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Engaging Pre-Service Teachers to Teach Science Contextually with Scientific Approach Instructional Video

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Abstract. Contextual teaching and learning/CTL presents new concepts in real-life experiences and situations where students can find out the meaningful relationship between abstract ideas and practical applications. Implementing contextual teaching by using scientific approach will foster teachers to find the constructive ways of delivering and organizing science content. This research developed an instructional video that represented a modeling of using a scientific approach in CTL. The aim of this research are to engage pre-service teachers in learning how to teach CTL and to show how pre-service teachers' responses about learning how to teach CTL using an instructional video. The subjects of this research were ten pre-service teachers in Department of Natural Sciences, Universitas Negeri Surabaya, Indonesia. All subjects observed the instructional video which demonstrated contextual teaching and learning combined with the scientific approach as they completed a worksheet to analyze the video content. The results showed that pre-service teachers could learn to teach contextually as well as applying the scientific approach in science classroom through a modeling in the instructional video. They also responded that the instructional video could help them to learn to teach each component contextual teaching as well as scientific approach.

1. Introduction

Science education has been reformed to encourage teachers to contextualize materials taught, providing an opportunity for students to construct how science is developed and how one concept relates to another [1]. Contextual teaching presents new concepts in real-life experiences and situations where students can discover the meaningful relationship between abstract ideas and practical applications in the context of their use. In contextual science teaching, it is also important for teachers to strengthen the use of scientific approach in which students actively find the knowledge to solve the problem using the scientific method and science process skills. Scientific approach makes science taught the way it found through objective data rather than conventional lectures [2,3,4]. Hence, implementing contextual teaching together with scientific approach will foster teachers to find the constructive ways of delivering and organizing science content. In this paper, we developed an instructional video to the model adequate example of contextual teaching integrated with a scientific approach. We propose that the use of this instructional video can engage pre-service teachers to learn how to teach science contextually as well as



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corroborate scientific approach along with material taught. In investigating how the instructional video affects learning process of pre-service teachers in applying contextual teaching along with scientific approach, this study addressed these research questions:

- Could the instructional video engage pre-service teachers in learning how to teach CTL with the scientific approach?
- What were pre-service teachers' responses about learning how to teach CTL using instructional video?

1.1. Contextual teaching in science

Contextual teaching is supported by cognitive psychology theory, stating that "cognition is contextually dependent and must be described in that context before the material is understood at all." There are two complementary usages of word context [5]. First, context used to denote domain specificity which relates to the disciplinary knowledge that the learners wish to acquire, while the later used to denote signal task that contains true-to-life problems for the learners in the process of acquiring or applying the knowledge [6, 7]. Contextual learning occurs when students process new information or knowledge in a way that it makes sense to them in their own frames or reference (their own memory, experience, and response) [8]. In order to do so, teachers need to design learning environment with appropriate and desirable contexts into which to fit students' new knowledge. Five strategies called Relating-Experiencing-Appling-Cooperating-Transferring (REACT) to apply contextual teaching. Relating refers to learning within context of learners or learners' prior knowledge. Experiencing refers to learning by doing, including exploration, investigation, discovery, and invention. Applying refers to the activities in which the concepts are used or implemented. Cooperating refers involvement of other learners during the learning process, including sharing, responding, communicating. Transferring refers to the use of classroom-acquired knowledge in new context or new situation. There are seven components of contextual teaching and learning: 1) constructivism; 2) modelling; 3) questioning; 4) learning community; 5) inquiry; 6) authentic assessment; and 7) reflection. In constructivism, students build their own knowledge by testing ideas based on prior knowledge or experience, applying these ideas to a new situation, and integrating the new knowledge gained with pre-existing knowledge [9]. In constructivist classroom, students are actively engaged in hands-on activities and encouraged to gain knowledge through exploration [8]. Inquiry has its origins in the practices of scientific inquiry, emphasizing students to pose questions, gather and analyse data, and construct problem-solving or conclusion based on evidence [10]. Modelling in contextual teaching can be performed by teacher himself/herself or even involving students to give example to other students relating to the material taught. Questioning aims to stimulate and foster students thinking skills; this can be conducted by encouraging students to ask questions to be answered by other students or whole classroom or simply asking the students about what they have not understood or they want to know. Learning community refers to increase the use of group work and help low-achieving students to learn with the assistance of high-achieving students. Authentic assessment utilized tasks that are real example of extended criteria performances of actual learning goals [11]. This kind of assessment also used rubrics and other criteria checklists as standards to improve learning and teaching, providing multiple opportunities for students to learn and practice the desired outcomes as well receiving feedback and reflection. Last component, reflection, engages students and teachers to review, think, and evaluate their learning process and what they have just learned.

In science, contextual teaching can be conducted by illuminating theoretical practices and providing an opportunity for hands-on investigation. The contextual hands-on investigation should increase the degree of openness, for instance by posing the problem, but methods and answers are left open; offering students to discover relations he doesn't already know; and confronting students with raw phenomena with open problems, answers, and methods [12]. Contextualized science should be taught like scientist' science or open-ended research in which 1) the task is simplified, 2) students' motivation and engagement are enhanced by the perception that their practical work is authentic. Essentially, contextual

teaching in science should also present concepts in familiar contexts and tangible examples or experiences compared to abstract conceptual models [1].

1.2. Teaching Science with Scientific Approach

As an attempt to increase the quality of education, one of the main characteristics of the new curriculum in Indonesia, known as Curriculum 2013, is the implementation of scientific approach throughout all of the subjects, including sciences (biology, chemistry, and physics). Curriculum 2013 describes five steps of scientific approach which are commonly known as 5M:

- Observing; involving the ability to use five senses to identify existing problems.
- Questioning; at which teacher encourage students to generate testable question; such as how a phenomenon happens or why the problem occurs. Scientific questions eventually lead the students to generate a hypothesis of the problem.
- Experimenting; involving any efforts collecting data to reject or accept hypothesis; such as experimentation, investigation, surveys, or interviews with the expert
- Associating; at which the collected data and information are associated one to another in order to avoid incorrect interpretation and affirm consequence
- Communicating result; involving activities used by students to share their discovery to classroom scale. This stage provides an opportunity for students to have comments, suggestions, or critics to their discovery.

According to this preceding discussion, scientific approach is strongly related (and can be indistinguishable in practice) to the inquiry within contextual teaching framework in which students generate problems or testable questions, observe phenomena, analyze data, communicate result, and evaluate what has been learned. This emphasizes the importance of combining contextual teaching with the scientific approach as well as training pre-service teachers to apply these pedagogy strategies to support educational reform efforts in Indonesia.

1.3. The use of instructional video in pre-service teacher education

Bandura's Social Learning Theories used as the theoretical framework for using instructional video in pre-service teacher education. Instructional video integrates modeling and video as visual cues in the expectation that the teachers will engage themselves in specific behavior which is planned to teach [13]. Video with classroom instruction also builds bridges between learning theory and teaching practice in the actual classroom. There are extensive research reports that observing video and discussing the whole content or edited segments/clips of video can raise insightful issues relating to good teaching practice [14, 15, 16]. There was also study confirmed that using video in teacher education, especially by embedding exemplary strategy in targeted-performance, likely to increase the ability to plan a lesson and observe authentic classroom sequences [17].

In this paper, our main purpose in providing instructional video to pre-service teachers is constructing knowledge about 'what to do' in the classroom. When they observe instructional video, they receive source model to apply pedagogical strategies as well as a reference regarding their need to modify these strategies in their future beginning career. However, at this point, pre-service teachers are not only become a 'viewer' but also an observer at the same time to reflect their own beliefs and practices. Therefore, our secondary purpose in providing the instructional video is encouraging pre-service teachers to critically analyze and evaluate teaching actions of a model teacher then consider how they will act to handle the problem in the similar condition [18]. In conclusion, the instructional video takes three important roles in pre-service teacher's education: (1) improving quality of teaching; (2) potentially enhancing drive to learn, memorize, and conduct specified teaching skills; and (3) helping to solve a specific problem that may be raised from actual classroom [19,20,21].

2. Research methods

2.1. Participants

Participants of this study were ten (10) pre-service teachers in Department of Natural Sciences, Universitas Negeri Surabaya, Indonesia. These pre-service teachers had been taught about a general overview of contextual teaching and learning as well as scientific approach and hadn't experience to teach in the actual classroom. All participants' names used in this study were pseudonyms.

2.2. Classroom procedure

All participants observed the instructional video which demonstrated contextual teaching and learning combined with the scientific approach as they completed a worksheet to analyze the video content [22]. During this activity, they were supervised by a lecturer (one of the authors). The worksheet asked pre-service teachers replayed the video on their own to discuss: (1) which scene showed characteristics of contextual teaching and learning, (2) which scientific approach steps appeared at each phase of contextual teaching and learning, (3) what social skills could be gained from learning activities and (5) what strength and weakness of learning activity could be noticed. Through this discussion, the lecturer explored how pre-service teachers perceive about how to teach any materials using contextual teaching and learning which was combined with a scientific approach. After observing the video, they were asked to teach other science topics based on the video modeling in the microteaching sessions. They only had 30 minutes to perform with the performance was randomly assigned. Their performances were observed and evaluated individually. The observation was conducted by the lecturer and two independent observers, while the evaluation was only prompted by the pre-service teachers by the lecturer. Observation and evaluation covered their teaching skills in applying contextual teaching and learning combined with a scientific approach. The end of the session, they were given a questionnaire to get their response to the video modeling and whole learning process.

2.3. Instructional video

Instructional video used in this study was developed to provide adequate modeling of contextual teaching and learning in the science classroom with a scientific approach. This instructional video was validated by three independent educational experts. A lesson in the video was taught by one of the authors on the subject of 'The Motion of Human Body' to a class of 13-14 year-old-students. The purpose of this lesson was to provide an opportunity to students to construct their own knowledge how simple machines work through contextual teaching and learning combined with a scientific approach. The instructional video was also featured with captions, showing which characteristic of contextual teaching was demonstrated at specific scenes and what element of scientific approach inserted along. Another feature, lecture notes, emerged before related scenes to explain the meaning of characteristics of contextual teaching.

In the video, firstly, the model teacher showed a video about how to smash correctly in a badminton game. Model teacher and students then discussed that when a server served, the shuttlecock should pass over the service line on the opponent's court or it would count as a fault. Both teachers and students agreed that a good serving should reach far enough distance at opposite court. Model teachers then asked some students to demonstrate a serving like the player did in the video. Some students served in the great distance but some students did not. The model teacher then encouraged students to ask how this difference could happen; what made one serving could reach great distance and what made another one could not. Students have then brainstormed a hypothesis that hand position might affect the serving distance. To investigate this hypothesis, teachers divided students into groups and asked them to conduct an investigation and write the result on the worksheet given. Model teacher distributed three objects which formed motion in the human body: high-heeled shoes, volleyball that should be supported with out-stretched arm and badminton racquets that should be held in the grip. A group could only work with one object. Within their groups, each group investigated how their object produced different force as they applied the different position of pivot point called fulcrum. The result of this investigation was written in the portfolio and shared with other groups through a classical presentation.

Groups with racquet and shuttlecock held a racquet (load) toward the wrist and curled it around with fingers (force), demonstrating first-class motion. First-class motion, they said, has fulcrum between force and load, thereby very useful to increase force. Groups with high-heeled shoes explained that wearing high-heeled shoes demonstrated second-class motion. The groups said that second-class motion locates load between force and the fulcrum; therefore resistance (weight of the body) is always greater than the effort applied to the heel. Groups with volleyball explained that supporting volleyball by stretching out the arm was third-class motion at which force was located between the load and the fulcrum. The fulcrum was the upper hand (at the elbow joint, precisely), and the force was applied by shoulder joint of lower hand, while the load or resistance was applied at the bottom end of upper hand (fingers). Hence, third-class motion increases the distance over which the force is applied. Comparing and communicating data of investigation result among groups hereby bridged model teacher and students to conclude that positioning hand like third-class motion (which is locating applied force between the load and the fulcrum) which will likely increase the distance of a serving, helping a badminton player to score point easily. They also constructed conclusion that bones and joint forms fulcrum and work exactly the same like the motion, one type of simple machine. Hence, as the muscle crosses the joint applying force (effort or input force/applied force), the body can move a load (resistance or output force). The class then ended as the model teacher reminded students to learn the next topic.

2.4. Data collection and analysis

In examining how pre-service teachers learned to teach with the contextual and scientific approach, we monitored how they planned their learning activities through their designed lesson plan and observed their teaching skills throughout microteaching using criteria and rubrics performances. Observers assessed pre-service teachers' teaching skills using four-point Likert scale: 1 = 'poor', scale 2 = 'fair', 3 = 'good', and 4 = 'advanced'. These teaching skills involved two criteria: (1) performing contextual teaching and learning and (2) integrating scientific approach into science topics. Score 3.0 or above indicated adequate teaching skills. We also examined the video-analysis worksheet (Appendix) to align the data how instructional video affected the teaching skills. Data about participants' responses were collected using questionnaire with open-ended questions asking whether the modeling through instructional video could help them to teach science contextually with a scientific approach. Prior to this questionnaire submission, the lecturer told the pre-service teachers that their answers or responses to the questions would not affect their grade. Data about pre-service teachers' views were analyzed descriptively.

3. Results and discussion

3.1. Could pre-service teachers teach contextually and scientifically with instructional video?

According to their average score (Table 1), pre-service teachers showed adequate skills in teaching science contextually and incorporated the learning activities to the scientific approach. They also taught with systematical fashion and selected relevant materials. We examined their teaching performance based on essential characteristics of contextual teaching learning and scientific approach elements.

Table 1. Pre-service teachers' performance in conducting contextual teaching with scientific approach

Performance aspect	Average score
Teaching science contextually	
a. Learning activities were relevant with seven components of contextual teaching and learning:	
1. Constructivism	3.3
2. Modeling	3.1
3. Questioning	3.4

4. Learning community	3.8
5. Inquiry	3.6
6. Authentic assessment	3.2
7. Reflection	3.4
b. Characteristics of contextual teaching and learning were conducted systematically	3.7
c. The material was relevant to be taught with contextual teaching and learning	3.5
Learning activities with scientific approach	
a. Learning activities were focused on teaching scientific approach	3.8
b. Developing scientific approach, including:	
Observing	3.8
Questioning	3.7
Experimenting (collecting data)	3.9
Associating	3.6
Communicating data	3.9
Creating (if any)	3.5
c. The applied scientific approach was relevant to be used with contextual teaching and learning	3.6

The performed pre-service science teacher number 1, taught heat and temperature by asking her students to make their own temperature scale in thermometer. Students were encouraged to generate questions and hypothesis then conducted an experiment which asked them to compare the temperature of freezing and boiling temperature of water between standard alcohol thermometer and non-scaled thermometer. She introduced her lesson with a brainstorm asking why people used a thermometer instead of simply declaring that something was hot and cold. Her constructivism was started well but she did not explore further this constructivism throughout her classroom. She also used scientific approach well, leading students observing that heat transfer happened as a hand touched warmer object to cooler object, generating testable questions, conducting an experiment, collecting and analyzing data, and having them to compare and communicate temperature reading using their scaled thermometer and commercial/standard thermometer. However, pre-service science teacher number 1 was still weak in utilizing authentic assessment in her classroom. On her video-analysis worksheet, pre-service science teacher number 1 wrote, "Though the caption said so, I barely noticed that the model teacher in the video conducted an assessment of students' practical work."

Pre-service science teacher number 2 wanted to teach the concept of a sound wave with its application in animals' ultrasounds. In order to so, she divided the material into one of the constituents at which she encouraged her students to discover the influence of pendulum length to the pendulum period. Similar to pre-service science teacher number 1, pre-service science teacher number 2 was so good at designing practical work as well as teaching with a scientific approach. Unfortunately, the way she contextualized and constructed the material into students' real-world situations was not relevant with students' practical work. She asked her students to sing together to model that the way human sing and talk were actually vibrations of vocal cords whilst the experiment utilized a pendulum which would be swung with different amplitudes and length. Compared to pre-service science teacher number 1, pre-service science teacher number 2 showed better skills in assessing authentically and encouraging reflection at the end of the lesson. However, at this point, both of them were still weak at bringing materials into real-world situations.

Pre-service science teacher number 3 taught her students to investigate the relationship between electrical charge and type of conductor materials. She initiated her lesson in real-world phenomena that houses and skyscraper buildings are essentially protected from direct strikes of lightning by installing

proper lightning protection called lightning rod. She and her students brainstormed how lightning rod worked against lightning surges. To study how a lightning rod works, pre-service science teacher number 3 showed electroscope, saying that they would learn the working principle of the lightning rod by conducting an investigation with an electroscope. Teacher modeled how electroscope worked by rubbing sheet mica to hair, bringing the ruler near the metal plate of an electroscope, and showing how foil leaves hanging from the bottom of the electroscope spread apart. The investigation continued with groups of students tried various materials to be detected with an electroscope, ranging from strong conductor materials to strong isolator materials, such as glass, wool, aluminum ruler, and sheet of mica. As they collected and analyzed data, students communicated investigation result and found out that the greater the charge, or the stronger the materials as a conductor, the farther the foil leaves of electroscope spread. They then discussed and reflected how the way electroscope work could explain the mechanism of a lightning rod in protecting buildings from a lightning strike. There was no further elaboration how investigation conducted by the students related to the initial learning goal of finding correct lightning rod materials. Pre-service science teacher number 3's contextualizing effort was interesting except she totally forgot that electroscope used detected static electricity by using thin metals which would be separated when it was charged. However, it was good that pre-service science teacher number 3 had the ability to notice that electroscope can detect good conductor, whilst the conductor was the perfect material to allow the electrical current to flow the ground. At this point, pre-service science teacher number 3 was the first pre-service teachers who almost successfully tried contextualizing her material. The authentic assessment was hardly observed in pre-service science teacher number 3's teaching.

Pre-service science teacher number 4 who almost successfully contextualized her material with the scientific approach as she encouraged her students to investigate why people could be suffered from hypertension. At first, she explored students' prior knowledge by asking them to have her blood pressure measured with automatic blood pressure monitor. They found out that blood pressure of one and others was quite different, could be really high and very low, and related the phenomena with an increased number of hypertension sufferers. They generated questions how could this happen and constructed a hypothesis that hypertension should be a related area of blood vessels. In groups, students conducted an experiment with two different set of apparatus. One apparatus was a bottle containing water connected to beaker glass with a wide plastic pipe, while another one was the same apparatus but with a narrow plastic pipe. They measured the diameter of the pipe with a ruler and pressed the bottle, thus the water was flushed out in measurable volume. Students analyzed then presented that the pressure in a small area was very high, resulting high force to pump the water out, as Pascal suggested. At presentation, pre-service science teacher number 4 asked the students to assess their friends' performance in communicating investigation. Pre-service science teacher number 4 then engaged her students to reflect their learning process, concluding that hypertension sufferer had narrowed blood vessels, thus their heart worked so hard in pumping the blood. Her general contextual teaching strategy was good, but she still needed to improve her ability utilizing teaching aids. It would be better if she learned how to measure blood pressure correctly and provided vernier caliper, thus her students could precisely measure the pipe diameter.

Pre-service science teacher number 5 planned to teach her students about a simple test for color additives in foods. She started the lesson by asking the students to come forward and drinking two different soft drinks. One student tried the red soft drink and her tongue turned red accordingly. Another student who drank colorless soft drink did not show color change on her tongue. She further explained that color additives were commonly found in foods, beverages, and cosmetics to improve their look. Some color additives were harmless but some other color additives could pose health hazards, thus retailers and consumers should know how to identify color additives as well as to differentiate natural color additive and artificial color additive. In groups, pre-service science teacher number 5 subsequently facilitated her students to conduct a simple test for color additives. Following an open worksheet, they extracted curcumin, an example of natural color additive, with ethanol solvent. This extract was then filtered and added into sodium hydroxide (NaOH). Curcumin extract remained yellow even though it mixed with NaOH. They were agreed that this was used as control representing natural color additive.

Pre-service science teacher number 5 asked her students to add five drops of NaOH on two different tested foods: cheese pasta and candy. Students surprisingly discovered that mixture of cheese pasta and NaOH immediately turned from yellow into red. Same color changes also occurred in the tested candy. These data draw a conclusion to pre-service science teacher number 5 and her students that there was dye or colour additives added into their food, the colour changed immediately to red. On the contrary, if the food was pure or used natural additive, there would not be any colour change occurred. Pre-service science teacher number 5 also conducted an assessment of social skills during this presentation. Constructivism and contextual approach conducted by pre-service science teacher number 5 was well developed although she still required teaching her students how to use pipette properly.

Pre-service science teacher number 6 and pre-service science teacher number 7 wanted to teach her students the working principle of mixture separation. Pre-service science teacher number 6 taught her students about chromatography while pre-service science teacher number 7 taught about filtration. As the lesson started, pre-service science teacher number 6 demonstrated a mixture of limestone and water which then separated with filtration. She encouraged her students to ask whether all kinds of mixture could be separated by filtration. Her video about mixture separation led students to ask and assume that mixture separation was determined by the characteristics of mixture itself. Pre-service science teacher number 6 continued her lesson by engaging her students to investigate ink separation using chromatography. Students formed groups and paint a dot on a piece of filter paper. This filter paper was then attached to paper clip and hang down inside a glass containing water, thus the tip of the paper touched the water (but the dot did not). Students observed that the filter paper absorbed the water, dispersed the painted dot into different colours. In group presentation, pre-service science teacher number 6 and her students reflected that chromatography could separate the ink and brainstormed that other type of mixture, such as water, passed different mixture separation called distillation, producing drinking water. In other hand, pre-service science teacher number 7 started the lesson with news from Tasikmalaya involving phenomena of water scarcity during drought season. She contextualized and constructed her material well as she read the headline that Tasikmalaya inhabitants had no access to clean water in the drought season. The inhabitants decided to use water from a muddy pond nearby since their well was dry and governments still had not supply Tasikmalaya with clean water, exposing themselves to health risk causing by drinking poor water. Pre-service science teacher number 7 then encouraged her students to redefine that muddy water was actually kind of mixture, composing of water with soil precipitates. She also tried to give hints that a mixture could be separated in many different ways. They brainstormed problem solving to make the inhabitants could obtain clean water and finally came to an idea that water filtration might be helpful. Pre-service science teacher number 7 then divided her students into groups and asked them to design a water filter from available materials, such as pebble, sands, coconut fibres, 600 ml plastic bottle, cotton, and active carbon. Students shared their water filter design and communicated the reason why they selected one material over another to form certain water filter structure. Other groups had responsibility to assess group who voluntarily presented their works. Pre-service science teacher number 7 and her students then reflected on their learning activity, declaring that filtration was one of techniques that could separate liquid materials from the solid one and would be promising to be utilized in Tasikmalaya.

Pre-service science teacher number 8 planned to teach her students about environmental pollution. Interestingly, she came to the class and asked her students to look around the classroom. Pre-service science teacher number 8 asked the students to take some snack and candy wrappers in the floor to be thrown away in the dustbin. She emphasized that polluted environment, with tons of garbage and hazardous chemicals, could affect living organisms. Pre-service science teacher number 8 continued her explanation to a footage showing environmental damage and asked her students to mention characteristics of pollution. She also asked her students to generate testable question related to the footage. They agreed to investigate the influence of pollutants on the survival of aquatic organisms. Within their groups, students conducted an experiment in which they observed how a fish could survive in two different environments. The first environment was a container with clean, colorless water, while another environment was a container with water from washing laundry. Pre-service science teacher

number 8's students discovered that the fish immediately died after exposure to washing laundry water. Fish operculum flapped over so fast at first minutes, then slowed down to death. On the contrary, fish's operculum in clean water tank moved stably. Groups compared and contrasted the data, delivering the result to their friends. Pre-service science teacher number 8 directed her students to relate investigation result with a hypothesis, reflecting that pollutants might harm survival of aquatic organisms.

Pre-service science teacher number 9 decided to teach her students to conduct standard measurements with a vernier caliper. She took two measuring instruments, ruler and vernier caliper to the classroom. Pre-service science teacher number 9's students, who had never seen vernier caliper before, was eager to ask why someone measured things with those tools. Later, pre-service science teacher number 9 pointed two students to measure the length of her desk with their hands. One student said that pre-service science teacher number 9's desk was five hands long, while the other one insisted that pre-service science teacher number 9's desk was only four hands in length. Pre-service science teacher number 9 ignited the discussion by asking how those two students measured one same thing but with different results. Afterwards, she asked other two students to measure the same table with a ruler. Compared to prior measurement, these two students reported the same length. This modeling led the students to a discussion about the importance of measuring things with standard instruments. Pre-service science teacher number 9 also demonstrated how to use a vernier caliper correctly. She grouped her students and encouraged them to try measuring two objects (a small wooden block and a cap of a plastic bottle) with a vernier caliper. Prior to this activity, pre-service science teacher number 9 already brainstormed what standard measurement was. She also looked around and helped their students to use vernier caliper. Each group presented their measurement data and discussed the result. Lastly, pre-service science teacher number 9 concluded the lesson and asked the students to write a report about their measuring activity that day.

As part of explaining the human excretory system, pre-service science teacher number 10, the last performed pre-service teacher, taught her students to prove that exhaled air from lungs contained carbon dioxide. She played a commercial break showing a marathon runner. The runner was covered in sweats. Pre-service science teacher number 10 modeled herself cleaning her forehead with a facial tissue. The facial tissue became wet, leading pre-service science teacher number 10 to engage her students to discover that skin could excrete water. They then discussed what another organ in excretory system, in particular, lungs, would excrete in response to metabolism excess. To investigate this question, pre-service science teacher number 10 asked her students to make groups then prove that one of the excretory products was carbon dioxide. Following a worksheet, the students mixed limestone with water and let them for few minutes to form precipitates. Students then filtered the upper layer of this solution and transferred them into new glass. Later, students blown out some air through a straw for 15 seconds, continued for prolonged time, then observed the changes occurred in limestone water. They discovered that the limestone water turned cloudy and formed other precipitates on the bottom. Students collected data and successfully analyzed that if limestone reacted with carbon dioxide, it would form calcium carbonate precipitates. As the groups shared their findings, this investigation cleared out that excretory system, specifically lungs, produced carbon dioxide. pre-service science teacher number 10 and her students reflected what they learned that day and agreed to make a mind map about the excretory system in the next meeting.

Inconsistency with their well-contextualized teaching, pre-service science teacher number 5, 8, 7, 9 and number 6 correctly identified all of model teacher's behaviors representing characteristics of contextual teaching and scientific approach elements. As pre-service science teacher number 7 asserted:

"Model teacher started *constructivism* approach as she played a show of badminton match. Later, as part of *modeling*, she asked several students demonstrated how a badminton player made a serve. At this early stage, we knew that the students *observed* both of badminton show and live-show of serving from their friends. As students became interested and *questioned* how badminton techniques related to the human locomotion, model teacher constructed the knowledge further by asking them to *make groups* (learning community) and

investigated the problem (inquiry) through an open-ended worksheet and portfolios. Within investigation, students *collected data* and *made the association* to their prior knowledge about the motion. The model teacher then directed the students *to communicate* their investigation portfolios. She said that she would *assess* students' involvement in the presentation. Accordingly, she complimented on groups who contributed more to discussion but still encouraged passive groups to do so. Last, model teacher *reflected* on learning process with her students, reviewing how motion system could work in the human body and how this principle can be a very useful trick to score a serving point."

Interestingly, although some pre-service teachers, such as pre-service science teacher number 4, 10, 3 and number 2 misidentified inquiry and authentic assessment during video-analysis, our preceding description about their microteaching indicated that they showed adequate skills within those criteria. For instance, this misidentification could be seen as pre-service science teacher number 2 asserted, "Inquiry can be seen as students work on their worksheet. Authentic assessment occurs as students generate research questions, invents a hypothesis, and performs an investigation." In her microteaching, although pre-service science teacher number 2 was still poor at contextualizing her material, she conducted an inquiry and authentic assessment well. Pre-service science teacher number 4 even had a good idea of authentic assessment by involving her students to do peer-assessment toward their friends' presentation. Perhaps, evaluation and reflection conducted by the lecturer upon the video analysis provided great help in noticing correct scenes.

3.2. What were they perceive?

All pre-service teachers perceived that the instructional video helped them to identify as well as learned how to contextually teach science with the scientific approach (Table 2), including each characteristics representing contextual teaching and stages of the scientific approach. The lowest response showed the perception that the instructional video did not use proper Bahasa Indonesia (40%).

Table 2. Pre-service teachers' views about learning with instructional video

Response	Response was given (%)
The video helps me to:	
Identify seven essential characteristics of contextual teaching and learning	100
Learn how to teach <i>constructivism</i> within contextual teaching and learning	100
Learn how to teach <i>modeling</i> within contextual teaching and learning	100
Learn how to teach <i>questioning</i> within contextual teaching and learning	100
Learn how to teach <i>learning community</i> within contextual teaching and learning	100
Learn how to teach <i>inquiry</i> within contextual teaching and learning	100
Learn how to teach <i>authentic assessment</i> within contextual teaching and learning	100
Learn how to teach <i>reflection</i> within contextual teaching and learning	100
Learn how to teach <i>observing</i> within scientific approach	100
Learn how to teach <i>questioning</i> within scientific approach	100
Learn how to teach <i>experimenting</i> within scientific approach	100
Learn how to teach <i>associating</i> within scientific approach	100
Learn how to teach <i>communicating data</i> within scientific approach	100
The video was easy to understand	90

In line with Table 2, pre-service science teacher number 4 also gave positive comments, "I love the idea learning to teach contextually with the [instructional] video. It encourages me to apply this approach

in my future classroom.” pre-service science teacher number 7 added, “[This] video is very useful reference for teaching practice.” pre-service science teacher number 1 suggested,

“It is very convenient to learn with the video because the caption helps me to identify specific scenes which are related to characteristics of contextual teaching. However, it would be nice if the video can show the clearer stage of authentic assessment.”

Moreover, most pre-service teachers suggested that the instructional video should use grammatically correct Bahasa Indonesia. They perceived that using some Javanese (one of the local languages in Indonesia) or modern slang Bahasa Indonesia was not appropriate in the classroom.

In general, this study showed that pre-service teachers could learn how to teach science contextually along with scientific approach to the instructional video that we had developed. They noticed the scenes in the instructional video as visual cues, which then attaching mental images in their system thinking, thereby helping pre-service teachers to construct more concrete knowledge and build greater interests in learning than verbal description does [19,13, 23]. Taking notes (on the worksheet) and discussing model teachers’ teaching behavior, as performed by pre-service teachers’ in this present study, also helps them to increase classroom awareness. Previous work reports that video lesson analysis improves pre-service teachers’ ability to pay attention to noteworthy events classroom interactions [24,25]. Higher scores on the video analysis task are also associated with better instructional quality [26]. Furthermore, pre-service teachers who write their own observations at video clips show better classroom awareness [27]. A Recent study also indicated that peer dialogue during the use of video potentially heightens teacher’s awareness about their own teaching practice [28].

The tendency of learning to teach contextually using instructional video was also affected by pre-service teachers’ reflective behaviors. The video made them evaluate that model teacher should be more open to the students about authentic assessment and interact with proper classroom language. Teachers often evaluate model teacher’s pedagogical approaches as viewed in the video, offering advice on what the teacher should have done differently [15]. The reflective behaviors engage pre-service teachers to learn in meaningful ways, improving their teaching practice based on their pedagogical knowledge and beliefs. For instance, pre-service teachers decided to apply peer-assessment during group presentation to strengthen authentic assessment and spoke in grammatically corrected Bahasa Indonesia.

We also find that these reflective behaviors may depend on the interaction between the facilitator and the pre-service teachers during the learning process. At the early microteaching session, when pre-service science teacher number 1 and pre-service science teacher number 2 taught with the poor contextual framework, the lecturer evaluated their techniques and strategies for teaching and asked the pre-service teachers to focus how their material would be learned within real-world situations which were familiar to students. Lecturer also raised issues on how constructivism and scientific approach built by reducing cookbook experiment in the instructional video. Pre-service teachers then improved ways of teaching. In the preceding description, we noticed that they used recent news on newspaper to contextualize their material and left the problem, method, and answers open within practical work to emphasize constructivism as well as scientific approach. Previous research also reveals that facilitator supports video-mediated teacher education by focusing issues to the learning goal, managing the noteworthy scene to be viewed and rewind, and explored understanding and interpretation upon viewing the video [15].

4. Conclusion

We concluded that pre-service teachers could learn to teach contextually as well as applying the scientific approach in science classroom through a modeling in the instructional video. Pre-service teachers’ teaching skills also showed that they became reflective about their own teaching practice and beliefs upon viewing the video and receiving an evaluation from the facilitator. Even so, we still can find that pre-service teachers may be weak at some criteria, such as utilizing teaching aids incorrectly, selecting irrelevant teaching aids, and associating one teaching ideas with the mismatched real-world

situation. At this point, it would be unrealistic to expect that pre-service teachers could teach contextually without single failure or weakness after one session learning with the video. Long periods of training are needed to sustain the way they learn to teach and improve their pedagogical content knowledge.

Moreover, all of the teachers responded that the instructional video could help them to learn to teach each component contextual teaching as well as scientific approach. They also saw that the video was easy to understand and valuable as a reference of teaching practice in their future career as a beginning teacher. It seems likely that the pre-service teachers perceived that classroom languages should be spoken in formal Bahasa Indonesia and avoid the use of local languages or slang words. We also consider that facilitator takes important parts to help pre-service teachers focus on essential characteristics of targeted-performance. In this study, we can observe that facilitator manages peer-dialogue during video analysis, prompt pre-service teachers to identify which classroom events represent components of targeted-performance, and helps pre-service teachers to evaluate their own teaching practice or notice missing elements of targeted-performance.

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