Using instructional video to improve awareness of scientific approach in science classroom

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Contents

Abstract

Instructional videos have been developed to engage pre-service teachers to learn how to teach scientific approach in science classroom. This study aimed to improve pre-service teachers' awareness of scientific approach in science classroom through instructional video along with their responses. Thirty two pre-service science teachers from Universitas Negeri Surabaya, Surabaya, Indonesia, participated in this study and observed two different instructional videos using video-analysis worksheet supplemented by the supervisor. In response to the instructional video, results showed that pre-service teachers noticed well about application of scientific approach in inquiry-based teaching and cooperative learning models. Pre-service teachers also showed positive views about the instructional videos and became a reflection for their own future teaching actions and practices. Supplementation of the video-analysis worksheet during the implementation and peer-discussion among pre-service teachers can be used to improve pre-service teachers' awareness as well as to provide clear exemplary about how to integrate scientific approach at each phase of inquiry-based teaching and cooperative learning models. This study implies that the present instructional videos and followed-up video-analysis task are adequate to facilitate pre-service teachers to understand what to do in actual classroom in terms of applying scientific approach as envisioned by Indonesia curriculum reform.

Keywords: instructional video, scientific approach, modelling, science teaching, pre-service teacher education

Introduction

In 2013, Ministry of Education and Culture (MOEC) of Indonesia reformed the curriculum of primary and secondary education in response to the goal of increasing quality of education. One of the main characteristics of the new curriculum, known

as Curriculum 2013, is the implementation of scientific approach throughout all of the subjects, including sciences (biology, chemistry, and physics) (MOEC, 2012). Consequently, local teachers should be prepared to teach with scientific approach and engage their students to do so in classroom activities, or even in daily life. In fact, though most teachers realize the need of applying latest strategies in the classroom, they often become clueless about how to put their thoughts and ideas into practice (Leden, Hansson, Redfors, & Ideland, 2013). Within this context, it is essential to educate pre-service teachers with the latest educational reform effort from the government and the wisdom of best practice (Moseley, Ramsey, and Ruff, 2004).

As MOEC implements Curriculum 2013, schools and Teacher Training Institutes within universities (LPTK) in Indonesia show the need of exemplary modelling to prepare teachers for teaching with scientific approach. This indicates the need of instructional video which can provide adequate example of teaching with scientific approach. Video promises accessible modelling of instructional practices for teachers, making dissemination of information in the new curriculum more effective (Dieker et al., 2009). Whyte (2011) also indicates that video technology can help teachers to be more concerned with pedagogical principles and wide-ranging teaching strategies. In terms of learning flexibility, instructional video provides opportunity to collaboratively study teaching practice without being physically present in the actual classroom or tied to the time and space (Borko, Koellner, Jacobs, & Seago, 2011; Sherin, Linsenmeier, & van Es, 2009).

Teaching science with scientific approach utilizes scientific method and science process skills to trigger the students actively finding the knowledge and concept they need to solve problem. Integration of scientific methods requires teachers to approach science teaching like a science in which practices and conclusions are based on the objective data rather than conventional lecture (Wieman, 2007; Wieman & Gilbert, 2015a; Wieman & Gilbert, 2015b). Curriculum 2013 describes five steps of scientific approach: (1) observing (to identify problem), (2) questioning (and posing hypotheses), (3) collecting data and information (conducting experiment), (4) analyzing data (associating), and (5) communicating result (MOEC, 2014). Observing involves the ability to use five senses to gather the data. This first step of observation aids the student to identify existing problems. Observation leads to question that needs to be answered, called questioning stage, such as how a

phenomenon happens or why the problem occurs. Scientific questions then lead the students to generate hypothesis of the problem. Building hypothesis requires careful preliminary research and literature review of the problem (McLelland, 2006). Following the effort to accept or reject the hypothesis, students need to conduct process of collecting data and information, for instance through experimentation, investigation, surveys, or interviews to the expert. Afterwards, the collected data and information should be analysed together with the hypothesis to avoid incorrect interpretation and affirm consequence; in advanced level, this is commonly conducted using mathematical analysis or model (Giere, 2001). Last, student can be encouraged to share or communicate the result of their discovery. Sometimes, scientific approach also includes other final stage called creating in which the students create original ideas to solve the existing problem or to apply solution in other situation (MOEC, 2014).

Instructional Video: Bridging Teachers to Learn for Professional Development

Instructional video has its theoretical framework in Bandura's Social Learning Theories which argues that human behaviour is primarily learned by observing others and/or modelling others; thereby implying that modelling is a process by which a model (live, recorded, or imagined) demonstrates behaviour that can be learned and/or imitated by the learners (Delano, 2007; LeBlanc et al., 2003). Instructional video integrates modelling and video as visual cues (Bellini & Akullian, 2007) then expects the teachers engages themselves in specific behaviour which is planned to teach. Escalada and Zollman (1997) also add that visual cues from simulations, models, and video develop understanding and concepts by attaching mental images or visual association. This mental images attachment causes instructional video become powerful tool to help teacher to describe pedagogical knowledge in more realistic and interesting ways than verbal description does.

According to the perspective of professional development, there are two main purposes of providing instructional video to pre-service teachers: (1) normative perspective and (2) 'developmentalist' perspective. The first purpose is constructing 'what to do' in classroom which is designed from 'normative' perspective, while the second purpose is building knowledge on 'how to interpret and reflect on classroom practices' which is designed from 'developmentalist' perspective (Blomberg, Renkl, Sherin, Borko, & Seidel, 2013). In normative perspective, instructional video

demonstrates best practice of teaching actions which build knowledge about 'what to do' in classroom (Yung, Wong, Cheng, Hui, & Hodson, 2007), indicating that teachers receives source model to apply pedagogical strategies and modify the details for their own need. On the contrary, developmentalist perspective put the instructional video to provide conception of 'good' and 'bad' teaching practice to challenge teachers in developing new personal understanding about teaching and learning (Wong et al., 2006). Once teachers observe an instructional video, they are not only simply a 'viewer' but also an observer who can reflect on their own beliefs and practices (Coffey, 2014; Newhouse, 2007; Masats & Dooly, 2011). Therefore, developmentalist perspective encourages teachers to critically analyse and evaluate teaching actions of model teacher then consider how they will act to handle the similar condition. Hence, instructional video takes important role in teacher's professional development by (1) improving quality of teaching and learning activity; (2) potentially enhancing drive to learn, memorize, and conduct specified teaching skills; and (3) helping to solve specific problem that may be raised from actual classroom (Agommuoh & Nzewi, 2003; Gaudin & Chaliès, 2015; Kisa, 2013; Lin, 2005).

Susantini, Faizah, Prastiwi, & Suryanti (2016) have developed instructional videos using ASSURE model, of which the videos have been given a copyright in 2016. Generally, the videos show a teacher who conducts a teaching and learning process followed by sequential activities covering six stages in scientific approach namely observing, questioning, exploring, associating, communicating and creating. Because there are two videos, thus, there are two different contents of the videos. The content of the instructional video for chemistry class covers the explanation as well as the experiment done to reveal the effect of catalyst to the chemical reaction. Meanwhile, the instructional video for biology class explains about acid rain including how it happens, its various level of acidity (pH), and the effect of different pH to plants. In the video, the teacher uses an inquiry-based teaching model for chemistry class while cooperative learning for biology class.

Varying Models of Teaching to Apply Scientific Approach in Classroom

Scientific approach as a teaching strategy requires incorporation with model of teaching with systematic series of prescribed steps or phases (called syntax) of teacher and student's behaviours. The two teaching models used in this study are

frequently taught in the Teacher Training institute of Indonesia universities (LPTK) to prepare pre-service science teachers to be familiar with student-centred approach: inquiry-based teaching and cooperative learning. Such models with student-centred approach become significant in Curriculum 2013 because both provide students with opportunities to engage with problem-solving activities.

Inquiry-based teaching trains students to conduct investigation to collect and process the data in order to establish conclusion; thereby inquire and figure things out by thinking (Sweeney, 2007). In this context, teacher may facilitate the whole learning process or provide small hints through a worksheet or other guidebook to aid the students solving a discrepant event. Discrepant event should ignite students' curiosity and meet three criteria (Magnusson and Palincsar, 1995 in Arends, 2012): rich of concepts, flexible, and relevant to the everyday's situation. Inquiry-based teaching is reported to be successfully incorporated with scientific approach in science classroom (Haefner, Friedrichsen, & Zembal-Saul, 2006; Wilke & Straits, 2005).

Cooperative learning fosters students to learn in small groups and help each other to learn collaboratively. In cooperative learning model, we notice that there are: (1) recognition of group's work; (2) individual responsibility; and (3) equal possibility to achieve successful learning (Slavin, 2009). In cooperative learning model, the instruction should involve students to work together so that the students learn in collaboration with more capable peers rather than depend solely on the teacher as primary source of information (Prince & Felder, 2006). Zakaria and Iksan (2007) reported that cooperative learning model in mathematics and science education was effective to actively stimulate students to complete academic tasks due to its nature of collaborative shared-ideas.

All in all, this study argues that inquiry-based teaching and cooperative learning model can be used for a student-centred learning approach which is relevant to Curriculum 2013. Moreover, the use of both models can support the implementation of scientific approach that has become a firm characteristic of Curriculum 2013 in Indonesia.

Importance of the Study

We developed sets of instructional video as a source model to test out scientific approach teaching strategy to be applied by the teachers in their own classroom. At

initial stage, we expect that this instructional video can build pre-service teachers' knowledge on what and how to do in science classroom to apply scientific approach. In future, this instructional video also aims to target Indonesian teachers to apply scientific approach in variety of classroom and subject circumstances. Brunvard (2010) argues that instructional video which is accompanied with microteaching helps pre-service teacher to connect authentic situation with their own existing knowledge about pedagogical strategies. Video helps teachers to learn what really happens in class, correct teaching practice, and reflect themselves in perceiving good teacher (Sherin & van Es, 2005; Wong, Yung, Cheng, Lam, & Hodson, 2006). In investigating how the instructional video affects learning process of pre-service teachers in applying scientific approach, this study is designed to improve pre-service teachers' awareness of scientific approach in science classroom through instructional video and describe pre-service teachers' responses about the instructional video.

Methods

Research Design

This study is qualitative research. The survey was carried out from a subject of pre-service science teachers in Universitas Negeri Surabaya, a teacher training institutes in East Java, Indonesia, by asking number of questions through task-based worksheet and questionnaire.

Participants

Participants of this study were 32 pre-service teachers in the Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya, Indonesia who took major in Biology Education (12 out of 32) and Chemistry Education (20 out of 32). The participants' age range was 19-20 years old. These pre-service teachers spent at least two years preparation program to learn about pedagogical skills, educational theory, and subject content of each major. They were also familiar with scientific approach in Curriculum 2013 but they had no actual classroom experience of its implementation. Before this study began, we explained that pre-service teachers' grades would not be affected by any assignments given during the study.

Research Instrument and Procedure

The data of the study were collected through pre-service teachers' video-analysis worksheet and questionnaires which examine pre-service teachers' understanding and perspective on teaching science with scientific approach. There were two instructional videos used in this study: (1) implementation of scientific approach in inquiry-based teaching for chemistry class; and (2) implementation of scientific approach in cooperative learning for biology class. All instructional videos, which were developed by the authors and got a copyright in 2016, were evaluated by three independent educational experts before implementation to the pre-service teachers. The evaluation covered physical dimension of the instructional video (quality of sound, picture, lighting, and texts), content of teaching, relevance of learning outcomes, relevance of scientific approach implementation, and syntax of models of teaching. The total duration of each video was 25-30 minutes. There were lecture notes in the beginning and the ending parts of instructional video, explaining learning syntaxes, principle of scientific approach, and constructivism-view why scientific approach was essential in science education. Some specific scenes which depicted learning phases and scientific approach steps were also captioned to help pre-service teachers notice essential events in classroom.

Instructional videos were simultaneously applied to the two different majors of pre-service teachers: first instructional video (scientific approach with inquiry-based teaching in chemistry classroom) was applied to the group of pre-service teachers majored in chemistry education, while second instructional video (scientific approach with cooperative learning in biology classroom) was applied to the group of pre-service teachers majored in biology education. In the beginning of the session, pre-service teachers were divided into groups to promote peer-discussion. They observed the instructional video as they completed a worksheet to analyse the video content (Susantini, Yonata, Faizah, & Suryanti, 2015) (as in Appendix A). The worksheet encouraged pre-service teachers to discuss which scientific approach steps appeared at each phase of model of teaching and explore any areas of teaching they want to improve in the instructional video. A supervisor (one of authors) also evaluated how the pre-service teachers noticed the scene where each scientific approach step appeared. The pre-service teachers also filled in a questionnaire about the instructional video and whole learning process.

Video 1: Scientific Approach with Inquiry-based Teaching in Chemistry Classroom

One instructional video depicted a model teacher who explained the effect of catalyst to the chemical reaction in chemistry classroom. Inquiry learning was started with phase where teacher compare chemical reaction which used catalyst and which is not through animation. Students were then directed to phenomena of laboratory inquiry in which purple solution consisting $H_2C_2O_4$, H_2SO_4, and $KMnO_4$ slowly changed into colourless when $MnSO_4$ was added. The other solution containing the same chemicals without addition of $MnSO_4$ remained purple. Students were led to synthesize the hypothesis that chemical reaction rate, which is indicated by the colour changes, was increased due to the addition of catalyst. Experiment was then continued and the data were recorded to prove whether the hypothesis accepted or rejected. Teacher asked the students to create project about the application of catalyst in everyday life. In the next meeting, the students presented various products representing the use of catalyst. The lesson was ended after teacher concluded what students had learned.

Video 2: Scientific Approach with Cooperative Learning in Biology Classroom

The other one instructional video showed that a biology teacher aimed to explain the effect of acid rain to the living organisms and environment by applying scientific approach in cooperative learning. Cooperative learning initial phases were followed up by laboratory session in which students conducted experiment using provided materials. The purpose of the experiment was to investigate the influence of various level of acidity (pH) with pH range 2, 4, and 6 to green bean germination. Students recorded the data covering number of leaves, the length of the plants, and the number of germinated seeds. They inferred that the bean showed optimum growth in pH 7 and poor growth in lowest pH. This result led students to the conclusion that acid rain damaged the environment and living organisms. After the experiment covering steps of scientific method finished, cooperative learning was preceded to the final phase in which model teacher ask students to creatively draw a poster about how to prevent acid rain. The lesson ended as the teacher announced best group to recognize students' studying effort and briefly concluded the lesson.

Data Collection and Analysis

Video-analysis worksheet was used to analyse how the video helps the pre-service teachers aware of the implementation of scientific approach in science classroom. Pre-service science teachers completed the video-analysis worksheet while they

observed the video and discussed about the content in groups (in 90 minutes). Answers to the worksheet, which were collected based on the pre-service teachers' group discussion, were then calculated in percentage. Data about pre-service teachers' response was collected using questionnaire. The questionnaire was arranged in dichotomous structured statements asking for a Yes/No response. Result of pre-service teachers' responses were calculated in percentage. There was also an open column in the questionnaire asking for comments to record pre-service teachers' unstructured response. These comments were described and analysed descriptively to support pre-service teachers' yes/no statements.

Reliability and Validity

The instructional videos were developed using ASSURE model (Susantini et al, 2016) and got a copyright in 2016. Generally, the videos depicted two teachers who handled different classes namely chemistry and biology class. The teachers used different teaching models namely inquiry-based teaching model for chemistry class and cooperative learning model for biology class. Both videos showed how scientific approach could be used in each model using followed six stages namely observing, questioning, exploring, associating, communicating and creating (Susantini et al, 2016).

In order to ensure the reliability and validity, implementation of the instructional video in pre-service teachers was observed by three independent observers. Observers monitored learning process and classroom interactions between supervisor and pre-service teachers based on 4 points Likert Scaling observation sheet comprising steps how well the instructional video carried out to pre-service teachers. This observation resulted 3.84 points for chemistry classroom and 3.82 points for biology classroom, indicating that implementation of instructional video in teaching scientific approach to pre-service teachers was quite reliable. Data triangulation between video-analysis worksheet and responses was also conducted to check the relevance and the consistency of the result and interpretation.

Result and Discussion

Scientific Approach in Science Classroom Identified

Pre-service teachers described the implementation of scientific approach in chemistry classroom using inquiry-based teaching as in Table I. It can be inferred from Table I that pre-service teachers noticed all elements of scientific approach at each phase of inquiry-based teaching. Observing stage appeared at phase presenting inquiry problem (phase 2), questioning showed at phase formulating hypothesis (phase 3), and collecting data staged at phase collecting data for testing hypothesis (phase 4). Analyzing data appeared at phase 5 when students formulated explanations, while communicating data and creating were demonstrated both in phase 5 and phase 6. Slightly low achievement at phase 3 (75%) indicated that not all pre-service teachers was aware of questioning stage.

Table I. Application of scientific approach in inquiry-based teaching which was noticed by the pre-service teachers

Phase of inquiry-based teaching	**Scientific approach (as in worksheet answers)**	**Percentage of pre-service teachers' correct answers (%)**
Phase 1: Gain students' attention and explain the inquiry process	Not appear	Not appear
Phase 2: Present the inquiry problem or discrepant event	Students *observed* the inquiry problem about catalyst effect on the chemical reaction rate in the worksheet	100
Phase 3: Have the students to formulate hypothesis to explain the problem or event	Teachers *guided the students to synthesize research question* according to the phenomena	75
Phase 4: Encourage students to collect data in order to test hypothesis	• Students *collected data* by defining hypothesis and variables of their experiments • Students *collected data and information based on their experiment* adding catalyst MnSO4 into solution of H2C2O4, KMnO4 and H2SO4	100
Phase 5: Formulate explanations and/or conclusion	• Students *analysed the data by comparing and contrasting* experiment result with the analysis question in the worksheet • Students *communicated* their experiment result • Teacher *asked the students to create project* about catalyst effect in everyday life	100
Phase 6: Reflect on the problem situation and the thinking process used to inquire into it	• Teacher asked the students *to communicate* whether their hypothesis fitted the experiment result in order to reflect on the thinking process	100

	• Students *showed their created product* which indicated how catalyst worked, i.e. yeast-fermented cassava, ethylene-ripen banana, auxin treatment on germination in light and dark places, and poster about enzyme.	

*italic sentences indicate scientific approach elements

Table II described the implementation of scientific approach in using cooperative learning model noticed by biology pre-service teachers. Similar to the application in chemistry classroom, the application of instructional video in biology classroom indicated that all elements of scientific approach at each phase of cooperative learning can be noticed well. Observing and questioning stage appeared at the same initial phase of cooperative learning as model teacher presented information (phase 2). This was followed by collecting data (experimenting) and analysing at phase assisting teamwork and study (phase 4). Communicating data and creating was demonstrated at phase testing on materials (phase 5). Compared to the chemistry classroom which showed low awareness in questioning stage, pre-service biology teachers was weak (70%) in noticing collecting data (experimenting) stage.

Table II. Application of scientific approach in cooperative learning which was noticed by the pre-service teachers

Phase of cooperative learning model	**Scientific approach (as in worksheet answers)**	**Percentage of pre-service teachers' correct answers (%)**
Phase 1: Clarify goals and establish set	Not appear	Not appear
Phase 2: Present information	• Students *observed* phenomena of acid rain and its ecological effects through documentary movies and interactive videoTeacher *encouraged students to give comments and ask questions* about acid rain phenomena which they had observed • Students *synthesized research question* and hypothesis concerning effect of acid rain to plant growth and development	100
Phase 3: Organize students into learning teams	Not appear	Not appear
Phase 4: Assist teamwork and study	• Students *conducted experiment* to investigate the effect of pH to plant germination	70

	• Students *collected and analysed data*, including number of germinated seeds and length of plants • Teacher asked the students to *create a poster* about the effect of acid rain to environment	
Phase 5: Test on materials	• Teacher have the students *to communicate the experiment result* in the presentation and classical discussion format • Students *created posters* concerning acid rain prevention campaign • Teachers asked students *to communicate their posters*	100
Phase 6: Provide recognition	Not appear	Not appear

*italic sentences indicate scientific approach elements

Despite slightly low scored awareness in noticing questioning stage and collecting data stage, both of the instructional video successfully enabled pre-service teachers to understand good teaching practices concerning application of scientific approach in science classroom as they regard each phase of specific model of teaching. This is in line with research from Wong et al. (2006) describing that teacher can perceive good science teaching from the instructional video by broadening their awareness of alternative teaching methods and approaches even they are not experience it on their own. Exemplary teaching in instructional video has been reported applicable to prepare teachers to perform and practice teaching skills in situation-specific classroom that closely match with targeted-performance (Star & Strickland, 2008; Yung et al., 2007). Sherin and van Es (2005) also argues that instructional video-based professional development provides opportunities for teachers to develop good techniques or teaching strategies that are in line with learning objectives and education reform efforts.

Interestingly, this study emphasize that writing notes about the scene, in terms by answering the video-analysis worksheet and discussing the instructional video in group, helped pre-service teachers to easily identify and analyse what elements of scientific approach activities appeared in each phase of model of teaching. Alsawaie and Alghazo (2010) indicated that video lesson analysis improved pre-service teachers' ability to pay attention to noteworthy events classroom interactions. Higher scores on the video analysis task were associated with better instructional quality

(Kersting, Givvin, Thompson, Santagata, & Stigler, 2012). In addition to these, Fadde and Sullivan (2013) reported that pre-service teachers who wrote their own observations when observing video clips showed better classroom awareness. Kourieos (2016) also added that peer dialogue during the use of video indicated great potential to heighten teacher's awareness about their own teaching practice, supporting the idea that the discussion with peers takes parts in pre-service teachers' learning process with the instructional video.

Pre-service Teachers' Response about the Instructional Video

Pre-service teachers showed positive response to the instructional video in which they had observed (Table III). In consistency with Table II, pre-service biology teachers also showed low positive response in collecting data.

Table III. Pre-service teachers' response about the instructional video

Criteria	Percentage who answered positive in chemistry classroom (%)	Percentage who answered positive in biology classroom (%)
Scene of the instructional video was clear	100	100
Sound of the instructional video was clear	100	91.7
Caption of the instructional video was clear	100	91.7
Language used in the instructional video was easily understood	100	100
Learning activities in the instructional video was systematically arranged	100	100
Content of the instructional video was appropriate with concepts in subject content	100	100
Learning objectives in the instructional video could be used as exemplary	100	100
Lab materials and instruments could be provided easily	100	91.7
Learning activities could help to describe teaching steps with scientific approach:		
• Observing	100	83.3
• Questioning	93.8	91.7
• Collecting data (experimenting)	100	66.7
• Analyzing/associating	93.8	83.3
• Communicating	100	100
• Creating	87.5	91.7

Pre-service teachers found that video-analysis worksheet helped them to figure out how to integrate scientific approach at each phase of model of teaching. As one of them asserted:

"Learning to teach from an instructional video was really helpful to figure out what really happened in the classroom between teacher and students during cooperative learning model. Video-analysis worksheet also made me easily observe noteworthy scene in scientific approach." (Biology pre-service teacher A)

"Prior to the instructional video observation, I had no idea about how to apply scientific approach in inquiry-based teaching. Observing [that] instructional video inspired me to design an inquiry-based student worksheet to help me structuring the whole idea of student's experiment in chemistry laboratory." (Chemistry pre-service teacher A)

According to those comments, pre-service teachers perceived that the instructional video was helpful in helping them to learn how to apply scientific approach in science classroom with any models of teaching. This was in line with studies from Akerson, Abd-El-Khalick, and Lederman (2000) and Akerson, Morrison, and McDuffie (2006) that indicated positive views of scientific approach perceived by the teachers who received reflective course in nature of science.

Pre-service teachers also showed reflective behaviour after they were asked to write what parts of the instructional video should be improved or conducted in different ways. They evaluated learning activity conducted by the model teacher in the instructional video and provide constructive advice. As several students asserted:

"I learned a lot about classroom teaching through the instructional video and I was trying to look closely about the essential points of scientific approach by rewinding the scene at home and evaluated what could I do better in my future classroom." (Biology pre-service teacher C)

"It is nice to know that implementing scientific approach makes students can construct their own knowledge rather than listening to teacher's explanation, but then I wonder that whole learning process really needs two meeting to complete the

material – it is really time-consuming. We suggest that the teacher make the project of creating acid rain poster as homework." (Biology pre-service teachers F 1)

"I did not think that showing lab-based catalyst like MnSO4 was the best discrepant event to start inquiry-based teaching with scientific approach. It would be more interesting if the teachers initiate the lesson by demonstrating well-known or daily life phenomena in order to gain more attention and stimulate questions from the students." (Chemistry pre-service teachers D)

"The scientific approach teaching in the instructional video was nice and neat, but I thought it would be better if the teacher strengthen collecting data stage, such as more focusing to show how the students measure the growth using ruler and count germinated seeds or number of leaves of the plants in the different acidity." (Biology pre-service teacher B)

Based on those views, reflective behaviours in terms of developmentalist perspective showed pre-service teacher's analysis and evaluation towards the instructional video. They ended up suggesting 'good' teaching practice, including selecting familiar discrepant events to initiate inquiry process and reinforce questioning stage, strengthening collecting data stage, taking the project to home for better time management. This indicates that teacher learn meaningful teaching strategies and pedagogical knowledge by observing the instructional video. In line with this result, Slavin (2009) confirms that learning can be done by observing others, supporting the idea that that teachers can learn how to teach in accordance to the observations from the model teacher's and students behaviour in the instructional video. Kucuk (2008) also reported the same finding that reflective approach, in this case through instructional video which followed by teaching practice, improved pre-service teachers' views about implementation of scientific approach in science teaching. The result of this study is also supported by study from Wong et al. (2006) arguing that instructional video (1) stimulates teachers to communicate their conception about teaching and learning, (2) encourages teachers to explore their ideas to respond similar problematic conditions, (3) presents teachers' alternative views beyond their own experiences, (4) supports teachers in developing their ideas to accommodate complexity of science classroom.

Conclusion and Suggestion

Although this study was only preliminary evaluation to the present instructional video, it could be inferred that pre-service teachers could learn on how to teach scientific approach in science classroom and perceive good response in that accordance through a modelling in the instructional video. To provide clearer evidence on how the instructional video affects implementation of scientific approach, there should be more studies which disseminates the instructional video to the large sample of teachers and evaluates pre-service teachers' pedagogical skills in implementing scientific approach.

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References

Agommuoh, P. C., & Nzewi, U. M. (2003). Effects of Videotape Instruction on Secondary School Students Achievement in Physics. *Journal of STAN*, *38*(1&2), 88-93.

Akerson, V. L., Abd-El-Khalick, F., & Lederman, N. G., (2000). Influence of reflective explicit activity-based approach on elementary teachers' conceptions of nature of science. *Journal of Research in Science Teaching*, *37*(4), 295-317.

Akerson, V. L., Morrison, J. A., & McDuffie, A. R. (2006). One course is not enough: pre-service elementary teachers' retention of improved views of nature of science. *Journal of Research in Science Teaching*, *43*(2), 194-213.

Alsawaie, O. N., & Alghazo, I. M. (2010). The effect of video-based approach on prospective teachers' ability to analyze mathematics teaching. *Journal of Mathematics Teacher Education*, *13*, 223-241.

Arends, R. I. (2012). *Learning to Teach* (9th ed.). New York: Mc Graw Hill

Bellini, S., & Akullian, J. (2007). A meta analysis of video modeling and video self-modeling intervention for children and adolescents with autism spectrum disorders. *Exceptional Children*, *73*, 264-287.

Blomberg, G., Renkl, A., Sherin, M. G., Borko, H. & Seidel, T. (2013). Five research-based heuristics for using video in pre-service teacher education. *Journal for Educational Research Online*, *5*(1), 90-114

Borko, H., Koellner, K., Jacobs, J., & Seago, N. (2011). Using video representations of teaching in practice-based professional development program. *ZDM Mathematics Education*, *43*, 175-187.

Brunvard, S. (2010). Best practices for producing video content for teacher education. *Contemporary Issues in Technology and Teacher Education*, 10(2), 247-256

Coffey, A. (2014). Using video to develop skills in reflection in teacher education students. *Australian Journal of Teacher Education*, *39*(9), 86-97

Delano, M. E. (2007). Video modeling interventions for individual with autism. *Remedial and Special Education*, *28*, 33-42.

Dieker, L. A., Lane, H. B., Allsopp, D. H., O'Brien, C., Butler, T. W., Kyger, M., Lovin, L., & Fenty, N. S. (2009). Evaluating Video Models of Evidence-Based Instructional Practices to Enhance Teacher Learning. *Teacher Education and Special Education*, *32*(2), 180-196.

Escalada, L.T. & Zollman, D.A. (1997). An Investigation on the Effects of Using Interactive Digital Video in a Physics Classroom on Student Learning and Attitudes. *Journal of Research in Science Teaching*, *34*(5), 467-489.

Fadde, P. & Sullivan, P. (2013). Using interactive video to develop teachers' classroom awareness. *Contemporary Issues in Technology and Teacher Education*, *13*(2), 156-174.

Gaudin, C. & Chaliès, S. (2015). Video viewing in teacher education and professional development. *Educational Research Review*, *16*, 41-67.

Giere, R.N. (2001). A New Framework for Teaching Scientific Reasoning. *Argumentation*, 15, 21-33.

Haefner, L.A., Friedrichsen , P.M., & Zembal-Saul, C. (2006). Teaching with Insects: An Applied Life Science Course for Supporting Prospective Elementary Teachers' Scientific Inquiry. *The American Biology Teacher*, *68*(4), 206-212.

Kersting, N. B., Givvin, K. B., Thompson, B. J., Santagata, R., & Stigler, J. W. (2012). Measuring Usable Knowledge: Teachers' Analyses of Mathematics Classroom Videos Predict Teaching Quality and Student Learning. *American Educational Research Journal*, *49*(3), 568-589.

Kisa, M.K. (2013). *Science teachers' learning to notice from video cases of the enactment of cognitively demanding instructional class* (Doctoral dissertation). Retrieved from ProQuest Dissertation & Theses database. (UMI No. 3577155).

Kourieos, S. (2016). Video-Mediated Microteaching – A Stimulus for Reflection and Teacher Growth. *Australian Journal of Teacher Education*, *41*(1), 65-80.

Kucuk, M. (2008). Improving Preservice Elementary Teachers' Views of the Nature of Science Using Explicit-Reflective Teaching in a Science, Technology, and Society Course. *Australian Journal of Teacher Education*, 33(2), 16-40.

LeBlanc, L. A., Coates, A. M., Daneshvar, S., Charlop-Christy, M. H., Morris, C., & Lancaster, B. M. (2003). Using video modeling and reinforcement to teach perspective-taking skills to children with autism. *Journal of Applied Behavior Analysis*, *36*(2), 253-257.

Leden, L., Hansson, L., Redfors, A., & Ideland, M. (2013, September). *Why, When, and How to Teach Nature of Science in Compulsory School: Teachers' Views*. Paper presented at the 10th Conference of the European Science Education Research Association (ESERA), Nicosia, Cyprus. Retrieved from http://www.esera2013.org.cy/proposal-view.2/?abstractid=988 (27 January 2017)

Lin, P. (2005). Using research-based video cases to help pre-service primary teachers. *International Journal of Science and Mathematics Education*, 3, 351-377.

Masats, D. & Dooly, M. (2011). Rethinking the use of video in teacher education: A holistic approach. *Teaching and Teacher Education*, 27, 1151 – 1162

McLelland, C. V. (2006). *The Nature of Science and the Scientific Method*. Retrieved from http://www.geosociety.org/educate/NatureOfScience.htm (27 January 2017)

MOEC (Ministry of Education and Culture of Indonesia). (2014). *Konsep dan Implementasi Kurikulum 2013* [Concept and Implementation of Curriculum 2013]. Retrieved from http://kemdikbud.go.id/kemdikbud/dokumen/Paparan/Paparan Wamendik.pdf (27 January 2017)

MOEC (Ministry of Education and Culture). (2012). *Lampiran Peraturan Menteri Pendidikan dan Kebudayaan Nomor 69 Tahun 2013 tentang Kerangka Dasar dan Struktur Kurikulum Sekolah Menengah Atas/Madrasah Aliyah* [Enclosed Document of Ministry of Education and Culture Policies Number 69 Year 2013]. Jakarta: Author.

Moseley, C., Ramsey, S.J., & Ruff, K. (2004). Science Buddies: An Authentic Context for Developing Preservice Teachers' Understanding of Learning, Teaching, and Scientific Inquiry. *Journal of Elementary Science Education*, *16*(2), 1-18.

Newhouse, C., Lane, J. & Brown, C. (2007). Reflecting upon teaching practices using digital video representation in teacher education. *Australian Journal of Teacher Education*, *32*(3), 51-61

Prince, M. & Felder, R. (2006). Inductive teaching and learning methods: definitions, comparisons, and research bases. *Journal of Engineering Education*, *95*(2), 123-138.

Sherin, M. G., Linsenmeier, K. A., & van Es, E. A. (2009). Selecting Video Clips to Promote Mathematics Teachers' Discussion of Student Thinking. *Journal of Teacher Education*, *60*(3), 213-230.

Sherin, M.G. & van Es, E.A. (2005). Using video to support teachers' ability to notice classroom interactions. *Journal of Technology and Teacher Education*, *13*(3), 475-491.

Slavin. R. (2009). *Educational Psychology: Theory and Practice* (9th ed.). New Jersey: Pearson Education

Star, J.R. & Strickland, S.K. (2008). Learning to observe: using video to improve preservice mathematic teachers' ability to notice. *Journal of Mathematics Teacher Education*, *11*, 107-125.

Susantini, E., Yonata, B., Faizah, U., & Suryanti. (2016). Developing Educational Video to Improve The Use of Scientific Approach in Cooperative Learning. *Journal of Baltic Science Education*, *15*(6), 725-737.

Sweeney, L. (2007). Inquiry-Based Learning. *Social Studies Explorations*, *1*(4), 1-2.

Whyte, S. (2011). Learning to teach with videoconferencing in primary foreign language classrooms. *ReCALL*, *23*(3), 271-293.

Wieman, C. & Gilbert, S. (2015a). Taking a Scientific Approach to Science Education, Part I – Research. *Microbe*, *10*(4): 152-156.

Wieman, C. & Gilbert, S. (2015b). Taking a Scientific Approach to Science Education, Part II – Changing Teaching. *Microbe.*, *10*(5): 203-207.

Wieman, C. (2007). Why not try a scientific approach to science education? *Change*: 1-15.

Wilke, R.R & Straits, W.J. (2005). Practical Advice for Teaching Inquiry-Based Science Process Skills in the Biological Sciences. *The American Biology Teacher*, *67*(9), 534-540.

Wong, S.L., Yung, B.H.W., Cheng, M.W., Lam, K.L., & Hodson, D. (2006). Setting the Stage for Developing Pre-service Teachers' Conceptions of Good Science Teaching: The role of classroom videos. *International Journal of Science Education*, *28*(1), 1-24

Yung, B.H.W., Wong, S.L., Cheng, M.W., Hui, C.S., Hodson, D. (2007). Tracking Pre-service Teachers' Changing Conceptions of Good Science Teaching: The Role pf Progressive Reflection with the Same Video. *Research in Science Education*, *37*, 239-259.

Zakaria, E. & Iksan, Z. (2007). Promoting Cooperative Learning in Science and Mathematics Education: A Malaysian Perspective. *Eurasia Journal of Mathematics, Science, & Technology*, *3*(1), 35-39.

Appendix A

One of the video-analysis worksheets used in the study. Source: Susantini, Yonata, Faizah, and Suryanti (2015).

VIDEO-ANALYSIS WORKSHEET

Analyzing Scientific Approach in Cooperative Learning

A. Aims

Students are able to:

1. Identify the scene of each phase of cooperative learning

2. Identify the scene of scientific approach: observing, questioning, collecting data/information, analyzing data/information, and communicating the result

3. Identify social skills developed in the learning activity

4. Identify the strength of learning process

5. Identify the weakness of learning process

6. Suggest an advice about the cooperative learning with scientific approach

B. Instructions

1. Make a group of four or five

2. Read this worksheet carefully

3. Observe the instructional video carefully. During the observation, please write notes about the learning activity as described in the worksheet. You may rewind the video twice (60 minutes).

4. Discuss your notes in your group. Write your discussion in this worksheet (30 minutes).

5. Share and discuss your work with other groups.

No.	Question	Answer/ result of group discussion	Scientific approach which is appeared
1.	Which part of the scene showed this phase: a. Clarify goal and establish set?		
	b. Present information?		
	c. Organize the students into study teams?		
	d. Assist the team and study?		
	e. Test on the material?		
	f. Provide recognition?		
2.	a. What social skills developed in the instructional video? b. In which scenes those social skills appeared?		
3.	What are the strengths of the learning process with scientific approach in cooperative learning?		
4.	What are the weaknesses of the learning process with scientific approach in cooperative learning?		
5.	What would you suggest to make the learning process in the video better?		