Teacher Preparedness and Practices of Inquiry Based Instruction in School Science

Mohan Paudel
Lecturer
Central Department of Education, TU, Kirtipur
paudelmohan1@gmail.com

Abstract

The study was carried out with the purpose to dig out science teachers' perspectives and practices of inquiry based science instruction at basic level of institutional and community schools in Kathmandu district. Furthermore, teacher preparedness, school facilities, administrative support and mechanism to support students' learning through inquiry based instruction were evaluated. A quantitative survey design was applied to collect data from randomly selected 36 science teachers teaching science at grade eight in the selected schools. Data were collected using pretested questionnaire containing Likert scale type items and open ended questions. Teacher, student, curriculum and school-related factors were found as major affecting factors in practice of inquiry based instruction in schools. Science teachers concerned more about facility related issues rather than pedagogical practices. Some factors including teachers' low level of confidence, inadequate knowledge and little experience in conducting inquiry based instruction, insufficient school facilities and resources, tight curriculum demanding little inquiry were identified which hindered the implementation of inquiry based approach in science instruction. Moreover, traditional teaching practices, over emphasis on exam are additional factors hindering the practice of inquiry based teaching. It is recommended that inquiry approach should be incorporated in student teaching, science curriculum framing, science teacher professional development programs, classroom management and student evaluation.

Keywords: Attitude, confidence, inquiry, instruction, perspective

Background of study

In Nepal, after signatory commitment to Education for All: DAKAR Framework of Action -2000, reform in education policies, execution of number of programmes and projects in education sector resulted in tremendous progress in the expansion of school education, increasing enrolment, school infrastructure development, teacher training and decentralized management practice by delegation of school management responsibility from ministry level to community. Despite efforts, students' performance and quality of education is below satisfactory level (Department of Education, 2010; Education Review Office, 2018). Some posing challenges to the effectiveness and quality of education are unsatisfactory achievement, poor absorptive capacity of students in higher education and their inability to achieve full success in external competitions, and so on (Department of Education, 2010). An over reliance on teachers and duplicating hand-outs is likely to decrease interest, motivation and engagement in science (Wellington, 2000).

Our classroom practice has a poor track record in managing child centered inquiry based science instruction (ERO, 2015). Classroom instruction is being criticized for being lecture dominated, predominantly recitation of textbook content and delivery of factual information, emphasizing rote memorization, less activity and under pressure to finish an over-loaded course for completion of exam with higher score within limited time frame: the supposed supreme measure of success. National Assessment of Student's Achievement (NASA) study carried out by Education Review Office (ERO) presents poor learning achievement in science with national average of 41 in the year 2013 for grade eight. Reports constantly showing Science stand along with Mathematics and English as three major subjects in which students' pass rate and average achievement is low for many years (Education Review Office [ERO], 2015; Education Review Office [ERO], 2018; Mahtema and Bista, 2006). In addition, NASA 2013 and 2017 studies revealed that student science achievement scores in grade eight remained low and going down over the years instead of improvement (ERO, 2015).

As NASA study 2013 posits, the root cause behind the downfall of achievement score and low achievement is due to low enquiry in subject matters; and it demands further enquiry to get into the root cause of fact (ERO, 2015). Center for Educational Human Resource Development [CEHRD], 2018 data showed low number of SEE graduates taking science

as major subject at +2 level (15 percent in 2018/19) and higher studies. Many students after completion of grade 12 get shifted to the non-science stream.

One of the main objectives of school science curriculum is to develop the basic knowledge of scientific concepts, principles and laws; impart the skills of observation and inquiry; and develop competence in applying knowledge and skills for the solution of problems in daily life. Science educators are constantly advocating that science should be taught in the way of scientific inquiry. Empirical literatures suggested that inquiry based instruction is more effective than traditional instruction and contribute to students' understanding of the nature of science (Backus, 2005), helps in development of thinking, problem solving and skills of scientific process (Crawford, 2000; Hofstein and others, 2004), increase motivation in science learning (Tuan and others, 2005), develop positive attitude towards science learning and laboratories (Holfstein and others, 2001) and increase science learning outcome. Bruce suggested five steps of inquiry based learning as ask, investigate, create, discuss and reflect – through which students can explore the meaningful answers to their own question and come up with meaningful solution (as cited in Sahin, 2013).

Learning science through inquiry is a constructive practice that can cover minds-on and hands-on activities and leads towards meaningful learning and help to solve life related problems, asking open-ended questions, using critical, reflective and creative thinking skills and perceiving the inquiry process as a good method of learning science (Osborne, 2014; Tobin and Tippins, 1993). Children may have pre-conceptions (alternative frameworks), and may have developed different knowledge, and understanding, possess different abilities, skills and learning style that they bring to the science classroom (Wellington, 2000, p. 128). Being child centered approach, inquiry based instruction addresses all the mentioned aspects of the students. In this approach, teacher is the facilitator and role model of inquiry process. Teacher facilitates in creating learning environment, arranges major facilities, encourages and helps students to develop their sense of inquiry. Inquiry is "a step beyond science as process, more than learning about observation, inferences, and experimentation" (National Research Council, 1996, p. 105).

For basic level science teaching, inquiry based teaching can be integrated within the different concepts in science curriculum as a whole. The learners

can be engaged with asking different types of questions and later on can be provided with conducting inquiry project individually or as collaborative work. Inquiry based integrated science not only covers the content but also involves the process of science through which students understand the world around them. What types of contents students should know, be able to understand, and how they learn within various grade levels is crucial in inquiry based science instruction. The approach does not limit itself around content delivery but goes further to develop science process skills and attitudes for further scientific inquiry. Teacher's role in inquiry based science is setting the learning environment, motivating them for inquiry process, giving respect for students' knowledge and ability, listening and asking reflective questions, giving regular meaningful and constructive feedback, promoting the interaction of children with material and resources, providing them with access to alternative ideas, monitoring progress, engaging students in investigation and making inquiry into events in the classroom and outside classroom (Harlen, 2000).

If teachers want to create inquiry situation in classroom they need to create meaningful opportunities for students to interact with each other, include problem-solving, and encourage collaboration and positive competition. The starting motivation for this study has been to empirically and conceptually examine the present situation of teaching learning practices in science classroom especially looking on inquiry based Instruction. In this context, the focus of this study is to find the current efforts and mechanisms adopted by the school to improve students' learning through improving the functioning of school.

This study was carried out with the purpose to examine science teachers' perspective, experiences, preparedness and practices of inquiry based science teaching at basic level in Kathmandu. This study concentrated on finding the "requirement and practice gap" and providing key implications for school improvement. Furthermore, it investigated the community of practice and produced information on school infrastructure and facilities, school support for inquiry based science instruction. Information regarding students was analyzed on the basis of the responses of participants in Kathmandu. The study addresses the gaps by providing nuanced data on inquiry based teaching learning of science and finds the factors related to it – informing the areas where meaningful and relevant changes are required in Nepalese schools.

Methodology

In total 36 schools including 25 communities and 11 institutional schools in Kathmandu were selected by simple randomization. One science teacher per sample school was selected as respondents. The selected schools were following the same curriculum designed by Curriculum Development Center and operating under educational act and rules-regulations of the country, although they differ in terms of governance as community schools and institutional schools. Each teacher was informed about the study and consent was taken for their participation. All the required ethical and methodological considerations were maintained.

Survey tool was designed by the author to solicit information about science teachers' perspectives, experiences and practices, as well as school support to encourage inquiry based science teaching. Data were collected using valid and reliable tools. Validity was ensured by expert judgment, while reliability was maintained by calculating Cronbach's alpha value and selected after factorial analysis through piloting. The Statistical Package for the Social Sciences (SPSS) version 20 was used to code and tabulate scores and perform the analysis. Quantitative data were analyzed statistically using descriptive statistics including percentage, weighted mean, the standard deviation (SD) and the estimated error of the mean (SEM) to present the data and explain the results of statistical analysis. Survey items were categorized under different themes and concepts, when combined, formed statistically significant patterns. The data were used to determine the characteristics and factors regarding the variables considered. Qualitative data were managed and discussed under different themes triangulating them against quantitative data. Privacy, trustworthiness and authenticity of data were maintained in taking the consent of participants as well as in data coding and analysis.

Results and discussion

The study found some crucial factors affecting learning outcomes in science in the study schools. It is worthwhile to present the findings under different subheadings as follows.

Teachers' perspective on curricular and socio-cultural aspects of inquiry based teaching-learning

Teachers' perceptions towards curricular and social aspects of teaching-learning of science using inquiry approach were evaluated by using five-

point Likert type scale. For decision making, weighted mean was categorized as – if weighted mean is up to 3 it was considered as not positive response (NP) while if weighted mean is above 3 the response was considered as positive (P).

Table 1: *Curriculum aspect and socio-cultural aspect of inquiry based science instruction*

	Variables (Indicators)	N	Mean	Std. Error	Std. Deviation	Decision
	Curricular aspect (4)	40	2.93	.08	.53	NP
	Socio-cultural aspect (4)	40	3.58	.09	.59	P

Teachers' perspective about school science curriculum of Nepal dealing with inquiry based approach is not positive with weighted mean below 3 (M= 2.93, SD = 0.53, SE = 0.08). They agreed that science curriculum is text-driven emphasizing passive reading of content over meaningful activity, demanding little inquiry (M = 3.27) and detached from inquiring science in day to day activities. They agreed that school science curricula need improvement for facilitating inquiry based teaching learning emphasizing the hands on and minds on activities (M = 4.16). School science should be connected to daily life activities comprising minds on and hands on activities and enabling them to come up with solutions to their day to day problems.

Teachers' perception was found positive towards social aspect of inquiry based science instruction, on average (M = 3.58, SD = 0.59, SE= 0.09). Above 59 % teachers agreed that science can be taught connecting to socio-cultural context where cultural and ethical diversity are potential sources of knowledge. More than 69.2% teachers support the statement that ethnic diversity can contribute in collaborative inquiry in science such that "different ethnic groups can contribute to each other's productivity with different skills" (Virginia, 2017, p. 293).

Students' aspect of inquiry based science instruction

The table below will depict the students' aspects of inquiry based science instruction.

Table 2: *Students' aspect of inquiry based science instruction*

	Variable (Indicators)	N	Mean	Std. Error	Std. Deviation
	Students' capacity and habit of inquiry (5)	36	2.89	.10	.65
	Students' motivation and interest (4)	36	3.34	.10	.63

Science teachers were found unsatisfied with students' habit of inquiry science. They argue that few students have the capacity for sound independent judgment (M =2.65) and habit of exploring possible alternatives in science; and low proportion of students come ready to learn science with eagerness. On the other hand, majority of students complete their assignment on time (M = 4.19). Overall, they were moderately satisfied with students' capacity of learning science by inquiry (M = 3.08). Teachers reflected lower level of satisfaction from students' motivation and interest in learning science. The lower level of motivation and interest in science is associated with ongoing conventional teacher-centered methods (Avraamidou and Osborne, 2009). Inquiry based science education is the need of today's science class which significantly enhances students' interest in science (Koksal and Berberoglu, 2012). To increase students' interest, curiosity and motivation in learning science, they must be provided with opportunities for exploring the best alternatives through independent judgment.

Teachers pointed disparities among students' achievement in science due to socio-economic status, ethnicity (particularly children from Tamang community perform poor and pay low attention and lack interest in learning), language and previous academic records.

School support and instructional practice

School support covers school facilities and administrative support for inquiry based science instruction. The Likert data were analyzed statistically using percentage weighted mean, standard error of mean and standard error.

Table 3: *School support and instruction practices for inquiry based science instruction*

	Variable (Indicators)	N	Mean	Std. Error	Std. Deviation
	School Support (4)	36	2.58	.15	.94
	Instructional Practice (5)	36	2.96	.09	.58

Teachers' view about school support (M = 2.58, SD = 0.94, SE = 0.15) for inquiry based instruction is not positive but more dispersed. Respondent teachers (55.11%) argued that they are not provided with sufficient teaching-learning materials, majority of the schools have science laboratory but inadequate laboratory materials. Carefully managed classroom with adequacy of ICT and other required resources is the demand of modern teaching-learning. Limited access to ICT facilities and no immediate technical support (when and where needed) for ICT during science instruction is a major problem highlighted by the participant teachers. In eight schools, classrooms are under surveillance system so as to control students' behavior and monitor the classroom activities but no projection facility for instruction. Four schools have projection facilities in seminar hall which are rarely used for instructional purpose.

Majority of the respondent teachers (89.25 percent) argued as classroom setting is traditional, congested, there is low flexibility as classrooms are covered completely by desk-benches/ table-chairs; and there is no open space and facilities for conducting demonstration and inquiry activities. Teachers were found positive towards their administration but showed dissatisfaction over more instructional load per day (4-8 periods per day). Some teachers mentioned that their head teachers are reluctant to purchase laboratory materials and instructional materials due to cost issue and considered science like other theoretical subjects. It was found that there is minimal formal sharing sessions, no peer tutoring and peer observation practices with the purpose of instructional improvement.

Respondent teachers opined that in science instruction inquiry approach was applied to a minimum (M = 2.98, SD = 0.58, SE = 0.09). Teachers (36.52%) pointed out that they have tight classroom routine (4-7 periods per day) and do not have enough leisure time to plan and conduct science activities such as inquiring science in the community, inquiring science by outclass activities, inquiring science with fun. Classroom instruction is going routinely as marked by ranging from teacher centered (more dominant approach) to child-centered (minimal) or sometimes within the continuum of mixed approaches. Delivery of textbook based factual information, emphasis on memorization of terms and facts, teachers' and students' orientation towards achievement in terms of exam scores, were found higher rather than understanding the concepts of science. Science teachers generally find it difficult to manage inquiry based approach (Cheung, 2007). Many researchers (Juuti, and others, 2010; Beerenwinkel and Borlin, 2014; Kang and Keinonen, 2016) reported that inquiry based science instruction is underdeveloped as a consequence of the constant use of more traditional teaching methods, while science educators are emphasizing on use of inquiry approach in science and students also want inquiry based science education. Therefore, focus is needed to be given on instructional management by the schools in order to bring change in ongoing science classroom practices.

Teachers' perspective and practice of inquiry based science

Data were analyzed for finding the teacher's attitude, their preparedness and confidence by using statistics like mean, standard error of mean and standard deviation.

Table 4: *Teacher attitude, teacher preparedness and teacher confidence regarding inquiry based science instruction*

	Variable (Indicators)	N	Mean	Std. Error	Std. Deviation
	Teacher attitude (4)	40	3.43	.11	.72
	Teacher preparedness (3)	40	3.04	.10	.63
	Teacher confidence (4)	40	2.59	.08	.50

Teacher attitude (M = 3.43, SD = 0.72, SE = 0.11) was found satisfactory with overall average above 3. Data depicts that teachers were moderately prepared (M = 3.04, SD = 0.63) and showed poor confidence (M = 2.59, SD

= 0.50) in implementing inquiry based instruction. Most of the teachers were found convinced that inquiry based instruction best suits for school level science. They argued that students can be benefitted by inquiry based instruction as it provides engaged, creative and challenging learning opportunities. They opined as inquiry based approach provides opportunities for learning by pace, sharing of ideas, provides sustainable knowledge through better understanding of scientific concepts, connect school science to day to day science, increase students' motivation, curiosity, interest and engagement; develop science process skills, habit of critical thinking and creative thinking and develop scientific attitude, and so on. Though they think inquiry based instruction is important for science instruction, they have a lack of explicit knowledge and idea of implementing it. Majority of teachers have the perception that inquiry based instruction is time consuming, requires specific facilities and arrangement, demands more talented mind, and it is difficult in implementation in the classrooms which are diverse in terms of students' socio-economic status and learning ability. About 65 percent teachers' responses lie in neutral level reflecting some confusions about the appropriate way and process of conducting inquiry approach in classroom instruction.

Almost 46 percent selected science teachers agreed that they have little knowledge and experience of teaching science by inquiry. 39.5 percent teachers (from science and technology background) have never learnt about inquiry approach in academic and training courses. There were 46.2 percent teachers (mostly from education stream) learnt inquiry based approach in university courses (in Bachelor or master or both); and rest of the teachers learnt little about inquiry based approach in teacher training courses. Respondent science teachers showed hesitation to use scientific inquiry in their classrooms. The data suggested that teachers need extensive training for changing them from deductive orientation to inductive inquiry approach.

This study has also revealed some school, teacher and student related factors associated with inquiry based science instruction that line up with the findings of international researchers such as low level of teachers' confidence and competence in using inquiry instruction in science; inadequate school facilities, insufficient school resources, tight curricula; inadequate professional training, professional science knowledge, etc. – in consonance with a few earlier studies (Ramnarain, 2016, Yoon and others, 2011; Harwood and others, 2006; Kang and Keinonen, 2016; Davis, 2003). This study suggests that teacher professional development course and

training in science education should combine an explicit focus on process of conducting inquiry based instruction in order to achieve the goal of quality teaching-learning in science (Van Aalderen-Smeets and others, 2017; Van Aalderen-Smeets, and Walma van der Molen, 2015).

All possible child centered methods are compatible with inquiry approach to teaching science. This flexibility gives benefit to students of all levels whether they are lower or higher achievers. Low achiever students may be further disadvantaged by using poorly designed inquiry based instruction, so it is important that inquiry based instruction are carefully designed and ensured to cover all kinds of cognitive knowledge and skills.

Conclusion

The study anticipated that teachers have positive attitude and good perception towards inquiry based science teaching. Teachers exhibited moderate to high curiosity, interest and intrinsic motivation in their practices; but they have substantially little knowledge, experience and confidence in adopting inquiry based science. Therefore, teacher training courses should be designed focusing on inquiry approach. Furthermore, majority of them did not get opportunity to learn inquiry approach in academic studies and trainings. Some important factors for poor inquiry process were identified as teachers' low level of confidence, inadequate knowledge and little experience in conducting inquiry based instruction; insufficient school facilities and resources, and tight curriculum demanding little inquiry.

Results of this study indicated that teachers' levels of readiness confidence and intrinsic motivation were moderate. This research therefore recommends to incorporate inquiry based science in teacher preparation courses emphasizing practical aspect of inquiry based science instruction to make the instructions context driven and prepare students' criticality towards concepts of science education. To improve student's learning outcome, school reform program, teacher training, curriculum reform, textbook revision, increasing library and laboratory facilities and developing infrastructure are the interventions needed to increase the quality of learning science at school level. Nepalese classrooms are traditional in nature. To implement inquiry based instruction, classroom setting and facilities need to be improved, classroom should have some available free space and flexible seating arrangement and must be equipped with projection facilities, online training

and delivery instruction to enhance ICT skills. Encouraging comprehensive and critical thinking and giving choice in learning were found to work effectively in inquiry based science learning. Science teaching must include minds on and hands on activities through open and guided inquiry approach. School science curriculum should focus on science process skills and should be designed in integrated way of linking modern science and science inside home and in locality that could help to solve day to day problems and to develop scientific temper and attitude. If school system does not function well, teacher effort and service delivery cannot be expected. The studies showed managing physical resources alone will not be enough to improve learning outcomes in Nepalese schools. Instead, planned way of instructional practice is required in which inquiry approach in integral part.

References

Avraamidou, Lucy; and Osborne, Jonathan. (2009). The role of narrative in communicating science. International Journal of Science Education, 31 (12), *1683–1707, Doi:* 10.1080/09500690802380695

Backus, Lisa. (2005). A year without procedures. *The Science Teacher, 72(7),*54-58.

Beerenwinkel, Anne; and Borlin, Johannes. (2014). Surface level: teaching time, lesson phases and types of interaction. In Fischer, Hans E.; Labudde, Peter; Neumann, Knut andViiri, Jouni (Eds.). *Quality of Instruction in Physics* (pp. 59-72). Waxmann.

Center for Education and Human Resource Development. (2018*). Flash I report 2018/19*. Kathmandu: Author.

Cheung, Derek. (2007). Facilitating chemistry teachers to implement inquiry-based laboratory work. *International Journal of Science and Mathematics Education*, 6, 107-130. Doi: 10.1007/210763-007-9102-y.

Crawford, B.A. (2000). Embracing the essence of inquiry: New roles for science teachers. *Journal of Research in Science Teaching, 37(9),* 916-937.

Davis, Kathleen S. (2003). "Change is hard": What science teachers are telling us about reform and teacher learning of innovative practices. Science Education, 87 *(1), 3-30.*

Department of Education. (2010). *National framework of child-friendly school for quality education*. Sanothimi, Bhaktapur, Nepal: Author.

Education Review Office. (2015). *National assessment of student achievement 2013*. Sanothimi, Bhaktapur, Nepal. Author.

Education Review Office. (2018). *National assessment of student achievement-2017: Public Report*. Sanothimi, Bhaktapur. Author.

Harlen, Wynne. (2000). *Teaching, learning and assessing science 5-12*. London: Paul Chapman Publishing Ltd.

Harwood, William S.; Hansen, John; and Lotter, Chiristine. (2006). Measuring teacher beliefs about inquiry: The development of a blended qualitative/quantitative instrument. Journal of Science Education and Technology, 15 *(1), 69-79. Doi: 10.1007/s10956-006-0357-4.*

Hofstein, Avi; Nahun, Tami Levy; and Shore, Relly. (2001). Assessment of the learning environment of inquiry-type laboratories in high school chemistry. *Learning Environments Research, 4(3)*, 193-207.

Hofstein, Avi; Shore, Relly; and Kipnis, Mira. (2004). Providing high school chemistry students with opportunities to develop learning skills in an inquiry type laboratory: A case study. *International Journal of Science Education*, 26 (1), 47-62. Doi: 10.1080/0950069032000070342

Juuti, Kalle; Lavonen, Jari; Uitto, Anna; Byman, Reijo; and Meisalo, Veijo. (2010). Science teaching methods preferred by grade 9 students in Finland. International Journal of Science and Mathematics Education, 8, *611-632.*

Kang, Jingoo; and Keinonen, Tuula. (2016). Examining factors affecting implementation of inquiry-based learning in Finland and South Korea. Problems of Education in the 21st Century, *74, 31-46. Retrieved from https://www.researchgate.net/publication/311936943*

Koksal, Ela Ays; and Berberoglu, Giray. (2012). The effect of guided-inquiry instruction on 6th grade Turkish students' achievement, science process skills, and attitudes toward science. International Journal of Science Education, 36 *(1), 66-78, Doi: 10.1080/09500693.2012.721942*.

Mahtema, Kedar Bhakta; and Bista, Min Bahadur. (2006). *Study on student performance in SLC: Main report*. Kathmandu: Ministry of Education and Sports.

National Research Council. (1996). *National science education standards*. Washington, DC: National Academy Press.

Osborne, Jonathan. (2014). Teaching scientific practices: Meeting the challenge of change. *Journal of Science Teacher Education, 25*, 177–196. Doi:10.1007/s10972-014-9384-1.

Ramnarain, Umesh. (2016). Understanding the influence of intrinsic and extrinsic factors on inquiry-based science education at township schools in South Africa. Journal of Research in Science Teaching, 53, *598-619. Doi:* 10.1002/tea.21315.

Sahin, Alpaslan. (2013). *STEM project- based learning: An integrated science, technology, engineering, and mathematics (STEM) approach*. In Capraro, R.M., Capraro, M.M., and Morgan, J.R. (Eds). Netherlands: Sense Publishers.

Tobin, Kenneth; and Tippins, Deborah. (1993). Constructivism as a referent for teaching and learning. In Kenneth Tobin (Ed.), *The practice of constructivism in science education (pp. 3-21)*. Washington, DC: AAAS Press.

Tuan, Hsiao-Lin; Chin, Chi-Chin; Tsai, Chi-Chung; and Cheng, Su-Fey. (2005). Investigating the effectiveness of inquiry instruction on the motivation of different learning styles student. *International Journal of Science and Mathematics Education*, 3 (4), 541-566. Doi: 10.1007/s10763-004-6827-8.

Van Aalderen-Smeets, Sandra I.; and Walma van der Molen, Julitte H. (2015). Improving primary teachers' attitudes toward science by attitude-focused professional development. *Journal of Research in Science Teaching*, 52, 710–734. Doi:10.1002/tea.21218.

Van Aalderen-Smeets, Sandra I.; van der Molen, Juliette H.; van Hest, Erna G.W.C.M. and Poortman, Cindy. (2017). Primary teachers conducting inquiry projects: Effects on attitudes towards teaching science and conducting inquiry. *International Journal of Science Education, 39*(2), 238-256. Doi: 10.1080/09500693.2016.1277280

Virginia, Maestri. (2017). Can ethnic diversity have a positive effect on school achievement?, *Education Economics*, 25:3, 290-303, Doi: 10.1080/09645292.2016.1238879

*Wellington, Jerry. (*2000*).* Teaching and learning secondary science: Contemporary issues and practical approaches. *London: Routledge.*

Yoon, Hye-Gyoung; Joung, Yong Jae; and Kim, M. (2011). The Challenges of science inquiry teaching for pre-service teachers in elementary classrooms: Difficulties on and under the scene. Research in Science Education, 42, *589-608.*