	AS1-Conducts a pre-assessment to determine what students already know	4.10 ±0 .88
		AS2-Observe student and ask questions as they work individually	4.09 ±0 .88
		AS3-Observe student and ask questions as they work in small groups	3.81 ±0 .93
		AS4-Observe student and ask questions as they work in large groups	3.54 ±1 .04
		AS5-Use assessments embedded in class activities (text book/Teacher Instructional manuals) to see if students are getting it	4.00 ±0 .86
		AS6-Review student home work on scientific investigations	3.93 ±0 .81
		AS7-Review student note books on scientific investigations	3.75 ±0 .80
		AS8-Review student portfolios on scientific investigations	3.48 ±0 .82
		AS9-Assess student long term science projects on scientific investigations	2.99±0 .961
		AS10-Give predominantly short answer questions on scientific investigations	3.99 ±0 .79
		AS11-Grade students' work on open-ended and /or laboratory tasks using defined criteria (Eg: a scoring rubric)	3.67 ±0 .98
		AS12-Have students assess each other (peer evaluations)	3.46 ±1 .07

SD: Standard deviation

Independent sample t-tests revealed significant difference in mean perceived usage of learning outcomes by education level($p<0.05$) while no such significance difference in mean perceived usage in learning activities or assessment tasks of scientific inquiry by gender or education level. Also One-way ANOVA test showed no significant differences in mean values within learning outcomes, learning activities or assessment tasks of scientific inquiry by area of certification. The means, standard deviations and t-test results are shown in Table 3.

Independent sample t-tests showed no significant differences in mean perceived TSESE, TSECM and TSEIS by gender or by education level. One-way ANOVA and nonparametric Kruskal Wallis Tests revealed that none of pairs of self-efficacy scales significantly differed by area of certification. The means, standard deviation and t-test results are shown in Table 4.

Table 3 Means of scientific inquiry subscales and t-test results

Demographic variable	n	Mean ± SD			p-value*			p-value**		
		LO(1-5)	LA(1-5)	AS(1-5)	LO	LA	AS	LO	LA	AS
Gender					0.501	0.530	0.402			
Male	38	3.64± 0.58	3.61± 0.63	3.67± 0.56						
Female	155	3.72± 0.70	3.68± 0.60	3.75± 0.57						
Education level					0.038	0.853	0.985			
Degree holders	53	3.54± 0.77	3.68± 0.67	3.74± 0.64						
Non-degree holders	140	3.77± 0.64	3.66± 0.58	3.74± 0.54						
Area of certification								0.099	0.225	0.894
Diploma/Training	71	3.57± 0.738	3.73± 0.58	3.76± 0.60						
PG qualifications	81	3.80± 0.62	3.69± 0.55	3.71± 0.48						
Not professionally qualified	41	3.74± 0.68	3.74± 0.72	3.64± 0.68						

LO-Learning outcomes, LA-Learning activities, AS-Assessment tasks of scientific inquiry
*Test of equality of means-Independent sample t-test ** Test of equality of means-one-way ANOVA

Changes in Teachers' Self-efficacy for enactment of scientific inquiry

For the 193 science teachers participated in the survey, the means and standard deviation for teacher self –efficacy in student engagement (TSESE), in classroom management (TSECM), and teacher self-efficacy in instructional strategies (TSEIS) in teaching scientific inquiry were 6.93 ±0.53, 7.49 ±0.53 and 7.43 ±0.51 respectively. The low performing self-efficacy domain was TSESE. Out of subscales of TSESE, the lowest reported for teachers' efficacy in motivating students who show low interest in scientific inquiry, while they are efficacious enough in helping students value learning through scientific inquiry. It is notable that the majority were quite bit confident in performing classroom management related practices in scientific inquiry teaching. Among the TSEIS, teacher efficacy in using variety of assessment strategies for assessing scientific inquiry and implementing alternative strategies for scientific inquiry found comparatively low. It is noteworthy to indicate that teachers' efficacy in crafting questions for scientific inquiry (7.74 ± 0.65) and responding difficult questions in scientific inquiry from students(7.47± 0.68) were bit higher in the classroom.

Association among teacher control variables, teacher self-efficacy and enactment of scientific inquiry

A General linear model (GLM univariate) procedure used to test association among teacher control variables (gender, education level and area of certification), three sub scales of self-efficacy (student engagement, (SE) classroom management (CM) and instructional strategies (IS)) in teaching scientific inquiry and usage level of scientific inquiry. The GLM procedure resulted (Table 4, Model) neither gender, education level, and area of certification was associated with science teachers' self-reported use of scientific inquiry in secondary classes (Grade 6-13). The results also showed the mean usage of scientific inquiry did not differ significantly for none of pairs of area of education: Diploma/Training holders (NDT), post graduate holders (PGQ) and the teachers with no professional qualifications (NPQ). Among the tested variables, only teacher self-efficacy in student engagement and self-efficacy in instructional strategies were significant, indicating that there was a positive relationship between these two subscales of teacher self-efficacy and the Usage Level of scientific inquiry. Results of GLM are shown in Table 5.

Table 4 Means of Teacher self-efficacy subscales and t-test results

Demographic variable	n	Mean ± SD			p-value*			p-value**/***		
		SE(1-9)	CM(1-9	IS(1-9	SE	CM	IS	SE	CM	IS
Gender					0.426	0.650	0.377			
Male	38	7.01± 0.50	7.56± 0.50	7.56± 0.47						
Female	155	6..91± 0.54	7.49± 0.53	7.42±0.51						
Education level										
Degree holders	53	6.93± 0.62	7.51± 0.56	7.45± 0.56		0.895	0.917		0.617**	
Non-degree holders	140	6.94± 0.49	7.49± 0.52	7.43± 0.49						
Area of certification								0.814****	0.552***	0.362****
Diploma/Training	71	6.97± 0.63	7.45± 0.54	7.43± 0.57						
PG qualifications	81	6.89± 0.42	7.47± 0.55	7.36± 0.48						
Not professionally ualified	41	6.98± 0.4	7.63± 0.56	7.61± 0.42						

SE-Student engagement, CM-Classroom management, IS-Instructional strategies in scientific inquiry
* Test of equality of means-Independent sample t-test, ** Non parametric Mann-Whitney Test, ***Test of equality of means of equality of means-one-way ANOVA, ****Non parametric Kruskal Wallis Test

Table 5 Results from GLM Univariate procedure

Variable	Mean ± SE	B	p-value	Conclusion	Comparison
Gender			0.517	Not Sig. diff.	F > M
Male	3.62 ± 0.11				
Female	3.69 ± 0.06				
Education level			0.508	Not Sig. diff.	ND >D
Degree holders	3.60 ± 0.13				
Non-degree holders	3.70 ± 0.69				
Area of certification			0.368	Not Sig. diff.	PGQ>NPQ>NDT
Diploma/Training(DT)	3.59 ± 0.08				
PG qualifications(PG)	3.75 ± 0.11				
Not professionally qualified	3.63 ± 0.13				
TSESE		0.306	0.013	Sig, diff	
TSECM		-.101	0.397	Not Sig. diff.	
TSEIS		0.407	0.004	Sig. diff.	

When insignificant variables were removed, one at a time, only area of certification, teacher self-efficacy in student engagement and self-efficacy in instructional strategies were significant, indicating that there was a positive relationship among these three variables and the Usage Level of scientific inquiry. Among the tested variables in the study, only area of certification for teaching science, teacher self-efficacy in student engagement and self-f-efficacy in instructional strategies were significant predictors. The R square value was 0.202, which means 20.2% of the variation in Usage Level of scientific inquiry can be explained by area of certification for teaching science, teacher self-efficacy in student engagement and self-efficacy in instructional strategies. The results of the reanalyzed GLM univariate procedure is presented in Table 6.

The relationship between area of certification and use of scientific inquiry in science differed across measures. Being certified with postgraduate qualifications to teach science was associated with increased use of learning outcomes of scientific inquiry than those certified with National level Diploma or no certification yet. Among the teacher efficacy related sub scales, the positive interaction would imply that teachers' perceived self-f efficacy in student engagement is likely to have an impact on increasing use of learning outcomes of scientific inquiry(^{2} = 0.279, p = .013). Similarly, teachers' self-efficacy in instructional strategies related to scientific inquiry in science reported having a catalytic effect on their increased use of scientific inquiry outcomes in the classroom (^{2} = 0.347, p =.005).

Table 6 Results from GLM Univariate procedure

Variable	Mean ± SE	B	p-value	Conclusion	Comparison
Area of certification			0.032	Sig. diffe	PGQ>NPQ>NDT
Diploma/Training(NDT)	3.56 ± 0.07				
PG qualifications(PGQ)	3.83 ± 0.01				
Not professionally qualified(NPQ)	3.70 ± 0.10				
TSESE		0.279	0.016	Sig. diff	
TSEIS		0.347	0.005	Sig. diff.	

DISCUSSION

Although inquiry-based learning teaching has been recommended as a reform oriented practices in science teaching, and even though the teachers are the key players of its enactment, there seems to be a dearth of research investigating teachers' actual practice of this valuable approach and their personal beliefs towards inquiry learning in Sri Lanka.

The outcomes of this study indicate the extant practices in teaching scientific inquiry, impact of teacher self-efficacy beliefs towards teaching scientific inquiry and predictors of science teachers' use of learning outcomes of scientific inquiry. The enactment of scientific inquiry was satisfactory among the respondents, however, it looks more towards "scripted approach to inquiry" as found by Bardone, Burget, Saage and Taaler (2017). Scripted approach means "teacher furnishes step by step guidance in each inquiry phase, steering the process toward the desired goal...they place more emphasis on the preparation of a good plan that would walk the students through the whole process" (p. 296). Although the proponents of open-inquiry learning claim that it enhances the students' levels of inquiry and their logical thinking skills (Berg, Bergendahl, Lundberg &Tibell, 2003), the enacted type of such inquiry in science classrooms remains debatable as per the outcomes of this investigation which also conformed to the previous studies (Almuntasheri, Gillies& Wright, 2016; Anderson, 2002, Seneviratne, 2018). It was also notable that science teachers considerably attempt to constructively align the inquiry-based science lessons, yet, simply as confirmatory activities with a bit higher teacher dominance. Their frequency of use of student centered learning strategies for implementing inquiry and more authentic techniques for assessing inquiry is problematic. The prior research shows that teachers must have refined pedagogical content knowledge for inquiry-based learning such as proper knowledge of orientations congruous with inquiry, student perception of inquiry, inquiry-based teaching materials and techniques for assessing inquiry (Crawford, 2000; Davis & Krajicik, 2005). Therefore, further research would benefit how teacher training modules could be effectively integrated in order to improve the teacher's understandings of inquiry-based science teaching as suggested by Lee and Shea (2016) through their analytical study.

The research also sought to describe the changes in teacher self-efficacy for enactment of scientific inquiry in the classrooms in terms of student engagement, classroom management and instructional strategies. The teacher self-efficacy in the said three domains in this study reported lower levels in student engagement domain compared to other two domains. This findings conforms to the previous studies (Roberts *et al*., 2006; Stripling *et al*., 2008; Swan, Wolf, & Cano, 2011; Wolf *et al*., 2008). It is reasonable to expect slightly a lower level (M= 6.93) for efficacy in student engagement than the other two constructs (M (classroom Management) = 7.49 and M (Instructional Strategies)= 7.43) This might be due to complex nature of interacting and connecting with diverse learners, coupled with teachers' more attention to the instructional strategies of scientific inquiry and classroom management. However, the study of Ahokoski and colleagues (2017) found teachers experienced an increase particularly in their efficacy for student engagement related to inquiry learning, yet it might be due to the fact that those teachers were able to directly observe students' engagement and enthusiasm while working on an inquiry activity in a training course, which then immediately influenced their confidence on the matter (p.311).This mixed result of changes in self-efficacy in student engagement with regard to inquiry-based teaching and learning need to be further supported from future research.

Apart from science teachers' self-efficacy towards inquiry – based teaching, this study also investigated the association among teacher demographics (gender, education level, and area of certification), teachers' self-efficacy towards inquiry and perceived use of learning outcomes of scientific inquiry. The fact findings showed only area of certification for teaching science, teacher self-efficacy in student engagement and self-efficacy in instructional strategies were significant predictors of perceived use of scientific inquiry. The results found relatively strong association between use of scientific inquiry outcomes and those being certified with postgraduate qualifications to teach science, which supports the previous studies (Cohen & Hill, 2001; Desimone *et al*., 2002; Smith *et al*., 2007). The reason for increased use of reform-oriented practices involving inquiry science could be the opportunity they had during postgraduate studies to deepen understandings of science concepts and to experience themselves of carrying out science inquiries through research component. This has been discussed in detail on professional development in inquiry-based science for elementary teachers of diverse students groups by Lee and colleagues in 2004.

Although not significant, it was also notable that the level of use of scientific inquiry in science by those certified with teacher training or National Diploma in teaching science was slightly lower than those with no certification yet. This calls for needs of research inputs on revisiting the professional development component of teacher training or National Diploma in teaching science at National College of Education in the country. Additionally, this study revealed no statistically significant differences in enacted type of scientific inquiry between males and females which conforms to Asiri (2018). However, the level of use was slightly higher among females than that of males.

Furthermore, the study revealed that teachers' education level was not related to use of scientific inquiry and in line with previous research (Desimone *et al*., 2007; Chichekian, Shore & Yates, 2016). Science teachers without degrees in science or science education had performed better in use rates of scientific inquiry outcomes in their science classes than degree holders. This findings should be encouraging for policy makers in upgrading the teacher education curricula, especially focused on developing educative curriculum materials as described by Davis and Krajcik (2007). Educative curriculum materials according to Davis and Krajcik address the degree to which the curricular materials themselves can be designed to promote teacher learning in addition to student learning.

The statistically significant association between teachers' perceived self-efficacy in student engagement and instructional strategies and use of learning outcomes of scientific inquiry pave the way forward in revisiting the existing curricula for teacher professional development in the country. It could be effectively employed in deciding the degree of level of integrating self -efficacy sources into science teacher training modules.

One of major limitations of this study is that it greatly depend only on teachers' perceptions of use rates of scientific inquiry and self-efficacy employs. The results would likely have been more valid and reliable if findings would be triangulated with student perspectives as well observatory data from the classroom on enactment of scientific inquiry too. These options would require more extensive resources and capacities of the researcher. Even if such resources were available, getting consent of the principals and also teachers for classroom observation and getting student perspectives on their teachers' use of instructional practices is not a guarantee, according to the ethical considerations of schools in Colombo district.

CONCLUSION

Despite the general consensus on educational value of inquiry-based science teaching and learning for raising students' motivation in science and improving authentic scientific inquiry in day today life, adaption of its enactment in the classroom by science teachers seem problematic in many countries including Sri Lanka. Therefore, enacted type of inquiry-based science teaching is still an ongoing endeavor that requires further input from research to identify effective inquiry-based practices and introduce them to teachers as suggested by Van Joolingen and Zacharia (2009).

This study provides valuable insights into the science teachers' perceptions on their capabilities towards the nature of inquiry-based science in the classroom and how these perceptions relate to teacher demographic variables, more specifically, their education level and area of certification. Yet, a great deal of research remains to be carried out to determine the enactment of authentic scientific inquiry by in-service science teachers and the barriers they encounter in terms of technical, political and cultural as highlighted by Anderson (2002). Further research would also benefit from improved scale of for measuring teacher self-efficacy towards this valuable approach in science teaching in school education context.

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