



## **In-service Training for Chemistry Teachers' Proficiency: The Intermediary Effect of Collaboration Based on Teaching Experience**

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This research determined the effect of in-service training, collaboration and teacher proficiency on chemistry subject based on teaching experience. A total of 184 teachers were involved in this study, only 64 of which had less than 10 years of teaching experience. The data were collected via questionnaires and analysed using the software SPSS AMOS 23. The MANOVA test indicated significant differences between in-service training and collaboration based on teachers' teaching experience and parallel results between teacher proficiency in chemistry and teaching experience. The SEM test showed that collaboration has a different intermediary effect on the relationship between in-service training and teacher proficiency. Therefore, chemistry teachers with less teaching experience required additional in-service training and collaboration to enhance their proficiency, whereas experienced chemistry teachers only required in-service training. Results of this study implied that schools should organize collaborative activities that involve teachers with various experiences. Teamwork and collaboration are expected to enhance teacher proficiency in the subject.

**Keywords:** collaboration, in-service training, teacher proficiency in chemistry, teaching experience, teachers

**Citation:** Copriady, J., Zulnaidi, H., Alimin, M., & Rustaman. (2018). In-service Training for Chemistry Teachers' Proficiency: The Intermediary Effect of Collaboration Based on Teaching Experience. *International Journal of Instruction*, 11(4), 749-760.  
<https://doi.org/10.12973/iji.2018.11447a>

## INTRODUCTION

The excellence of a teacher determines the success of a school and the quality in knowledge and experience of students that it produces (Jussim & Harber 2005). Teachers must have dedication and spirit in performing tasks designed to impart valuable knowledge for students. Most superior teachers started humbly by first mastering their knowledge, which, in this context, refers to resources and curriculum content that are disseminated to students. Chu, Loyalka, Chu, Qu, Shi, Li, and Rozelle (2015) found that highly professional teachers have a profound effect on student achievement. A superior chemistry teacher should master the entire curriculum and be capable of choosing important aspects that should be focused on. Darling-Hammond (2006) claimed that teacher readiness and credentials directly affect academic achievements. An ideal chemistry teacher can also provide clear explanations and descriptions through a variety of teaching aids and instructional media. Teaching media can be in the form of technology utilisation in teaching and learning. Othman (2007) even reported that technology-assisted teaching methods had a positive impact on student achievement.

Teachers should implement changes to enhance education quality. They need to consider establishing communication through various elements and mingling with members of the scholastic community. Fullan (2011) found that teachers need educational innovation to execute improved teaching concepts and to help them become knowledgeable in delivering classroom instructions. According to Mulyasa (2007) and Brundrett and Silcock (2002), developing student creativity provides students with additional opportunities to explore and explain their learning materials. In addition, teachers should refer continuously to theories or teaching models when designing and planning lessons. Theories in teaching and teaching models will help teachers accelerate the process of developing materials by assisting them in teamwork communication and covering all phases of teaching design (Shariffudin, 2007).

Although teachers are professionals, they have limitations in mastering general knowledge related to their subject. Teachers need uplifting activities to enhance and expand knowledge acquisition and skills. These activities should be used as communication networks for a community of teachers and aim at sharing information related to the subject and education. They could then develop and share their knowledge with others. Teachers may increase their knowledge and adopt additional scientific attitudes by attending academic forums continuously, such as seminars and panel discussions and so on. Abdullah et al. (2014) stated ineffective communication can hinder effective teaching and achievement of learning objectives and can cause discomfort, disappointment, psychological stress, physical health, loneliness and loss of affection among others. Finally, Liu and Tsai (2017) revealed that initiatives to reform education should encourage school teachers to be innovative in teaching strategies to improve teaching quality.

Continuous training to improve learning quality among chemistry teachers should be implemented particularly to develop the Academic Online Community and to improve the quality of chemistry learning continuously. Teachers must also have a mindset to

provide valuable experience in facilitating the mastery of chemistry by using appropriate and skilled methodologies, such as conducting laboratory experiments. Cullingford (1995) and Muijs and Reynolds (2010) reported that direct and simultaneous interactions of students who used all of their senses while working or performing an experiment are necessary; such interactions help them function well, resulting in improved understanding. Everybody experiences new and different things daily, which requires a process for understanding (Tovey & Lawlor, 2008). Training is required when a gap between what teachers have and what are expected of them exists with regard to competencies, skills, knowledge and attitudes. According to Dafou (2009), academic qualification is a fundamental factor that demonstrates the marketability of new employees who are novices or with zero working experience. Hence, high academic qualifications distinguish the suitability and acceptability of the job applicant. Employers prioritise applicants who have high academic qualifications. Trainings organised for employees throughout their career add value to their substantive skills. However, according to Burnham and Sullivan (2010), problems arise in diversifying in-service trainings because they require long periods and high financing or additional costs.

Previous studies have revealed that teachers' experience has an effect on student achievement (Chu et al., 2015; Darling-Hammond, 2006). Innovative teachers can improve the quality of teaching (Liu & Tsai, 2017; Fullan, 2011). Teachers are required to master their subjects taught to facilitate improvement of student understanding. Training and collaboration are necessary to increase teachers' proficiency in the subjects. However, prior studies do not focus on direct and indirect effect relationships between training and collaboration on teacher mastery. This issue led to the implementation of training in services provided, which focuses on mastery of the subject matter regardless of the collaborative aspect that emphasised weak communication skills that could lead to less effective teaching (Abdullah et al, 2014).

### Focus of the Study

The current study aimed to identify teacher's perceptions related to in-service training, collaboration and proficiency of teachers in chemistry based on teaching experience. In addition, it intended to identify the role of collaboration as an intermediary factor between in-service training and subject proficiency based on experience (Figure 1).

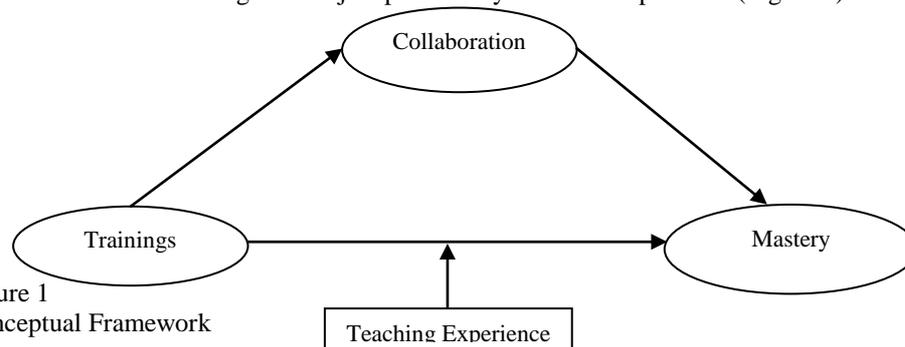


Figure 1  
Conceptual Framework

## **LITERATURE REVIEW**

Many studies have been conducted to improve teacher professionalism in teaching and learning, and they yielded various findings on teacher collaboration, training and teaching experience (Liu & Tsai, 2017; Sexton, 2015; Nugent, Reardon, Smith, Rhodes, Zander, & Carter, 2008). The role of teachers includes practical knowledge (Driel, Bejaard & Verloop, 2001) and knowledge sharing through collaboration with pre-service and other types of teachers (Liliane & Colette, 2009). Reviews from Vangrieken et al. (2015) on effective collaborations encourage teachers to build teamwork with high levels of congeniality. The current studies revealed the need to improve professionalism in teaching and knowledge acquisition through in-service trainings to be organised by schools and other organisations. The main purpose of the current study was to enhance teacher knowledge in content and pedagogy.

Liu and Tsai (2017) highlighted information on education and revealed many cases of uncoordinated collaborative teacher activities and discussions that focus on irrelevant and outdated issues. This revelation is in contrast with the findings of Liliane and Colette (2009), which indicate teachers collaborating with other teachers leverage the discussion as an opportunity to acquire new ideas. According to Liliane and Colette (2009), teachers questioned their own knowledge and beliefs and even wanted to obtain, share and study new knowledge.

Teacher competency in achieving educational goals should be improved and require a wide range of training and development programs to motivate them and enhance their creativity in teaching and understanding the field of knowledge. According to Rahmadhani (2014), the training process influences teachers and improves goal achievement. He added that trainings provide teachers or workers with knowledge and skills to be applied in their field. Continuous trainings add value to schools and organisations because the strategies gained from trainings can be used in the intended destination or mission. This finding is in line with the views of Rahman et al. (2011). They posited that training and development can be considered as a process for improving educator knowledge, skills and professional attitudes which help improve student learning.

Ezeani and Oladele (2013) reported that continuous employee trainings or guidance provides latest knowledge on subject content, scope and networking in an organisation. Training has a direct effect on teacher productivity (Eze, 2016). Therefore, teachers should aim and be motivated to attend training courses to utilise gained knowledge in the teaching and learning process. Based on the ILO (2010), differences in demographics and economic structure and development of a country are sources of information that can help organisations provide appropriate trainings and develop skills for teachers.

## **METHOD**

The survey was conducted on chemistry teachers in Riau, Indonesia, by using questionnaires to evaluate their perception related to in-service training, collaboration and teacher proficiency. This study examined how training and collaboration among

chemistry teachers affect their proficiency in chemistry. In addition, the differences among in-service training, collaboration and teacher proficiency based on teaching experience were determined.

### **Respondents**

The current study involved 184 teachers handling chemistry subject in senior high school, only 64 (34.8%) of which have less than 10 years of experience. With regard to gender, 50 (27.2%) are male and 134 (72.8%) are female.

### **Measure**

The current study focuses on three main variables: teacher's perception on in-service training, collaboration and teacher proficiency in chemistry. The researchers constructed instruments used to evaluate these variables and consulted experts to verify the instruments. Questionnaire validity test was conducted to strengthen language use and improve clarity and item content. The experts facilitated instrumental development and reliability test of each item (Gay & Airasian, 2003). Questionnaire reliability was evaluated through a pilot study involving 60 chemistry teachers in Pekanbaru, Riau. Results of the pilot study showed a high level of reliability at 0.70–0.73. Items with values greater than or equal to 0.7 are accepted as reliable.

*In-service training:* The instrument used for testing teacher's perception on in-service training contains 35 items that measure training needs, methods, materials and information and communication technology (ICT) applications through a five-point Likert scale (i.e. 1, Strongly Disagree; 2, Disagree; 3, Undecided/Not sure; 4, Agree; and 5, Strongly Agree). Results of the pilot study of teacher's perception on in-service training indicated a high level of reliability at 0.70

*Collaboration:* The instrument for testing collaboration contains 30 items that measure teacher commitment to collaboration, interaction with fellow teachers, ability to express opinions and discussion with other teachers during problem solving through a 5-point Likert scale (i.e. 1, Strongly Disagree; 2, Disagree; 3, Undecided/Not sure; 4, Agree; and 5, Strongly Agree). Results of the pilot study of *collaboration* indicated a high level of reliability at 0.73.

*Proficiency in chemistry:* A total of 32 items measure teacher proficiency, including pre-teaching preparations, topic proficiency, laboratory management and skills in linking topics to current development through a 3-point Likert scale (i.e. 1, Disagree; 2, Not sure; and 3, Agree). Results of the pilot study of *proficiency in chemistry* indicated a high level of reliability at 0.72

### **Data Analysis**

The MANOVA was conducted to identify the differences among teacher's perception on in-service training, collaboration and teacher proficiency in chemistry based on teaching experience. Meanwhile, SEM analysis was conducted to determine the correlation between latent (training, collaboration and mastery) and observed (teaching experience) variables under the assumption of a causal relationship among the hidden variables and to evaluate the correspondence of the covariance structure between the model and the observed variable. It considered the measurement error of each item in determining

model suitability. The SEM coefficients were estimated using the software AMOS 18. The current study used chi-square test, comparative fit index (CFI), goodness of fit index (GFI) and root mean square error of approximation (RMSEA) to assess model suitability and examine the null hypothesis. SEM tests were used to identify the effects of collaboration as an intermediary between in-service training and teacher proficiency in chemistry based on teaching experience. The current study also evaluated the indirect effects of collaboration by using the delta method based on the Sobel test (1982), which is suitable for large sample sizes.

## FINDINGS

### Differences among in-service training, collaboration and proficiency in chemistry based on teaching experience

Table 1 shows a significant difference between teacher's perception on in-service training ( $F = 5.25$  and  $\text{sig} = 0.02$ ,  $p < 0.05$ ) and collaboration ( $F = 5.79$  and  $\text{sig} = 0.02$ ,  $p < 0.05$ ) based on teaching experience. The eta-squared value of teacher's perception on in-service training and collaboration based on teaching experience is small (0.03). Teachers with more than 10 years of experience (mean = 4.03) have undergone more in-service trainings than teachers with less than 10 years of teaching experience (mean = 3.90). However, teachers who have less than 10 years of teaching experience (mean = 3.56) have higher collaboration levels than teachers who have more than 10 years teaching experience (mean = 3.49). Results of the MANOVA test showed no significant difference in teacher proficiency based on teaching experience ( $F = 1.69$  and  $\text{sig} = 0.20$ ,  $p > 0.05$ ), and the value of eta squared is small (0.01).

Table 1

MANOVA test results on differences among teacher's perception on in-service training, collaboration, and chemistry subject proficiency based on teaching experience

Variables	Teaching Experience	N	Mean	Standard Deviation	Type III square	df	F	Sig.	$\eta^2$
Trainings	< 10 years	64	3.90	0.30	0.69	1	5.79	0.02	0.03
	> 10 years	120	4.03	0.37					
Collaboration	< 10 years	64	3.56	0.22	0.22	1	5.25	0.02	0.03
	> 10 years	120	3.49	0.20					
Proficiency	< 10 years	64	2.51	0.22	0.07	1	1.69	0.20	0.01
	> 10 years	120	2.47	0.18					

### Effect of collaboration as an intermediary between teacher's perception about in-service training and chemistry proficiency of teachers with less than 10 years of teaching experience

Results of the SEM analysis via AMOS showed the collaboration mediated between teacher's perception on in-service training and proficiency and obtained values as follows:  $\text{chi square/df} = 1.59$ ,  $\text{RMSEA} = 0.04$ ,  $\text{GFI} = 0.98$  and  $\text{CFI} = 0.97$ . All measurements indicated that the data used in the current study are reasonably compatible with the proposed model.

The SEM analysis results indicated that the regression model is suitable and that teacher's perception on in-service training significantly affects proficiency ( $\beta = 0.23$ ,  $p$

<0.05) and collaboration ( $\beta = 0.35$ ,  $p < 0.05$ ). Furthermore, collaboration as an intermediary has a significant effect on proficiency in chemistry ( $\beta = 0.42$ ,  $p < 0.05$ ). The Sobel test results showed that the intermediary effect is significant ( $z = 2.82$ ,  $p < 0.05$ ), thereby proving that collaboration plays a significant intermediary role in the relationship between teacher's perception on in-service training and the proficiency of teachers who have less than 10 years of teaching experience.

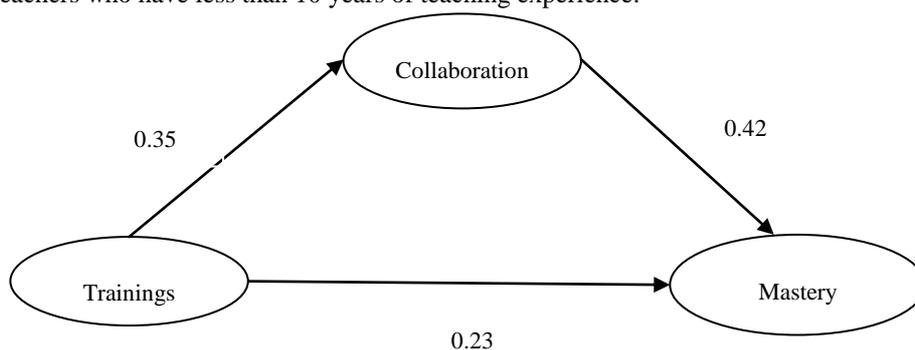


Figure 2  
Model of collaboration as an intermediary between teacher's perception on in-service training and proficiency in chemistry of teachers with less than 10 years of teaching experience

**Effect of collaboration as intermediary between teacher's perception about in-service training and chemistry proficiency of teachers with more than 10 years of teaching experience**

Results of the SEM analysis via AMOS showed collaboration mediated between teacher's perception on in-service training and teacher proficiency and yielded the values as follows: chi square/df = 2.71, RMSEA = 0.05, GFI = 0.95 and CFI = 0.94. All measurements indicated that the data used in the current study are compatible with the proposed model.

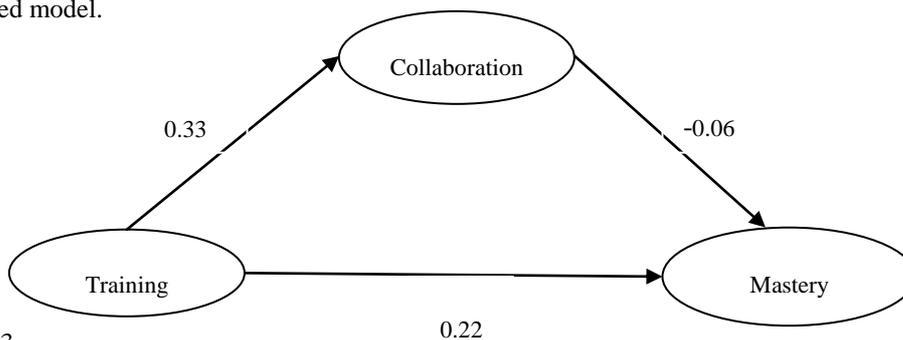


Figure 3  
Model of collaboration as an intermediary between teacher's perception on in-service training and chemistry proficiency of teachers with more than 10 years of teaching experience

The SEM analysis results indicated the regression model is appropriate when teacher's perception on in-service training significantly affects proficiency ( $\beta = 0.22$ ,  $p < 0.05$ ) and training significantly affects collaboration ( $\beta = 0.33$ ,  $p < 0.05$ ). Furthermore, collaboration has no significant intermediary effect on proficiency ( $\beta = -0.06$ ,  $p < 0.05$ ). The Sobel test results showed that the intermediary effect is significant ( $z = -0.55$ ,  $p > 0.05$ ). This result indicated that collaboration plays no significant intermediary role in the relationship between teacher's perception on in-service training and proficiency in chemistry among teachers who have more than 10 years of teaching experience.

## **DISCUSSION**

The MANOVA test results showed a significant difference between teacher's perception on in-service training and collaboration among chemistry teachers based on their teaching experience. Teachers with more than 10 years of experience have more perception on in-service trainings than teachers with less than 10 years of experience. Thus, experienced teachers have attended additional in-service trainings organised by government or by private organisations. Meanwhile, teachers with less than 10 years' experience are still new to the field of teaching, and they have not yet received sufficient in-service trainings. However, new and experienced (senior) teachers have the same proficiency level, indicating that senior teachers have not improved their proficiency or mastery of the chemistry subject. The equal proficiency or mastery level in chemistry that new and senior teachers possess revealed that in-service training has a positive effect on teacher proficiency or mastery of the subject. Mustafa and Othman (2011) stated that teacher's perception on in-service training plays a significant role in improving teacher performance through the acquisition of theoretical and practical aspects of knowledge and skills. This claim demonstrated further that teachers' perception on in-service trainings attended by chemistry teachers enhance their mastery and proficiency in chemistry.

The MANOVA tests showed that new teachers have higher levels of collaboration than senior teachers. Therefore, new teachers learn further about classroom preparation and engage in frequent discussions with friends to address instructional problems. Senior teachers have reduced their working involvement with colleagues. Senior teachers find that teaching on their own, that is, without collaborating with other teachers, is easy. Richter et al. (2011) stated experienced teachers actually prefer to teach on their own rather than to collaborate with other teachers, resulting in lack of communication among teachers, which will sequentially result in uninteresting teaching. According to Rashid (1999), a boring and unobtrusive teaching style leads to dull classroom conditions. This statement is supported by Abdullah et al. (2014), mentioning that non-specialist teachers or weak classroom teaching strategies negatively affect student learning.

Although a teacher might possess high qualifications, knowledge and training, he or she may fail and is unlikely to succeed in teaching if he or she cannot implement an effective teaching style. Thus, despite additional experience and training of a teacher, a lesson is meaningless without the use of good teaching styles, which will then affect student learning. Therefore, teachers must collaborate with their colleagues, especially in finding appropriate methods in teaching chemistry.

The SEM test results indicated that new chemistry teachers have mastered the subject through professional collaboration. Hence, aside from participating in in-service trainings, new teachers collaborate with other colleagues to improve their knowledge of the subject. The results of the current study proved collaboration is a significant medium for mastering the subject. Dufour et al. (2008) emphasised the importance of collaboration and discussed why teachers should not work in isolation because doing that hinders them from improving their teaching performance. Cooperation in a team of teachers can help enhance knowledge on the subject. All relevant parties should consider organising additional in-service trainings and collaborative activities for teachers with less teaching experience. Collaboration affects teacher proficiency and teaching practice and improves student achievement. Fullan (2011) supported this statement and mentioned that continuous efforts to work with colleagues establish a great learning team or workable networking. The implications of these efforts will improve student achievement.

The SEM test showed that unlike new teachers, senior teachers do not require collaboration to improve their proficiency or mastery of the subject. Senior chemistry teachers are more concerned in attending in-service trainings to improve their subject knowledge than new ones. Therefore, senior teachers are less likely to collaborate with other teachers than new ones. Generally, this result is one of the reasons why collaborative efforts among teachers are still rare in certain schools. The results of the current study are in line with the research findings on the professional learning community in schools. Educational institutions and relevant parties should be aware of the importance of teamwork and collaborative efforts. Thus, schools should create a culture of collaboration. However, certain schools do not encourage teachers to create such a culture (Boyd & Hord, 2012) because some chemistry teachers view collaboration in the process of subject mastery to be meaningless.

The findings of this study can be used by various parties in the field of chemistry education especially to the Education Ministry, who should organise in-service trainings as a contributing effort to enhance proficiency among chemistry teachers. The low proficiency of chemistry teachers implied previous trainings organised for teachers have not succeeded in enhancing their proficiency. Increasing teacher awareness on the importance of collaboration is also necessary, and schools should organise collaborative activities to involve teachers with various experiences. These efforts can be regarded as a part of an intervention program between senior and new or novice teachers. The current study will help pave the way for future researchers to conduct further studies on in-service training, collaboration and subject proficiency among chemistry teachers. Additional details, such as trust among colleagues and teacher credentials in determining how they affect teacher proficiency or mastery of chemistry, are important because they are potential contributing factors for improving collaboration and proficiency.

## **CONCLUSION**

The current study proved that collaboration is an influential factor in the proficiency and mastery of the chemistry subject among teachers with less than 10 years' experience. Thus, in-service trainings should be organised to encourage teachers to engage in

collaborative activities and to communicate and discuss with other partners to improve their teaching quality and proficiency. Various parties, including ministry and non-governmental agencies, should also be involved in this proposal to enhance teacher knowledge.

#### ACKNOWLEDGEMENT

The authors of this study would like to extend their sincere thanks to the Faculty of Teacher Training and Education of Riau University for the financial support, thus making this study a success.

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