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Discovering Mechanisms of Changes during Lesson Study in Mathematics Classroom

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In the current study the Main purpose is to use a new model of lesson study which discover mechanisms of change in the mathematics classroom. In this regard, six secondary school mathematics teachers and one professor of mathematics education co-operation for developing a new lesson which related to concept of trigonometry. This study administrated in 6 months and all members participate in 6 sessions for developing 3 research lessons. Indeed, lesson study was used as research design in current study. Results of this study show that the modified lessons which developed through respiting lesson study cycle in 3 times, work effectively and teaching method of mathematics' teachers was enhanced caused by this lesson study experience. Analysis of data reveals the mechanism of changes during this lesson study which are common attention, share experiences, observe challenges of teaching in the classroom, and feel the need and urgency of change. Furthermore, participants in this study mentioned some benefits of doing lesson study as affordances which are considering students' needs, increasing teachers' capability in the process of teaching and learning mathematics when students work in the group. Participant teachers in current study discussed about difficulties of using lesson study in their mathematics classroom.

***Keywords*:** lesson study, mechanism of changes, ratio, affordances

There are many factors which influence the process of learning and teaching mathematics. Some researchers such as Elsayed, Abbas, and Abdou (2021) focused on using educational theories for enhancing creativity of students in math education. However, in recent decades, many scholars in the field of education have emphasized the influence of the knowledge of teachers for increasing the quality of teaching and learning (Stigler & Hibert, 1999). Indeed, a high quality curriculum will be succeeding if educated teachers conduct it (Gooya, 2001). But, teachers of mathematics don't interest to follow top-down decision which provide by policy makers for curriculum changes (Clements & Elerton, 1996) and this caused increasing gap between educational theories and teachers teaching practices. Review of literature show that there are several approaches for engaging teacher in curriculum change. For example, through lesson study, teachers can collaborate for improving their teaching method upon solid knowledge from literature.

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DİSCOVERİNG MECHANİSMS OF CHANGES

Lesson study was introduced by Yoshida (1999) and after publication of a book with the title "Teaching Gap" (Stigler & Hiebert, 1999) distributed to the English speaking world.

Ministry of education in Iran introduced Lesson study and action research for several years, but results of several researches show that there is little evidence for improving teaching process (e.g. Chaichi, et al., 2006). In this regard Ponte (2017) call for doing more researches in new cultural context to adopt a suitable model for lesson study. In our study we try to present challenges and affordances of conducting modified lesson study model in Iran context. So, in this regard below three research question direct current study.

- In the process of teaching trigonometry ratio, what are the mechanisms of change?
- What are the component of modified lesson study cycle which works in the context of Iran?
- What are the limitations and affordances of using modified lesson study cycle?

The Lesson Study approach was used in Japanese schools for the first time for professional development of teachers. Indeed, this approach used by Japanese teachers. According to Isoda (2007) historical trend of lesson study reach to Meiji government in the 1880s. doctoral dissertation of Yoshida by 1999, introduced lesson study to the world. After that by the book with title "The Teaching Gap" lesson study introduced broadly to international educators (Stigler & Hiebert, 1999). Japanese lesson study has four steps contain goals, plane, research lesson and reflection (Lewis, 2002).

Currently, lesson study used by teachers and researcher from many countries around the world. Especially lesson study adopted for teacher education (Doig & Groves, 2011). In another study, Lewis et al., (2006) pointed to distribution of lesson study in many schools all over the United States of America. Similarly, in other places of the world modified model of lesson study has been implemented for example in UK (Department for Children, Schools and Families, 2008), in Canada (Miller 2010), in Australia (Pierce & Stacey 2009).

Iranian mathematics educators became familiar with lesson study through several papers that published in the national journals in Persian language (the official language of Iran). Gooya (1991) was one of the pioneers' papers related to lesson study which published in quarterly journal of education. Then the book with title "The Teaching Gap" translated into the Persian and then several master theses conducted around the countries in this regard. For example, Khakbaz (2007) in her master thesis developed a professional development model for middle school mathematics teachers based on lesson study, but her model concern about general aspects of education and wasn't related to specific mathematics content in real classroom.

Several studies (e.g. Lewis & Tsuchida 1998; Stigler & Hiebert 1999, Chen & Yang 2013), report that lesson study cause improve teaching process. Some other studies (e.g. Puchner & Taylor, 2006; Lewis et al., 2011; Murata et al., 2012; Lewis et al., 2013) show that lesson study cause improve teacher's pedagogical knowledge.

Methods

Participant of the study was six secondary school math teachers. All participants were female who participate voluntary in the study and they are interesting to learning through the process of this research in six months. Teaching experiences of participants varied from 10-20 years and all teachers work at secondary school level in one of the southeast provinces of Iran. Eight research lessons were designed during fifteen sessions of group discussion in the content of trigonometric ratio. Lesson study focused on trigonometric ratio, because, upon teachers' experiences usually students have difficulties to understanding trigonometric ratio. Several studies in literature discuss students' difficulties in trigonometric ratio, function and concepts (such as Weber, 2005; Gür, 2009; Akkoç & Akbaş-Gül, 2010; Moore, 2012 & Klein, 2015). Since trigonometric ratio, function and concepts appear in higher level of education and have several applications in different disciplines at university level, teachers who participated in this study concentrate on trigonometric ratio.

Several tools were used for data collection (e.g. interview with participants, observation of the process of teaching research lesson, fields note of participant, video of teachers meeting and classroom teaching, finally all handwriting of students' in the classroom). For data analysis, constant comparison method (Glaser & Strauss, 1967) applied for two sessions of research lessons. There are different ideas and models for lesson study, simple model has four step (see figure 1) which introduced by Lewis et al., (2006) which similar to the action research cycle introduced by Clements and Elerton (1996, see figure 2).

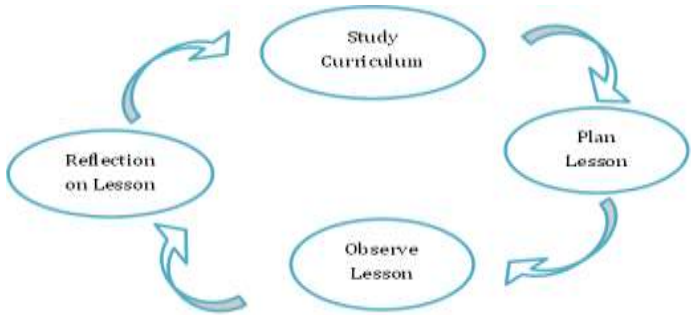

FIGURE 1. Four step model for Lesson Study (Lewis et al., 2006)

FIGURE 2. one cycle of Action Research (Clements and Elerton, 1996)

Results

Results which present in this section triangulated from field note, group discussion, and transcript of video recording. Results reveal that modified model of lesson study works properly in the Iran context. Teaching process of participant's teachers was changed and this show that the modified model of lesson study work effectively. For example, one of the teachers report she started her lesson with a diagnostic test in the future to find the strengths and weaknesses of learners.

Four changes identified in research lesson which are changes in discussion through whole-class, changes in structure of lesson, changes in choosing rich mathematical tasks, and changes in questions that teachers ask during the process of teaching of concept. Mechanisms which direct these changes were common attention, share experiences, observe challenges of teaching in the classroom, and feel the need and urgency of change.

Participants of current study reveal affordances and challenges of using modified model of lesson study. Indeed, they discussed that lesson study increased teachers' consciousness for considering students' need and ability of teachers improved through group working. Teachers who engaged in this study also talk about challenges of using modified lesson study model which are administrative structure and limitation in time. Participants start to introduce typical classroom which teacher teach trigonometry ratios. One of teachers said that I usually start the teaching with a question "how you can calculate the height of a supposed building with math concept?" and then I start to teach trigonometry trough discussing about right triangular. But, another two teacher said we start with an activity from textbook. Indeed, they start by asking students to do special activity. Another Teacher prefer to start with figure 3 to introduce trigonometry ratios.

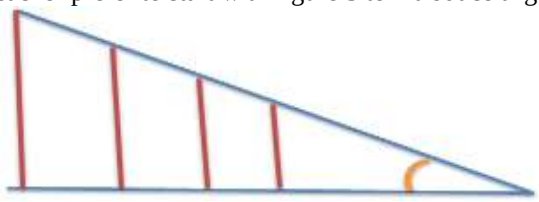

FIGURE 3. *Starting point for introducing trigonometry ratios*

The last teacher who start her lesson by figure 3, discussed about trigonometry ratio in different triangular which gives us a same result. Indeed, if we consider angle constantly, the sides become larger as the ratio of the opposite side to the chord and the side adjacent to the chord remain constant. After several discussions about starting point for teaching trigonometry ratios, participants start to plane a lesson.

Review of literature about lesson study cycle (e.g. Fernandez, & Yoshida, 2004; Lewis, Perry, & Hurd, 2009; Robinson, & Leikin, 2011; Rafiepour, 2017), show there are some common features in all lesson study cycle. Upon literature review and experiences of writers a suitable model introduced as figure 4. Indeed, essence of all lesson study cycles are the same and based on teachers' collaboration around a common educational goal. In the previous lesson study cycle that exist in literature, there is no starting point

for discovering a problem for starting lesson study. Although in Rafiepour (2017) point to this issue briefly, but researcher experiences show that teachers of mathematics still need more help for defanging a problem for starting lesson study. As shown in figure 4, three sources (teachers' experiences, teachers' knowledge and solid knowledge from research) introduced for discovering a problem in lesson study cycle.

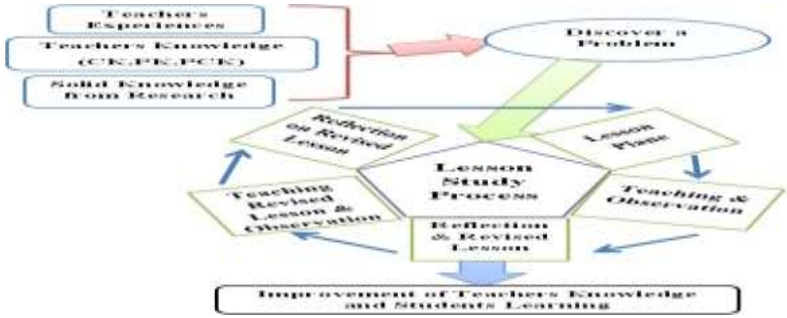

FIGURE 4. *Modified Lesson Study Model*

Discussion and Conclusions

Lesson study discussed in several research paper and it seems that implementation of lesson study is simple, but according to Yoshida (2008) it is not an easy activity. Several researchers try to adopt lesson study in new cultural contexts, but there are some evidences which show lesson study doesn't implement in a new context necessarily. As an example, Stigler and Hibert (2016) mentioned reasons of failure of USA at using Lesson Study for teacher professional program. Like Stigler and Hibert (2016), Yoshida (2012) discussed that sometime, lesson study focused on developing an exemplary lesson rather than developing knowledge of teachers and in some cases teachers watch videotaped research lessons rather than observe live lessons. These experiences could be misleading of teachers and researchers.

Research report show that there are several adaptations for lesson study in different countries around the world. Fujii (2014) like Yoshida (2012) discussed that some of these adaptations of lesson study which occurred outside Japan include misunderstanding. Indeed, we have to mention the cultural assumptions that underpinning the process of teaching and learning in each culture and we have to consider gradual change for reaching to educational goals. So, we have an open research question which is to what extent lesson study can be implemented into the new context (Lewis et al., 2009). In our study this open question examined in the Iranian context, through a cycle which is shown in figure 4. Results of our study show that implementing of this cycle can be useful and efficient for Iranian math teachers. Further research can use modified lesson study model that shown in figure 3 and try to present more empirical data to indicate the appropriateness of lesson study cycle which used in current study.

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