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Context-Based Chemistry Teaching within the 4Ex2 Model: Its Impacts on Metacognition, Multiple Intelligence, and Achievement

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ABSTRACT

The purpose of this study is to investigate the impact of context-based chemistry education on the metacognition and multiple-intelligences of preservice chemistry teachers, and their achievement in chemistry lessons in the laboratory environment that includes the 4Ex2 model. Within the framework of the general chemistry laboratory lesson, the treatment group was taught with a context-based chemistry teaching method in the chemistry laboratory using the 4Ex2 model, while the traditional methods were applied in the control group's lessons. It is determined that after the application, abilities to control the metacognitive thoughts of the preservice teachers, who were taught with a context-based chemistry teaching method in the chemistry laboratory within the 4Ex2 model, positively changed compared to those included in the control group. Additionally, the results showed that the preservice teachers in the treatment group, who received context-based chemistry teaching within the 4Ex2 model, were more successful; therefore, this model is an effective teaching method.

Keywords: Context-based chemistry teaching, metacognition, multiple intelligence, preservice teachers, 4Ex2 model.

INTRODUCTION

When students meet the wonderful world of productive chemistry in a laboratory, effective chemistry teaching is realized. Within this scope, the quality of chemistry teaching should not be sought in the test tubes, but in the art of the experiment and in the teachers who design the experiment (Pfeifer, 1995). Additionally, in order to solve the problems emerging during the teaching of chemistry, it is required to have teachers with qualifications that allow them to associate chemistry with daily life in a more meaningful way. Training such chemistry teachers will be possible by closely monitoring various characteristics of the prospective chemistry teachers enrolled in educational institutions and forming these characteristics in the environments that are closely linked with daily life (Freienberg, Kriiger, Lange, & Flint, 2001). Indeed, daily life stands for a one-day period of the mental and physical world (Lindemann & Brinkmann, 1994, Yaman, 2009). According to Fensham

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(2009), daily life covers various contexts and scientific aspects. In teaching the notions that are scientifically examined or in understanding the nature of scientific evidence, comparing these notions with questions and enriching them with examples from daily life create realistic learning environments. According to Wu (2003), when connections are established between daily life and chemistry topics, it would be possible to associate multiple contents experienced outside school and the information gained in the classroom. Separating students' daily lives and school subjects causes students to develop useless information systems (Osborne & Freyberg, 1985).

The importance of context-based learning is highly emphasized by constructivist and sociocultural learning theorists. It is suggested that context-based learning is quite effective in students constructing, transferring, and implementing knowledge through their own experiences (Andrée, 2003; Gilbert, 2006). Therefore, presenting course contents involving context-based chemistry activities according to the methods, models and techniques in line with the constructive approach in learning resulted in positive effects favoring the achievement of context-based chemistry teaching (Choi & Johnson, 2005; Coştu, 2009; Kerber & Akhtar, 1996; Kutu & Sözbilir, 2011; Toroslu, 2011; Ulusoy & Önen, 2014; Ültay & Ültay, 2013). However, it is quite easy to find a daily life connection with a chemical reaction or a chemical problem that is the subject of chemistry courses. Learning and inference occur following a series of cognitive processes. Therefore, the adequacy of the cognitive processes of prospective chemistry teachers is of great importance in order for the learning and inference process to be efficient. This is closely related to the nature of cognition. As Brown, Collins, & Duguid (1989) stated, when the nature of cognition is ignored, the provision of information, which is the main objective of education, cannot take place completely. Therefore, Cognitive Theory became one of the theories that have a significant impact on the field of education. This theory focuses on the skill that allows individuals to associate mental states such as beliefs, intentions, desires, and information with themselves or others and to comprehend that others may have different beliefs, intentions and desires (Premack & Woodruff, 1978).

Metacognition is one of the cornerstones of Cognitive Theory. Defined as knowledge and beliefs about mental processes, meta-cognition is a key concept in Cognitive Theory, which helps the maximization of learning (Benjamin & Bird, 2006). Using the concept of metacognition for the first time, Flavell (1976) defined metacognition as the knowledge of individuals about cognitive processes that are necessary for them to comprehend and learn. However, metacognition stands not only for individuals' knowledge of the strategies that are employed while learning, but also for their knowledge about when and where to use these strategies. A healthy individual who is aware of her/his metacognitive abilities knows how to learn, what she/he knows and what she/he should do to gain new information (Wilson & Bai, 2010). On the other hand, some metacognitive functions lead to certain dysfunctional thoughts and coping styles in psychological disorders. In other words, some people may have positive or negative beliefs (meta-cognition) about their thoughts, which affect their evaluation of events (dysfunctional cognition). These kinds of metacognition lead individuals to develop incompatible response styles (Cartwright-Hatton & Wells, 1997, Gwilliam et al., 2004). In further cases, this situation may cause the negative evaluations of individuals about their metacognitions to become permanent, while also decreasing in their reliance on their memories (Mather & Cartwright-Hatton, 2004, cited in Tosun & Irak, 2008).

Questions that explicitly help students think about questions such as "How do I study best?" or "What kinds of tools help me learn?" all engage metacognitive knowledge. This can range from information that helps students assess their own abilities and intelligence to reflections on specific learning processes students tend to use in different situations. Metacognitive regulation involves the ability to think strategically and to solve problems, set goals, organize ideas, and evaluate what is known and not known. It also involves the ability to teach others and make thinking processes visible (Jaleel & Premachandran, 2016). In this context, it is very important that prospective chemistry teachers have positive and healthy metacognitive skills. Today, many concepts, theories, approaches and methods can be associated and configured with metacognition. In this way, it has been possible to justify the relationship between intelligence and multiple intelligence theory thanks to meta-cognition (Kuhn, 2000). Another theory that had a substantial effect on the field of education is the Theory of Multiple Intelligences (Shearer, 2004). This theory, which directs more different and much more varied studies, has been proposed by Gardner (1993). In Gardner's theory, the characteristics of people's different intelligence types are described. Gardner indicates that either one of these intelligence areas is superior to the others; however, other areas do not emerge as the dominant ability. Everybody has these intelligence types; however, each person has them in different combinations or blends (Gardner, 1993). Moreover, the importance of how, when and in which environments learning takes place for an individual is also addressed in this theory (Gardner, 2006). Gardner indicates that when students' multiple intelligence types are associated with the information they learn at school in training and education, acquisition of more information could be achieved (Gabala, 1991). Wilson (2011) also stated that activities that are carried out according to the multiple intelligence types offer students the ability to establish cognitive connections, metacognitive understanding, and various studying techniques. However, Goodnough (2001) confirms that the theory of multiple intelligences opens the door to a variety of teaching strategies that can be implemented within the classroom and suggests that there is no one set of teaching strategies that suits all students at all times, because they have different intelligences; therefore, a particular strategy may succeed with a group of students and not succeed with another. Hence, it is important for prospective teachers to associate the theory of multiple intelligences with the concept of metacognition and to use contexts based on daily life in teaching environments. The realization of the aforementioned aspects would be possible by training teachers who are self-aware, aware of different metacognitive features and various intelligence types, and who know that the acquisitions related to chemistry would be enriched through the availability of teaching environments that are associated with daily life. However, more open and dynamic models need to be suggested in order to realize the individual's potential of using the intelligence types (Marshall, Horton, & Smart, 2008). One of the models proposed based on this opinion is the "4Ex2 Model" proposed by Marshal et al. (2008). The 4Ex2 Instructional Model is based on the 5E instructional model (Marshall et al., 2008).

The researchers argue that the 4Ex2 instructional model provides an education and training environment with an advanced perspective, from which both the students and the teacher would benefit, thanks to its Engaging, Exploring, Explaining and Extending stages. This model allows students to make in-depth inquiries and helps them in comprehending information. In the 4Ex2 model, learning experiences are associated with conceptual understanding, and students are assisted in the learning process (Allal & Ducrey, 2000). This model also assigns importance to combining the metacognitive thinking of students and interrogative teaching models with formative assessment structures (Marshall et al., 2008).

Aim

The purpose of this study is to investigate the impact of context-based chemistry education on the metacognition and multiple-intelligences of preservice chemistry teachers, and their achievement in chemistry lessons in the laboratory environment, which includes the 4Ex2 model.

METHODS

The study is conducted with a purpose that reflects the theoretical framework it is based on and with a method that will serve this purpose (Keeves, 1998). Findings are interpreted within the scope of this purpose. This research is a quasi-experimental study that tests the effectiveness of context-based chemistry teaching within the 4Ex2 model in the chemistry laboratory on the metacognitive abilities, multiple intelligence types, and achievement levels of preservice chemistry teachers, using pre-tests and posttests for control and treatment groups (Campbell & Stanley, 1996; Cohen, Manion, & Morrison, 2001).

The sampling of the study consisted of student teachers randomly chosen from students of Hacettepe University, Faculty of Education, with choosing 43 individuals in total. This study was conducted using the pre-posttest design involving a control group and a treatment group. The experiment group included 22 and the control group included 21 preservice teachers. Metacognitive Scale, Multiple Intelligence Scale, Achievement Test and Structured Grids were applied in the form of the pre- and posttests in both the treatment and control groups. Within the framework of the general chemistry laboratory lesson, the treatment group was taught by applying a context-based chemistry teaching method in the chemistry laboratory by using the 4Ex2 model, while the traditional methods were applied in the control group.

The researcher taught a Chemical Changes module to the treatment group using the 4Ex2 model, supported by context-based learning activities. In the context of the research, five chemistry experiments were designed. These experiments were appropriate for the aims of the research; they could be carried out with simple and cheap materials, and they were interesting for the students. Experimental activities were done with daily substances and materials, without having the necessity for materials related to chemistry and chemical substances. Chemistry experiments appropriate for the Chemical Changes module that can be done with daily materials were designed according to the 4Ex2 model and presented to students as working sheets. The 4Ex2 model consists of four phases. It allows for the integration of laboratory practice to the course (Marshall et al., 2008); therefore, context-based experiments were conducted with the students. The stages of study according to the 4Ex2 model are the following: 1. Engaging Stage: A sample incident selected from daily life related to the subject is shown to students to get their attention. 2. Exploring Stage: In this stage, materials used in the experiment and the ways of doing the experiment are explained so that the experiment is conducted by students without any problems. 3. Explaining Stage: In the stage of explanation, students are asked to explain the results and observations obtained from the experiment. This is achieved through classroom discussions. 4. Extending Stage: In the challenge phase of the 4Ex2 model, students complete the activities on the worksheet.

Analysis of the data obtained in this study was performed by using the SPSS 21 software package. The data obtained following the applications were subject to parametric tests. The ANCOVA test was performed for determining whether the answers given by the preservice teachers differed according to the group they were included in (Treatment-Control). The calculated values were evaluated at the $p=0.05$ level of significance.

a) Data Collection Tools

The “Multiple Intelligence Scale” developed by McClellan & Conti (2008) and adapted into Turkish by Babacan (2012) was used in the study. The scale was administered in order to determine in which field of intelligence the students were dominant. The Cronbach’s Alpha Internal Consistency coefficient of the scale was identified as 0.85 (Babacan, 2012).

Another one of the data collection tools used in this study was the MetaCognition Scale developed for examining negative metacognitive beliefs, judgments, and processes of an individual. Developed by Cartwright-Hatton and Wells (1997) and adapted to Turkish by Tosun and Irak (2008), the scale is a data collection tool that is suitable for assessing positive and negative metacognitions. Increase in the scores obtained from the scale indicates the increase in negative metacognitive beliefs. In the study conducted by Tosun and Irak (2008), the Cronbach Alpha reliability of the scale was found to be .86. Also in this study, the researcher (Koçak, 2013) structured and developed an achievement test by making use of the questions in the Scientific Achievement Test developed by Ekmekcioglu (2007), in order to determine the preservice teachers' level of knowledge. The average difficulty and Point-Biserial Correlation Coefficient of the achievement test were found to be 0.71 and 0.56, respectively. Alternative assessment and evaluation techniques were also employed for offering equal opportunities to each participating student with different thinking and learning styles (Marshall et al., 2008). In addition to the achievement test, the abilities of the preservice teachers to associate their basic information with daily life were determined using the Structured Grids (Kocak, 2013) developed by the researcher.

b) Data Analysis

Before analyzing the data obtained in the study, the Kolmogorov-Smirnov Test was used to determine whether there was a normal statistical distribution. For the variance analysis planned to be done within the framework of the statistical analysis, the homogeneity of the distribution was first observed with Levene's Homogeneity of the Variances Test. Parametric tests are stronger and more flexible than non-parametric tests. While making statistical analysis on the data, the data are at least required to comply with the normal distribution (Kalayci, 2006). As shown in Table 1, the data obtained from the data collection tool have normal distribution and their variance is homogeneous. According to this finding, no statistical inconvenience was found with regard to the use of parametric tests for analyzing the data.

Table 1. *Results of the Kolmogorov-Smirnov and homogeneity tests (df1 1 df2: 41)*

		Mean	Ss	K Smirnov Z	p	Levene Statistic	pp
Multiple Intelligence Scale	Pretest	4.348	2.428	1.041	.228	.612	.439
	Posttest	4.418	2.565	.952	.325	.000	.984
Meta Cognition Scale	Pretest	3.071	.413	.542	.930	1.412	.242
	Posttest	3.194	.483	1.069	.203	1.977	.167
Achievement Test	Pretest	39.72	14.78	1.16	.135	.082	.775
	Posttest	49.19	16.65	.80	.541	.005	.944
Structured Grids	Pretest	39.61	16.378	.521	.949	.186	.668
	Posttest	44.25	24.167	.546	.927	5.131	.057

FINDINGS

ANCOVA analysis was performed for understanding whether there were significant differences in the dominant intelligence types of the preservice teachers in the treatment and control groups. The results of the ANCOVA analysis given in Table 2 show that when the distribution of the preservice teachers in the treatment and control groups according to their multiple intelligence areas before the application are considered, there are no statistically significant differences in the post-application distributions.

Table 2. *Results of the covariance analysis on the data obtained from the multiple intelligence scale*

Source	Type III Sum of Squares	Mean Square	F	p
Pretest	56.239	18.746	3.817	.75
Group	68.987	68.987	14.04	.30
Error	209.143	5.363		
Total	1116.000			

While the Meta-Cognition Scale pre-test average scores of the preservice teachers in the treatment and control groups were checked, the ANCOVA test was applied in order to determine whether there were significant differences among the posttest average scores of the same scale. Table 3 shows that the overall average of the control group after the test is much higher than that of the treatment group. The results of the ANCOVA analysis indicate that there are significant differences between the overall Metacognition Scale pretest scores and overall adjusted posttest scores of the preservice teachers. In other words, it is determined that after the application, abilities to control the metacognitive thoughts of the preservice teachers who were taught by the context-based chemistry teaching method in the chemistry laboratory within the 4Ex2 model, positively changed compared to those included in the control group. After obtaining the scores of the achievement test on the prior knowledge of preservice teachers and the average pretest scores of the structured grid, the ANCOVA test was administered to determine whether there were significant differences among the posttest average scores of the same data collection tools.

Table 3. *Results of the covariance analysis on the data obtained from the metacognition scale*

Group	Mean	Source	Type III Sum of Squares	Mean Square	F	p
Treatment	3.14	Pretest	1.777	.59	2.87	040
		Group	2.176	2.17		
Control	3.25	Error	8.028	.20	10.52	.002
		Total	448.632			

As shown in Table 4, it is determined that the achievement scores of the treatment group were statistically significantly higher than those of the control group. In other words, the scores of the achievement test and structured grid in the treatment and control groups after the application of the 4Ex2 model were compared using the ANCOVA test; and it was determined that there were statistically significant differences favoring the treatment group.

Table 4. *Results of the covariance analysis on the data obtained from the achievement test and structured grids*

	Group	Mean	Source	Type III Sum of Squares	Mean Square	F	p
Achievement Test	Treatment	84.4	Pretest	6442	2147	8.97	.00
			Group	1335	1335	5.58	.02
	Control	67.5	Error	367	239		
			Total	198			
Structured Grids	Treatment	50.6	Pretest	6855	2285	4.63	.00
			Group	5083	5083	10.33	.00
	Control	37.4	Error	2764	492		
			Total	15100			

DISCUSSION and CONCLUSION

In today's chemistry teaching programs, more advanced and more functional models that interpret the ideas of students in a more comprehensive way are required (Stains & Talanquer, 2007). In this study, context-based chemistry education was carried out by employing the 4Ex2 model in the laboratory, with the aim to contribute to alternative research studies. The main reason for choosing the laboratory as the application environment was that the laboratory activities could be efficient in improving mental development, scientific inquiry and problem-solving skills (Lunetta, 1998). Scientific process skills, which facilitate learning, attain research methods, ensure individuals' active participation and responsibility taking in learning as well as increasing permanence of learning, could be developed through laboratory studies in science (Alkan, 2016). Whether the context-based teaching of chemistry within the 4Ex2 model had any impact on the metacognitive abilities of preservice teachers was specifically examined. In this study, the metacognitive structures of preservice teachers were approached in terms of educational psychology, and the results concerning the level of learning, self-regulated learning and learning improvement were examined (Karakelle & Saraç, 2010). Indeed, with the help of the findings obtained after the application, it was determined that the competencies to control the metacognitive thoughts of the preservice teachers included in the treatment group, who were taught by using a context-based chemistry teaching method in the laboratory within the 4Ex2 model, significantly changed in a positive way, when compared to those included in the control group. According to Flavell (1979), metacognition involves the metacognitive information and metacognitive experiences of an individual. The 4Ex2 model is defined as a model that combines learning experiences with the powerful conceptual structure of the taught content in order to learn better. The 4Ex2 model ensures that students improve their learning abilities by offering them opportunities for using learning experiences (Marshall et.al., 2008). Therefore, a decrease in negative metacognitive beliefs was observed in the group in which the 4Ex2 model was applied.

As a result of their study, Wells and Papageorgiou (1998) determined that different types of metacognition were in a positive relationship with signs of anxiety. Therefore, high metacognitive scores of preservice teachers in the control group could be associated with their levels of anxiety and concerns while studying in the laboratory. In this research, how the context-based chemistry education contributed to the academic achievements of the preservice teachers in the laboratory environment within the 4Ex2 model, was determined with the help of the achievement test and structured grids. It is recommended that the evaluation of daily life-based chemistry teaching be assessed through alternative assessment and evaluation methods, instead of through traditional exams and tests (Bennett, 2003; Gilbert, 2006; Pilot & Bulte, 2006; Yıldırım & Maşeroğlu, 2016; Yıldırım & Konur, 2014). According to the findings obtained as a result of the traditional and alternative assessments and evaluation tools, the achievements of the treatment group, which was taught according to the 4Ex2 model was, were found to be higher than those of the control group, in which traditional method was applied. In other words, the results showed that the preservice teachers in the treatment group, who received context-based chemistry teaching within the 4Ex2 model, were more successful; therefore, this model is an effective teaching method.

In a study conducted by Kerber and Akhtar (1996), a chemistry course was taught through associations with daily life and it was supported by laboratory activities. It was found that students gained more information as a result of the application, compared to traditional laboratory lessons. Similar findings were found in a study conducted by Wu (2003) and it was determined that the achievement level increased when a connection between the daily-life experiences of students and the scientific information they learned was established. In addition, it was understood that students could establish the connections on their own after the applications and they converted their daily life experiences into scientific information. In another study carried out by Zucht, Rossow, Lange and Flint (2004), it was suggested that connections may be established between the chemistry lessons and daily life through the activities and students could have the opportunity to practice their knowledge in such learning environments. It is thought that the reason why the preservice teachers in the treatment group, who were taught context-based chemistry by using the 4Ex2 model, were more successful was that the model provided students with the opportunity to participate in activities affecting their metacognitive strategies more effectively.

Metacognition consists of the conscious controls that individuals apply to their learning process by using their memory effectively (Schneider & Lockl, 2002) and it is about what a cognitive study requires, its impacts and challenges. Since not all tasks are at the same level, different tasks can force individuals to apply different cognitive rules (Victor, 2004). The meta-cognitive strategies employed with effective formative assessments have an important role for individuals in achieving success (Black & Wiliam, 1988). Metacognitive abilities should be developed among school students. Only then can they reflect on their learning methods, their performance in classroom activities, and improve their academic achievements accordingly. Teachers should know the individual differences in the level of metacognitive awareness in a classroom and should teach by taking into consideration students' individual differences so that by effective instructions in the classroom, their metacognitive abilities may enhance well. On the other hand, failure in operating or controlling metacognitive processes is believed to cause poor performance in academic problem-solving tasks of an individual (Brown, Bransford, Ferrara, & Campione, 1983). Methods, techniques, and approaches that ensure that social and physical contexts are employed deliberately help in comprehending cognition and learning in a clearer way (Brown, Collins, & Duguid, 1989). It is known that education informed by considering the fact that individuals have different ways of thinking will be of better quality, and if the different intelligence components are identified the encountered problems can be solved more successfully (Gardner, 1993). From this viewpoint, the multiple intelligence types of preservice teachers were observed after the treatment and control groups had been determined. Metacognitive variances and differences in the achievements of the preservice teachers were caused by intelligence types. In the study conducted by Veenman et al. (2006), the relationship between metacognitive abilities and intelligences, and learning performances of the students enrolled in classes of different levels was examined. According to the findings obtained, significant positive relationships were found between the metacognitive abilities and intelligence levels of students.

Cooper (2008) found that a statistically significant effect of using Multiple Intelligences Theory and metacognition skills is the improvement of academic achievement among students. Furthermore, since metacognition is a long developmental process, research indicates that metacognition increases with age and its different elements have different developmental periods (Flavell, 1979; Hanten, Dennis, Zhang, Barnes, Roberson, Archibald, Hartman, & Sternberg, 1993). For example, in the study carried out by Tosun and Irak (2008), it was determined that there were significant positive relations between age and the ability to use metacognition effectively. In this study, it was determined that there were no significant differences in the intelligence fields of the preservice teachers in the treatment group which was taught according to a context-based chemistry education within the 4Ex2 model, and the preservice teachers in the control group who were taught according to the traditional method. In some studies, it was concluded that the treatment group showed higher performance than the control group, as a result of the applications based on their dominant intelligence fields (Al-Balhan, 2006; Mokhtar, Majid, & Foo, 2008). Through previous results illustrated in general, all intelligence patterns among students came in the following order: self, social, bodily, logical, verbal, visual, musical, and natural intelligence. This arrangement differed among male students: social intelligence came first, followed by self, bodily, logical, verbal, visual, natural, and musical intelligence, whereas self-intelligence came first among female students, followed by bodily, verbal, social, logical, visual, natural, and musical intelligence (Kandeel, 2016). However, it is seen that in some cases there are no significant differences in the intelligence fields of the participants after the applications in general (Uhlir, 2003; Tahriri & Divsar, 2011). The literature review concluded that there were no studies about context-based chemistry teaching in the laboratory within the 4Ex2 model. However, there were certain studies similar to this study on determining different samples and problem situations from daily life, performing tests and preparing worksheets that would draw students' attention in terms of content and type and transferring them to the learning cycle model (Schmidt, Freienberg & Flint, 2002; Yıldırım et al., 2007; Akpınar and Özkan, 2010; Toroslu & Güneş, 2010; Ulusoy & Önen, 2014, Çepni, Ülger & Ormancı, 2017). The findings of these studies are supportive of the findings of this study. Generally, in the studies that were carried out according to the learning cycle models, it was found that students were quite satisfied with the activities and they expressed that similar activities based on daily life should be performed more often (Schmidt, Parchmann, & Rebentisch, 2003; Huntemann, Honkomp, Parchmann, & Jansen, 2001). Recently, greater importance has been given to the relevance of chemistry education in the events that we face in our daily lives. Context-based learning has been supported simultaneously with a model, method, and technique in research projects. It is expected that meeting students' needs and desires to learn a subject using context-based learning activities will make a positive contribution to research in this field.

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The Impact of Virtual Lab Learning Experiences on 9th Grade Students' Achievement and Their Attitudes Towards Science and Learning by Virtual Lab

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ABSTRACT

Laboratories are important environments in science teaching. There is no doubt that the employment of technology in these environments may change the learning of science, especially as the technology has made its way into nearly every aspect of daily life. This study aimed to investigate the impact of using virtual labs on students' achievement and as well as their attitudes towards science and learning by virtual lab. Achievement pre and posttest and attitudes scale towards science were examined for 69 students divided into two control and experimental groups. Another attitude scale towards virtual labs was only administered to the experimental group. The results indicate that the virtual lab has no impact on students' academic achievement or their attitudes towards science. The results show that the students had overall positive attitudes toward learning by virtual lab. Some recommendations and suggestions are proposed to develop effective learning of science.

Keywords: Virtual Lab., Achievement, Attitudes.

INTRODUCTION

Laboratories are an important part of teaching science and achieving its objectives. They can be described as controlled conditions in which scientific experiments are carried out. Previous researches (Bretz, Fay, Bruck, & Towns, 2013, Bruck, Towns, & Bretz, 2010, Johnstone & Al-Shuaili, 2001) have been shown that there are many advantages of using labs in teaching science such as students' deep understanding of science concepts and correcting their misconceptions. In addition, it develops students' abilities in design, evaluation, and problem solving. Furthermore, science laboratory increases students' curiosity and positive attitudes toward science while nurturing communication skills between students. Laboratory activities can support meaningful learning by forming a link between the new information and

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the existing information, thus improving students' conceptual understanding of the material (Hakim, Liliasari, Kadarohman, & Syah, 2016).

The use of computers in education has increased dramatically in recent years and now computers and related technologies are in most schools all over the world (Dincer, 2015). There is no doubt that the use of information and communication technology (ICT) in classrooms has been increasing dramatically in science classrooms. This is not because the technology provides one way to help science teachers overcome obstacles of their teaching and improve the learning outcomes (Keller & Keller, 2005) only, but it goes beyond that to support the individual with different life skills. One of the recent advances in ICT is what is known as virtual lab, which is appeared besides the traditional laboratories. Virtual lab offers interesting possibilities for disseminating educational material to students (Fridman, 2014). Rajendran and Divya (2010) considered virtual labs as educational potential because they provide an opportunity to "learning by doing for everyone." Users can explore a variety of scenarios by changing the input and observing the effect on the output.

In the traditional laboratories students use hands-on to activate experiential ideas and engage with scientific phenomena in real conditions. This type of laboratory benefits students by incorporating concrete objects in science learning and give opportunities to interact directly with the scientific phenomena being studied (Lunetta, Hofstein, & Clough, 2007). It can be distinguished from the virtual laboratory in two ways;1) all the equipment required to perform the laboratory is physically set up; and 2) the students who perform the laboratory are physically present in the lab(Ma& Nickerson, 2006). There are some challenges that have limited the effectiveness of this type of laboratory and led to the emergence of other types of laboratories. These challenges including:1) only a limited number of tests and lab exercises can be undertaken in the time available with the limited resources,2) keeping students safe and secure while they are working in the practical experiments and 3) the materials and instruments that should be provided in these laboratories are highly costs.

The virtual laboratories facilitate the formation of conceptual models by several processes utilizing the benefits of technology. This type of laboratories centered on three basic phases including: 1) immersion that enables the student to experience the phenomena by themselves rather than teachers' eyes or textbooks. 2) Interaction, which allows the students to move from passive observers to active thinkers. Finally, 3)engagement where the learners control the computer to reach their targets in sophisticated ways (Trindade, Fiohais & Almida, 2002). Utilizing technology in virtual laboratories taking into account the containment of animations and interactive programs has remarkable effects in science learning. Several studies showed that interactive animations and computerized learning have been found an effective tool for enhancing conceptual understanding of different scientific concepts (Akpınar 2014; Karacop and Doymus 2013; Khan 2011; Kumar et al. 2011). Other advantages of virtual labs have been highlighted by previous researches. For example, this type of laboratory gives the students experience in planning an experiment and analyzing data, participating in a team, operating a pipette or microscope, and exercising any of the other practical and social skills essential for success in science. In addition, it may also be used to simulate complicated, expensive, and/or inaccessible devices (for example, a nuclear reactor) or to replace environmentally hazardous laboratory experiments (Kocijancic& O'Sullivan, 2004). It allows for free exploration and collecting/assembling items of apparatus. It also helps students to read information about the items of apparatus and about laboratory procedures (Dalgarno, Bishop & Bedgood, n.d). The students also will be able to carry out safe, rapid, and cost-efficiency experiments with minimization of error (El-Sabagh, 2010). Virtual laboratories can also be presented as a solution to distance learning because they offer to students the possibility to interact and practice the content and enrich way (Joao & Clara, 2007). In addition to that, virtual experiments enable students to experience an activity via images and data presented online sharing with large numbers of students (Gibbins & Perkin, 2013).

A review of several studies as presented below using virtual laboratories in different science classes indicated that they varied in their effectiveness (Hawkins & helps, 2013). Despite the positives points mentioned above, there are some drawbacks regarding the use of virtual laboratories. One of the criticisms of virtual laboratories is the fact that they do not teach laboratory techniques and manipulative skills well (Hawkins & Phelps, 2013). The experiment in the virtual lab does not exist in reality and therefore, the dangerous or unsafe for the real experiments do not exist. Because students do not work with real materials and equipment, they lack their responsibility, and carefulness towards them. Students in this type of laboratories feel like they are playing a video game, not in a learning situation (Potkonjak et al., 2016).

Baladoh, Elgamal & Abas (2017) conducted a study to investigate the effectiveness of virtual lab in improving students' understanding of concepts and their skills in handling electronic circuits. The experimental work was carried out in Mansoura vocational preparatory schools for hearing-impaired students in Egypt. The results clearly revealed the effectiveness of the virtual lab in improving students' achievement and practical skills with respect to handling electronic circuits.

Tuysuz (2010) stated that the use of virtual labs overcomes some of the problems faced in traditional laboratory applications and makes positive contributions in reaching the objectives of an educational system. The findings of his study in a unit of "Separation of Matter" for 9th grade students showed that virtual laboratory applications made positive effects on students' achievements and attitudes when compared to traditional teaching methods.

El-Sabagh (2010) illustrated that utilizing the virtual lab as a tool enhances understanding, improves operational skills, promotes learning interest, and inspires innovation. In his study, he compared the impact of a web-based virtual lab environment with traditional teaching method in relation to conceptual understanding and science process skills among 4th grade primary school by using an instructional design model of 3D animations and interactive experimental activities. Pretest results indicated that the entry-level for conceptual understanding in science and science process skills of both groups of students were equivalent. The findings of the posttest showed that students in the experimental group had significantly better performance in both conceptual understanding and science process skills.

Tatli and Ayas (2013) examined the effect of a virtual chemistry laboratory on 90 students' achievement from three different 9th grade classrooms divided into one experimental group and two control groups. Study data were gathered with pre and post chemical-changes unit achievement test, laboratory equipment test, and unstructured observations. It was concluded that the developed virtual chemistry laboratory software was at least as effective as the real laboratory, both in terms of student achievement in the unit and students' ability to recognize laboratory equipment. In their study, Borrero and Marquez (2012) investigated the effect of using virtual learning in teaching some engineering concepts. The study sample consisted of 10 teachers and 20 students chosen randomly. The results indicated that the views of teachers and students were similar, and that positive attitudes were developed using virtual learning to teach engineering concepts. In addition, the results showed that using virtual learning caused satisfaction and acceptance among teachers and students. The presence of the graphics interface and the ease of use and installation process were good elements to exist in such learning that made it preferable to users.

Redha's (2010) study aimed at investigating the effective use of virtual lab in teaching chemistry on students' development of scientific thinking. The study used quasi-experimental approach in which the sample was divided into two experimental groups and one control group. The results showed the effectiveness of the virtual lab in the development of scientific thinking which is varied according to lab type in favor of the enquiry-based virtual labs. Ahmad (2010) carried out a study entitled "the effect of using a virtual lab on the physics concepts achievement, acquisition of higher-order thinking skills and motivation toward science learning among students of the third preparatory class." The researcher pursued a quasi-experimental approach with a sample consisted of 90 female students randomly selected from the 3rd preparatory class and equally distributed to two experimental and control groups. Achievement test in physics concepts and achievement test were used to measure the acquisition of higher-order thinking, along with a motivation scale towards science learning. In addition, multimedia software adopted by the Ministry of Education in teaching "sound and light" unit for the 3rd preparatory class was used. The results indicated statistically significant differences in favor of using the virtual lab. The study revealed the effectiveness of the virtual lab in the development of thinking skills in addition to raising the level of achievement in academic concepts. The results also demonstrated the impact of the virtual lab in increasing students' motivation toward science learning.

Sahin (2006) highlighted that the appropriate use of multimedia in laboratories (computer simulation) offers a high degree of interaction and attractiveness. It also supports both constructivist learning and problem-solving skills and develops many science process skills including hypotheses, interpretation, and prediction. The study by Kerr et al. (2004) compared achievement among students instructed using hands-on chemistry labs versus those instructed using virtual chemistry labs. They found out that there were no significant differences in achievement gain scores for the traditional versus the virtual lab students. They commented that the findings obtained from their study demonstrated that students who completed the traditional, hands-on labs performed as well as students who completed the virtual labs.

In Omani context, Al-Balushi (2009) conducted a quasi-experimental approach study that aimed at investigating the effectiveness of chemistry virtual lab on the development of practical skills and achievement of students at the post basic education and their attitudes toward it. The results showed statistically significant differences between the mean scores of pre-posttests in the academic achievement in the experimental group in favor of the posttest. In addition, the results showed statistically significant differences between the mean scores of the experimental group and the control group in the improvement of the practical skills in favor of the experimental group. Statistical significant differences were also found between the mean scores of pre-post applications of the attitudinal scale toward chemistry virtual lab in the experimental group in favor of the post application. There was a positive attitude towards this type of labs among 11th grade students.

Al Balushi, Al-Musawi, Ambusaidi, & Al Hajri (2016) conducted a study to reveal the effectiveness of interacting with scientific animations in chemistry using mobile devices on the Omani 12th grade students' spatial ability and scientific reasoning skills. A quasi-experimental design was used with an experimental group of 32 students and a control group of 28 students. The experimental group studied chemistry using mobile tablets that had a digital instructional package with different animation and simulations. A spatial ability test and a scientific reasoning test were administered to both groups before and after the study. The findings showed that there were significant statistical differences between the two groups in terms of spatial ability in favor of the experimental group and that there were no significant differences between the two groups in terms of reasoning ability.

This study was conducted to test the efficacy of virtual labs as a replacement for the hands-on laboratory normally used in science teaching, and to investigate the impact of virtual labs on the Omani students' achievement and to report on their attitudes towards science and learning by virtual lab. Therefore, the study is seeking to answer the follwoing research questions:

1. What is the impact of virtual lab learning experiences on the Omani 9th grade students' academic achievement?
2. What is the impact of virtual lab learning experiences in developing the Omani 9th grade students' attitudes toward science?
3. What is the impact of virtual lab learning experiences in developing the Omani 9th grade students' attitudes towards using virtual lab in learning science?

METHODS

a) The Study Group

The sample of the study consisted of 69 9th grade students selected from one Second Cycle Basic Education girls school (grades 5–10). All public schools in Oman with grades 5–12 are characterized as single-gendered and taught by the same gender teacher. The researchers selected this school intentionally because it was equipped with technological materials and resources required to conduct the experiment and its principal and science teacher expressed willingness to cooperate in applying the treatment for the experimental group. Two classes were selected from the school, with one serving as an experimental group and the second as a control group. The experimental group consisted of 34 students who studied science supported by virtual lab learning that was prepared by the researchers specifically for the purposes of this study. The control group consisted of 35 students who studied science through the conventional method of teaching (i.e. in normal science class.

b) Data Collection Tools

One test (achievement test) and two scales (attitude towards science and attitudes towards virtual lab) were developed and used to collect quantitative data. For both groups, the difference in students' knowledge levels and attitudes towards science before and after the study were measured, whereas attitudes toward virtual lab were measured after the treatment and only for the experimental group.

Academic Achievement Test

An academic achievement test was developed to measure participants' academic achievement. The test encompassed of 21 items: 8 multiple-choice items and 13 open-ended questions. To ensure that the test questions were fair for both groups, all questions were based on the science content existed in student textbooks. Panel of experts reviewed the test to check the validity of the achievement test. The panel checked the appropriateness of the test for the purpose of the study and its scientific accuracy, readability, alignment with the textbook content, appropriateness for 9th grade students. The panel also checked whether each item measured the assigned cognitive level. The panel suggested re-phrasing of some items and clarification of certain figures. The estimated test time was 40 minutes (approximately one lesson period). The test was administered to similar sample to test its reliability using internal consistency using Cronbach's Alpha, which was 0.83.

Attitude towards Science Scale

This scale was developed for measuring the attitudes of students toward science. It consisted of 35 items using five-point Likert type scale (strongly agree, agree, neutral, disagree, and strongly disagree). The followings are some items from the scale:

- I like to study science
- Studying science helps me to get a good job.

- I feel very comfortable when I study science.
- Studying science helps me understand issues of nature to better my life.

Validity of this scale was conducted by a panel of six reviewers specialized in curriculum and instruction and seven science supervisors working at the Ministry of Education. The panel was asked to verify that the five-point Likert type was appropriate for the purpose of the study and that the items were clear, readable, and accurate. Based on their feedback, the researchers rephrased some items. Reliability was calculated using Cronbach's Alpha, which was (0.75).

Attitude towards Virtual Labs Scale

This scale was developed to measure the attitudes of students toward virtual labs. It consisted of 38 items in its final version. The scale used a three-point Likert-type scale (agree neutral and disagree). The followings are some items from the scale:

- Using virtual lab develops my mental accuracy skills.
- Learning science through virtual lab is fun and interesting.
- Virtual lab focuses on observation, inquiry, and exploration that enhance my scientific knowledge.
- I like conducting practical experiments and procedural activities through virtual lab.
- Virtual lab provides me with new skills and practical development.

The validity of this scale was examined by a panel of eight reviewers specialized in curriculum and instruction and seven science supervisors working at the Ministry of Education. The panel members were asked to verify that the three-point Likert type was appropriate for the purpose of the study and that the items were clear, readable, and accurate. Based on their feedback, the researchers rephrased some items. Reliability was calculated using Cronbach's Alpha, which was (0.75).

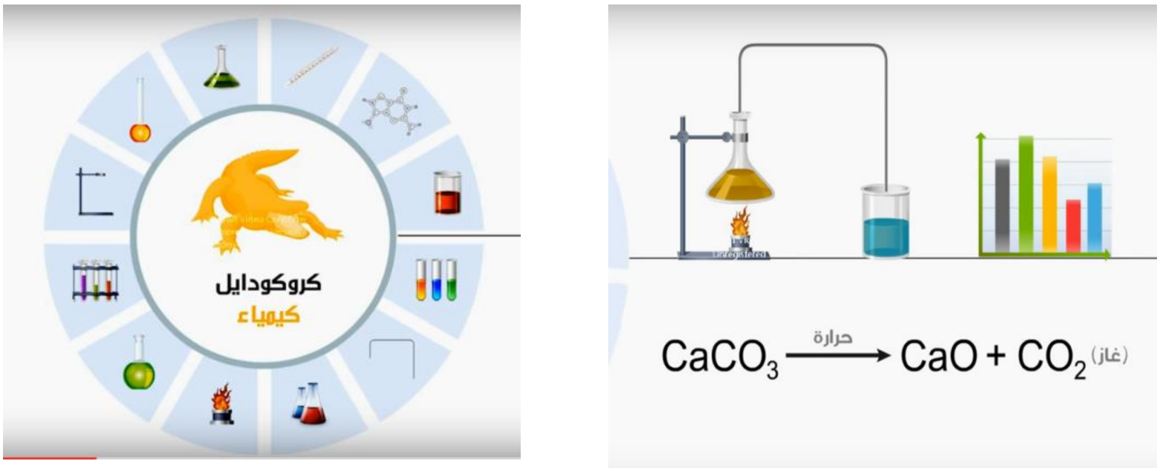
The Virtual Lab

Crocodile virtual lab, originated from academic work implemented on chemistry lessons with computer simulations, was used. It is a unique product in that it incorporates both an interactive simulation and a lab notebook workspace with separate areas for theory, procedures and student observations (Tatli & Ayas, 2013). Commonly used lab equipment and procedures were used to simulate the steps involved in performing an experiment. Users go through the actual lab procedure while interacting with animated equipment in a way that is similar to the real lab experience. This virtual lab also comes with a range of pre-designed lab experiments for general chemistry. Users can expand upon the original lab set by using virtual materials and equipment, thus allowing educators develop curriculum specific lab simulation (Alexiou, Bouras & Giannaka, 2001). These users designed simulations combine both text based instructions and the simulation into a single distributable file.

The researchers prepared the virtual lab learning to specifically serve the instructional purposes of this study by aligning it to the Omani science curricular content, modifying the instructional activities as described in student textbooks, and choosing Arabic modules as this is the language of instruction in Oman.

A panel of eight reviewers specialized in curriculum and instruction and seven science supervisors working at the Ministry of Education ensured the content validity of the lab. The panel members were asked to verify that the curricular content of the lab was appropriate and clear for the purpose of the study. Based on their feedback, the researchers made the required modifications. Figures 1 shows icons and implementation of the program.

Figure 1: *Sample of virtual lab program used in experimental group*



Focus Group

A focus group discussion was used to provide a natural setting in which students normally state and form their opinions about the virtual lab. Discussions took place during two sessions arranged for the experimental group only with 12 students selected as members of the focus groups. In each session of the two, three participants from those who scored high and three of those who scored low in achievement test.

A semi-structured protocol was used for every focus group discussion to make sure that differences between the groups were minimized and that the same procedures were followed in every discussion. The protocol consisted of two parts: the student opinions in science teaching, and benefits gained in science lessons during the experiment period.

At the beginning, the interviewer (the 4thauthor) welcomed the group members explained the purpose of the discussion and that the information collected would be used for research purposes only and assured the members that their identity would be kept anonymous. Participants were asked to discuss their opinion about the two parts of the above-mentioned protocol. They were asked to express their opinions and state whether the program helped them to learn science better. Each group discussion lasted between 1–2 hours.

C) Study Design

A quasi-experimental design was used in which the two groups were divided into a control and experimental group (Table 1). Pre and posttests were used for two instruments and a posttest was used the third one only.

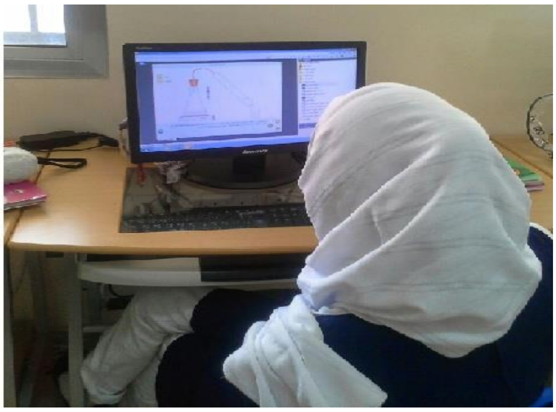
Table (1): *The Research Design*

Pre- Test	Group	Instructional method	Post-Test
• Achievement Test • Attitude towards science Scale	Experimental	• Taught by Virtual experiments (Crocodile software)	• Attitude towards virtual labsScale
			• Achievement test • Attitude towards science
	Control	• Taught by Conventional method of instruction	

For the control group (with 33 students), the chemistry experiments were taught by using the conventional method (i.e. inside the classrooms as demonstrations and mostly by the teachers). Most of the experiments in this form of teaching carried out in the lab manually as mentioned in the textbook starting with the practical presentation by the teacher and the participating of students. The main role of the student was recording observations and results followed by discussion with the teacher and other students.

For the experimental group (with 35 students), the chemistry experiments were taught to students using Crocodile virtual lab. This software stimulates real laboratory where the students carried out chemistry experiments virtually. Each computer uploaded with a large number of readymade reactions. Animations provided to the software units in different languages. Arabic version used since the Arabic is the language of instruction for science subjects in public schools in Oman. The experiment lasted for 12 weeks, during two lessons per day. Each student in the experiment group worked in separate PC to view and interact with different animations related to different topics that belonged to the chapters in the 9th grade science textbook (Chemistry Unit). Figure 3 shows examples of students working in the experiments.

Figure 2. Sample of students working in the virtual lab program.



d) Data Analysis

The data collected in this study were analyzed using the SPSS statistical package. Means and standard deviations for achievement test and attitudes towards science were calculated before the treatment, and a t-test was used to determine if there is any significant difference between the two means for each test.

Group equivalence in pretest of academic achievement test and attitude towards science was calculated. Table (2) summarizes the results.

Table 2: *Pretest of academic achievement test and attitude towards science*

Variables	Experimental group		Control group		t-Test
	Mean	SD	Mean	SD	
Academic achievement	9.59	4.35	7.36	4.14	0.033*
Attitude towards science	2.46	0.32	2.36	0.393	0.238

* Significant at ($\alpha = 0.05$)

Table (2) shows that there is a significant difference in the mean scores of pretest implementation of the achievement test between the two groups in favor of the experimental group (see Table 3 for details). However, there is no such difference in the attitudes towards the science test so that the two groups are equivalent in their attitudes towards science.

FINDINGS and DISCUSSION

Posttest for the Achievement Test

As shown above in Table (2), the pretest results of the achievement test showed significant difference between the control group and experimental group (t = 0.03< 0.05). Therefore, ANCOVA was used for the posttest of the Achievement Test in this case (Tables 3 and 4). All ANCOVA assumptions were met.

Table 3: *Posttest of the academic achievement*

Variable	Experimental group		Control group	
	M	SD	M	SD
Academic Achievement	12.79	5.68	13.74	4.46

Table 4: *ANCOVA results of achievement test*

Source	Sum of Squares	Df	Mean Square	F	Sig.	Eta Square
Corrected Model	865.667	2	432.833	32.058	.001	.493
Intercept	516.787	1	516.787	38.276	.001	0.367
Pretest	850.143	1	850.143	62.966	.001	0.488
Group	127.834	1	127.834	9.468	.003	0.125
Error	891.101	66	13.502			
Total	13917.000	69				
Corrected Total	1756.768	68				

Post- test for attitudes towards science and attitudes towards virtual lab Table (3) and (4) show that when the effect of the covariant in the dependent variable (pretest) was deleted, the variance resulting from the dependent variable was statistically significant (F = 0.03, α< 0.05). This means that in the achievement test there is a significant difference between the experimental and the control groups in favor of the control group. This result was in line with many previous studies (Kerr et. al, 2004; Akpan 2004; Rosenquist, Shavelson, &Araceli, 2000; Lee, Wong & Fung, 2010), which found that using virtual lab had no effect on students' achievement. There are many reasons behind this result. The important reason is that virtual laboratories do a poor job of acquiring students 'practical skills compared to traditional laboratories in which the teacher clearly outlines procedures and action steps. Students in traditional laboratories work with real materials and equipment, which allow them to acquire easily the practical skills. The only way to acquire scientific skills is often through actual hands-on experience which is not available in virtual laboratories (Potkonjak et al., 2016).

However, many studies related to virtual experiments, proved that students generally facilitated by virtual experiments and outperforms others in performance (Tuysuz, 2010; El-

Sabagh, 2010; Herga & Direvski, 2012; Siegel& Foster, 2001; Shegog et al., 2012; Baltzis & Koukias, 2009). These studies attribute this result to many benefits of the virtual lab. For example, virtual lab provides opportunities to students for self-learning and a chance for arranging time needed depending on their pace of learning. The virtual lab also may increase the understanding level of the scientific concepts faster than the traditional lab. Furthermore, using animation and simulation containing sounds and movement raise students' motivation in the laboratory activities and make chemistry learning more fun and interesting.

In order to find out if there was a significant difference between the two groups in the attitudes towards science, independent t-test was used (Table 5).

Table 5: *Posttest results of attitudes towards science scale*

Variable	Experimental group		Control group		t-Test
	M	SD	M	SD	
Attitude towards science	2.46	0.39	2.46	0.39	0.94

As it can be seen from table (5), there was no significant difference between the two groups in terms of students' attitudes toward science. Therefore, it is not obvious that teaching chemistry experiments using virtual lab is effective than traditional lab in developing students' attitudes towards science. This may be because laboratories usually motivate students to learn since that students interact positively while conducting experiments by using new tools and reaching exciting results in reality, which is weak in virtual experiments. Students' attitudes toward science along with the many factors affecting it, ranging from students' gender to the involvement of parents or guardians at home (Zangmo, Churngchow, Kanin, & Mophan, 2016). This finding was in line with Shegog et al. (2012) study results, while in opposition to Tuysuz (2010) study that found a positive impact of using virtual labs on science attitude.

For the attitudes towards virtual labs, the students' responses of each item in the three-rating scale were calculated and presented in Table (6).

Table 6: *Descriptive statistics of students' responses in the attitudes towards virtual labs post scale*

No. item	Items	Mean	SD
1	I would love to be an educational designer for the virtual lab in the future	2.18	0.75
2	I am not worrying that I will lose the information because of pressing the wrong button in the virtual lab program.	2.15	0.81
3	I like doing practical experiments through the virtual lab	2.05	0.62
4	I do not feel worried and scared when dealing with the virtual laboratory	1.97	0.61
5	I do not need the presence of a lab technician in conducting any experiment in the virtual lab	1.91	0.8
6	The virtual lab helps in developing my practical.	1.91	0.63
7	I do not feel the length of about the time I spend in conducting practical experiments and learning through the virtual lab	1.88	0.61

8	There is not difficulty in transferring the results and observations of my colleagues in the virtual lab.	1.83	0.67
9	The work in virtual lab is enjoyable	1.82	0.53
10	I trust my ability to conduct practical experiments by myself without a guide in the virtual lab.	1.80	0.92
11	I love writing reports of practical experiments and its equations in the virtual lab rather than in the traditional lab.	1.80	0.79
12	The virtual Lab made me love science, despite its difficulties	1.78	0.94
13	I do not fear to make mistakes when conducting experiments in the virtual lab.	1.71	0.86
14	Learning shapes, symbols and scientific equations became easy in the existence of the virtual lab	1.68	0.88
15	The virtual lab tools help me to evaluate my practical skills	1.66	0.91
16	I like conducting practical experiments and procedural activities through the virtual lab	1.63	0.43
17	I can follow in the progress in conducting of practical experiment and record my observation as my speed in learning	1.6	1.42
18	I like to practice on the basic skills of using tools and experiment materials before starting out in the virtual lab.	1.6	0.86
19	I feel happy while performing practical experiments through virtual lab rather than the traditional lab.	1.57	0.81
20	What I learn in the virtual lab integrates with what I learn in theoretical lessons.	1.57	0.87
21	The virtual lab helps me to organize thinking and expect the results more than the traditional lab.	1.55	0.79
22	I like the idea of having an integrated virtual lab within in the computer tablet.	1.54	0.83
23	I feel confident and responsible when I do practical experiments in the virtual lab.	1.51	0.83
24	I felt active and interactive learner in the virtual lab more than being the recipient of the information only	1.51	0.81
25	The Virtual lab helps me to form an accurate mental view of learning	1.49	0.81
26	The Virtual lab focuses on observation, inquiry and exploration that enhance my scientific knowledge	1.48	0.81
27	I like the form of the virtual lab and its design that includes interesting scientific materials and instruments	1.48	0.81
28	The virtual lab makes me feel safe and secure when dealing with dangerous lab materials and experiments.	1.47	0.75
29	I am sure of the availability of materials and tools that I need for the experiments in the virtual lab.	1.45	0.83
30	The virtual lab allows me to conduct any practical experiment without fear.	1.45	0.81
31	I like the idea of self-learning through the virtual lab	1.43	0.75

32	I feel free and interested in repeating the practical experiments until I am able to learn it	1.43	0.77
33	There are clear instructions to guide my activities in the virtual lab.	1.43	0.75
34	I like the diversity of activities and lab instruments in the virtual lab and accurate design and ease of use	1.42	0.77
35	I feel I can do well in the virtual lab.	1.42	0.75
36	I can conduct practical experiments and record my observations and results in a calm atmosphere when using virtual lab	1.41	0.7
37	The Virtual lab provides me with new skills and practical development	1.38	0.72
38	The virtual lab allows individual and collective work.	1.34	0.69
	Total Mean	1.63	0.24

The table above refers to the students' responses about Virtual Laboratory in descending order, where it was found that there were several items that shows positive impacts of using virtual lab. These items illustrate the features that made the students enjoyed and motivated while working with this kind of labs. For examples the highest mean value (2.18) was achieved in the item “I would love to be an educational designer for the virtual lab in the future.” Furthermore, both items “I am not worrying that I will lose the information as a result of pressing the wrong button in the virtual lab program” and “I like doing practical experiments through the virtual lab” also achieved high means (2.15, 2.05) respectively. This means that students relay on such program while studying science. In addition, it seems to be that students like much doing the practical experiments through the virtual lab. Students also indicated that there is no need to have a lab technician working with them while they are conducting any experiment in the virtual lab with mean value of (1.91) which shows that students owned confidence and responsibility during their practical experiences. Moreover, this type of lab can be cost effectiveness in terms of utilizing human resources (less needed of lab technician). Similarly, both items “trusting students’ ability to conduct practical experiments by themselves without a guide in the virtual lab” and “love writing reports of practical experiments and its equations in the virtual lab rather than in the traditional lab” with a mean of (1.80) confirmed the previous result, which indicate positive attitudes towards the virtual lab.

The items with a low means value are “The Virtual lab provides me with new skills and practical development” (1.38) and “The virtual lab allows individual and collective work” (1.34). Virtual labs from students’ point of view do not add a value to students" practical skills. This means that students are not gaining any skills that will develop their abilities to carry out the experiments. Virtual labs, from students' point of view, is the same as normal practical work, which can be done individually and collectively. This means that virtual lab has no unique thing that is weight more than normal lab work in term of the way of conducts it.

These results were supported by student's responses in the focus group discussion. For example, students stated that the virtual lab program was very comprehensive and contained many methods of delivering and explaining the information to students. “Graphs and chemical equations in this program make the learning much easier and more interesting.” Some students also connected their experience with a game or something they enjoyed doing, therefore it was a better choice for them. Backing it up we had one student saying, “Of course there was a positive impact of the virtual lab on my thinking. I felt that dealing with this type of lab like a game or puzzle, it is more fun and faster to get the idea. I felt that I was doing a real experiment regardless. I did not feel about the computer screen at all." Taking in account an individual learning time for each student was also another impact of the virtual lab. "In the virtual lab we can adjust the time during the working with the experiments and that cannot be done in the normal laboratory" one student replied.

However, some responses were not in favor of the virtual lab in which the mean of related items were less than the total mean. For example, students found that the ability of conduct practical experiments and record observations and results in a calm atmosphere when using virtual lab achieved mean of (1.41) only. Similarly, students respond on "virtual lab provides new skills and practical development" and "the virtual lab allows individual and collective work" were also low with means of (1.38, 1.34) respectively.

The results of students' attitudes towards virtual labs were consistent with many previous research findings (Borrero & Marquez 2012; Ketelhut, et al., 2010). Virtual environment overall and virtual laboratory in particular develop students' self-confidence and contribute to developing self-responsibility in their own learning. In addition, in this type of learning, students prepare materials and tools of the experiments, implement the steps, record their observations and make own conclusions without relying on the teacher. This is what has been generally concluded from the qualitative results related to focus group discussion. Students thought that the animations used in the program helped to them to better understand and remember the information. The integration between different stimuli (i.e. pictures, sounds and motions)make students to interact throughout the learning time. Furthermore, the richness of information provided and the opportunity to recall the previous information and linked them in an integrated template was another point that student highlighted very clearly. Finally, the ability of the program to take into account the individual differences between students and learning according to their abilities and potential. It's worth to mention that although there is no statistical impact of this program on students' achievement and their attitudes towards science, students seem to be very positive towards using their teachers the program in their science practical work lessons.

CONCULSIONS and SUGGESATIONS

In the current era, technology plays a major role in the development of different learning environments providing educational atmosphere that stimulate students and motive them for better learning. Therefore, active and meaningful learning conditions are likely to accomplish with virtual environments due to the development of virtual/computer tools nowadays. Although using the virtual lab did not show a positive impact on academic achievement but it has had a clear impact in raising their attitudes towards it. As mentioned in students' responds in focus group interviews, it decreases the level of abstractness that usually accompanies normal or traditional chemical labs works and helps the students to interact both with theoretical and practical knowledge. Hand on activities also is an inseparable part of the nature of science, and it is an interesting and important part of learning science because students in this type of activities working with real equipment. The only way to acquire these fine skills is often through actual hands-on experience (Potkonjak et al, 2016).

No doubt that the virtual lab provides opportunities of diversifying of activities and the use of various laboratory instruments in different experiments. The students have chances to carryout experiments including testing the cases, observing, and recording the results in a peaceful and safe environment. Despite that, this study showed that a virtual lab was just as good as the traditional laboratory at teaching concepts in chemistry. Thus, it is good to use a mixed system that involves a lab consisting of real (authentic, physical) equipment and virtual equipment, "co-present" at the same time (Potkonjak et al., 2016). Therefore, this study recommends more research needs to be done to determine virtual laboratories efficacy integrating with traditional hands-on laboratory. The research conducted in this filed should also go in depth and try to find out the factors that affect more students learning via virtual labs. More research should be conducted to explore more benefits of the virtual learning in science education and other subjects. For example, more research is needed to explore the impact of virtual environment in improving students' self-regulation and science process skills.

Some limitations may affect the results of this study. One limitation of current study was the relatively short time for the study. Although the study was implemented in 12 weeks, but the actual use of virtual lab was related to the presence of the practical experiment in the lesson or not. Further researches could consider the extension of the of the study longer period with higher chance of more practical experiments. Some students were also unfamiliar with the program despite their beginner-level training, which led them to be delayed in their performance compared to other students. It is thus important to consider the proper preparation of all students in any new program.

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Effect of Science-Technology-Society Approach on Senior High School Students' Scientific Literacy and Social Skills

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ABSTRACT

This study aims to determine the effect of Science-Technology-Society (STS) approach on senior high school students' scientific literacy and social skills. Within a quasi experimental research designed (with pre- and post-test control group), this research was carried out at Senior High School 2 Banguntapan, Bantul, Yogyakarta, Indonesia. The sample of the current study was randomly drawn from students, which attended to XI Science at Senior High School 2 Banguntapan in the 2016/2017 academic year. Data were collected via test, observation sheets and questionnaires and analyzed by MANOVA Test. The results showed that there were statistically significant effects of STS approach on senior high school students' scientific literacy and social skills concerning the 'rate of reaction' subject ($p<.001$).

Keywords: STS, Scientific Literacy, Social Skill.

INTRODUCTION

Challenging the 21st century requires students to comprehensively have a 'science and technology' skill. The problems affected by science and technology call for scientific literacy, which is one of the important skills mastered by the students(Turiman, Omar, Daud, & Osman 2012; Ogunseemi, 2015; Mohapatra, 2013). Scientific literacy skills are also considered as a relevant aspect of qualified education in a country (Holbrook & Rannikmae, 2007). Based on the Program for International Student Assessment (PISA), Indonesia was ranked 53 out of 57 countries in 2006 (Organization for Economic Co-operation and Development [OECD], 2007), 60 out of 65 countries in 2009 (OECD, 2010), 64 out of 65 countries in 2012 (OECD, 2014), and 69 out of 76 countries in 2015 (OECD, 2016). This means that Indonesia has a low scientific literacy. Fibonaccy and Sudarmin (2014) define that scientific literacy purposes to link science learning with daily life. Youssef and Mohammed (2016) also explain that science learning should engage students in searching information, decision-making, problem solving, investigation, policy analysis, critical thinking, and creative thinking through daily activities. Therefore, science learning intends to not only get

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students to transfer scientific knowledge to daily life, but also to encourage them to develop problem-solving skills, communication, and lifelong learning ability.

Because science learning cannot be separated from the social context, science education include science concepts and scientific inquiry to obtain a conclusion. Therefore, science learning attracts students' social skills. Science learning involves academic competences and interactive social skills (Beheshtifar & Norozy, 2013; Marks & Eilks, 2009). Strong social skill can, in turn, facilitate the interpersonal interaction leading to effective learning outcomes. Social skills positively develop effective problem solving skills, stimulate learning interest, and improve academic skills (Rashid, 2010; Davies, Cooper, Kettler, & Elliott, 2014). Therefore, social skills need to be trained and developed in the learning process.

Finland education system, which is one of the popular exemplary state education system, focuses learningactivities on student engagement, student’s learning motivation, so students can construct their own knowledge (Ministry of Education and Culture of Finland, 2016). In addition, science lessons in Singapore, which is the best rank at the PISA 2015, concentrate on a ‘everyday life’ theme. The Singaporean science curriculum emphasizes a science-technology-society-environment cycle. Students act as scientists and teachers are mentors of inquiry-based activities (OECD, 2016).

Science-Technology-Society (STS) approach, which incorporates in similar learning activities implemented in Finland and Singapore, intends to increase students’ scientific literacy and social skills. Indeed, it is normal because the STS approach focuses on the scientific investigation conducted by the students, so that students experience how to analyze daily life issues. Students are trained to develop skills, to increase the activity of students, to take responsibility, to respond the existing issues in practicum, and to increase social interaction (Smitha & Aruna, 2014). Learning STS also encourages students to investigate the issue or problem and apply the newly gained concept or knowledge to new situations (Akcay & Akcay, 2015). That situation may improve creativity, critical thinking, and problem solving skills, attitudes toward science. Such learning encourages students to achieve meaningful learning.

Learning with STS approach motivates students and is more effective in meaningful learning than traditional methods (Zan & Seçken, 2015). STS approach involves students in analyzing the related issues through discussions with fellows, so that it develops students' skills via active learning processes (Smitha & Aruna, 2014; Autieri, Amirshokoohi, & Kazempour, 2016). In addition, STS learning encourages students to conduct scientific investigations so that they can see the relevance of content through context (MacLeod, 2013). STS approach represents a new paradigm in science learning, called student-centered learning, within science, technology, and society (Aikenhead, 2009). Besides, learning with STS approach makes students apply the newly acquired concept or knowledge to novel situations and results in better learning in high school (Yager & Akcay, 2008). Gormalli, Brickman, Hallar, and Armstrong (2009) also suggest that inquiry-based learning promotes scientific literacy and social skills. STS approach, which has been used in the Turkish science curriculum, utilizes students’ knowledge, decision making, critical thinking, problem solving, and effects of science and technology on society (Dikmentepe & Yakar, 2016). The related literature has shown that the inquiry-based learning has much more efficient at student achievement than science process skills and attitudes towards science (Aktamiş, Hiğde, and Özden, 2016). Therefore, the study aims to determine the effect of the Science-Technology-Society (STS) approach on senior high school students’ scientific literacy and social skills.

METHODS

Within a quasi experimental research designed (with pre- and post-test control group) (Sugiyono, 2010), this research was carried out at Senior High School 2 Banguntapan from October to November 2016. The population of the current study was all students in XI Science class at Senior High School 2 Banguntapan in the 2016/2017 academic year. The sample of the current study comprised of 56 students (Experimental Group: 28 students at Science XI-3; Control Group: 28 students at XI-4) randomly drawn from Science XI-3 and XI-4. The experiment group was exposed to the STS approach, whereas the control group was taught via students centered approach.

Data were collected via tests, observation sheets and questionnaires. The test instrument was developed to measure the students' science literacy, whilst observation sheets and questionnaires were designed to measure their social skills. There were other instruments for triangulation: a self assessment rubric, questionare of interest, and student worksheet. A self-assessment instrument required their individual evaluations at each meeting on the following topics: Rate of Reaction,, Collision Theory and Energy Activation, Surface Area, Temperature, Concentration, and Catalyst. A questionare of interest was purposed to measure their responses to the STS approach.

The validity of the instrument was ensured through theoretical and empirical validities. A group of experts (an expert judgment and chemistry teacher) confirmed expert validity reviewing test items (Subali, 2016). The empirical validity was tested by students in other classes before the real study. Hence, the validity and reliability of each item and the test were calculated by the help of the Quest program. Acceptance criteria fit / valid item was ranged from 0.77 to 1.3 (Keeves & Alagumalai, 1999). This means that it was higher than the acceptable reliability value (0.70) (Cronbach, 1951; Wells & Wollack, 2003).

Science literacy was analyzed based on the gain value of the *scientific literacy* description, while social skills were conducted with the gain values of the observation sheets and questionnaire. Multivariate Analysis of Variance (MANOVA) was run at 5% significance level in that independent variable of this study was only one, the STS approach, and its dependent variables were science literacy and social skills. The statistical analysis included: the prerequisite test of normality and homogeneity, correlation test, and multivariate hypothesis. The gain values of the pre-test and post-test were counted with the formula:

$$\text{gain} = \frac{\text{posttest value} - \text{pretest value}}{100 - \text{pretest value}}$$

The analysis of categories used the formula (Azwar, 2015):

(M+1.5s)	<	X			excellent
(M+0.5s)	<	X	≤	(M+1,50s)	good
(M-0.5s)	<	X	≤	(M+0,5s)	moderate
(M-1.5s)	<	X	≤	(M-0,5s)	poor
		X	≤	(M-1,5s)	very poor

Note : M = Means; s = deviation standart

The Ministep program was also used to measure the experimental group's ability and difficulty levels of science literacy.

FINDINGS

The experts suggested some revisions for the data collection instruments, i.e., test, observation sheets, questionnaires, and assessment instrument. The Quest program indicated that the reliability value of the questionnaire was found to be 0.95, which is higher than the acceptable value. The Quest program showed that the test instrument had an instrument reliability of 0.95 (> 0.7 = enough), while the reliability of the questionnaire instrument was counted to be 0.78 (> 0.7 = enough).

The results of the science literacy were obtained from the 21-item-test, while the social skills were evaluated through observations and questionnaires. The gain values of science literacy and social skills were analyzed using MANOVA test. The results showed that there were significant effects of the STS approach on the students' scientific literacy and social skills ($p<0.001$). The gain averages of the experimental and control groups for scientific literacy and social skills are presented in Table 1.

Table 1. The Gain Averages of the Experimental and Control Group for Students' Scientific Literacy and Social Skills

Variable	Group	Gain Averages	Category	Standard Deviation
Scientific Literacy	Experimental	0.75	Excellent	0.156406
	Control	0.54	Moderate	0.151152
Social Skills	Experimental	0.35	Moderate	0.185755
	Control	0.32	Moderate	0.163434

The results of the experimental and control groups' descriptions of scientific literacy are presented in Table 2.

Table 2. Results of The Experimental and Control Groups' Descriptions of Scientific Literacy and Social Skills

Variable	Description	Experimental Group		Control Group	
		Pretest	Posttest	Pretest	Posttest
Scientific literacy	Category	Poor	Excellent	Poor	Good
	Average Value	34.53	85.21	34.85	69.321
	Minimum Value	21	70	20	45
	Maximum Value	50	97	51	90
Social skills	Category	Moderate	Good	Moderate	Good
	Average Value	65.44	77.67	61.78	73.95
	Minimum Value	56.25	62.5	51.25	62.5
	Maximum Value	75	91,66	73.75	87.5

Because the student's individual competences were evaluated at the each meeting, the average value is presented in Table 3. Results of student interest in the STS approach showed a score of 18.82 or 94.10%, indicating excellent category.

Table 3. The Results of The Experimental and Control Groups' student's Individual Competences

Sub-Chapter Material	Experimental Group	Control Group
Rate of Reaction	75.1	-
Collision Theory and Surface Area	77.2	-
Temperature	79.2	73.8
Concentration and Catalyst	80.5	77.6
Average	**78**	**75.5**
Category	**Excellent**	**Excellent**

DISCUSSION and CONCLUSION

Ilaah and Yonata (2015) addressed that the 'rate of reaction' subject needs experimental evidence by asking students to investigate, analyze, and summarize the experiment results. Further, the student activities should be associated with everyday life, so that students can meaningfully find their own concepts of the subject. Meaningful learning acquires an experience and directly evidence to improve the students' competences and skills (Alkan, 2016).

The results of correlation test showed that there was a statistically correlation between the two variables. This means that increased science literacy can improve students' social skills. This may stem from scientific literacy skills, which afford students to understand the nature of science and its development; basic scientific concepts, principles, laws, and theories; to use the scientific processes in problem solving or decision making; and interlinks amongst science, technology, society and environment. In addition, students are able to understand and apply their knowledge to everyday life appropriately and effectively, as well as having communication skills. Therefore, equipping students with scientific literacy also trains their social skills indirectly.

The results of MANOVA revealed that the STS approach had an effect on the students' science literacy and social skills of the 'rate of reaction' subject ($p<0.001$). This may come from the use of the student worksheet in the experimental group introducing the students to the issue with images, news, or phenomena that attract students' attention to the subject. This might motivate them to raise the curiosity of the situation, causing a good discussion between students and teachers. They might shape and develop the concept throughout the discussion, so that they could apply the concept in a novel situation. At the end of learning, the students had formulated their conclusions by integrating an understanding into the technological developments, and their impacts on society and individual evaluation (Poedjiadi, 2010; Rosario, 2009). The fact that the STS approach was designed to improve the interactions between student-student and student-teacher may have facilitated their understanding of the content, process and context of science. This is in accordance with Vitiello and Williford's (2016) statement of students' good social skills that engage them in classroom and doing a good job.

Since the experimental group was directed to analyze the presented issues and link scientific knowledge to it, they were trained for connecting dimensions of process, content, and context for the learning within the ability of scientific literacy. So, the experimental group was more literate in science than the control group. This is supported by Yörük, Morgil, and Seçken (2009), stating that the STS approach makes students have the capability of connecting science, technology, society, and environment as well as unveiling their insights. An increase in their insights make students have a comprehensive understanding of science concepts and relate to everyday life.

In addition, Lee and Erdogan (2007) depict that the STS approach is more effective in encouraging students to develop science and to become more interested and motivated to learn science. Students are also more frequently asked questions to identify the problems, so that they acquire the skills to provide a settlement analysis. Therefore, learning process becomes more interactive because discussions are dominant at learning activities. This is supported by Rahman (2011) stating that the discussion method is more effective than a lecture. Because discussion activity trained the students' social skills in terms of cooperation, mutual respect, and communication, the STS approach can improve their scientific literacy and social skills.

The results of pre-test pointed that both groups (the experimental and control group) were in poor category for the scientific literacy skills. It can be inferred that the students had not previously been trained to improve scientific literacy. The results of the research shows of significant post test improvements for the experimental group. That is, the experimental group was at excellent category with gain increase of 0.75, while the control group was at good category with gain increase of 0.54. This shows that the experimental group outperformed the control group. This is in accordance with Ogunseemi's (2015) statement "involveing science and technology in the learning develop scientific literacy skills (p.XXX)".

In analyzing the science literacy question, the content dimension adjusts to the reaction subject level indicator, while the process dimension identifies the scientific problem, explains the phenomenon scientifically, and uses scientific evidence, and the context dimension adapts to daily life (OECD, 2007). Given the results of Ministep software, the experimental group found three questions the highest difficulty level. Those are the process dimension of explaining phenomena scientifically. They saw the process dimension of identifying scientific issues as the lowest difficulty level. The results of the student ability in the experimental group indicated that the three students with the lowest ability were able to complete on the easier question. In addition, there were also three students in the experimental group that had the ability above average. This is evidence that they were able to complete on the highest difficulty questions to achieve the maximum score on those three questions.

The results of social skills showed that the experimental group experienced a better improvement than the control group. The result of the initial analysis revealed that the two classes were in the moderate category, while the final results indicated that the two classes were in the high category. The experimental group had higher average at the final result (77.67) than the control group (73.95). The maximum value obtained by the experimental group (91.66) was also higher than the control group (87.5). This may result from the use of student worksheet in the experimental group, which requires to negotiate with other students in their groups. Further, they needed to discuss issues or analyze the phenomena, answer questions, do practicum, apply the concept in everyday life, and formulate conclusions. Even though the control group also followed the student centered approach, their activities were not as much as those in the experimental group.

At the end of each meeting, the experimental group was evaluated individually to measure the individual's cognitive ability to understand the subject. The average evaluation result appeared a value of 78. This showed that although the experimental group analyzed the phenomena in everyday life, they were capable to mastery of the material concept.

At the last meeting, students were given a questionnaire to measure the attitude of interest in learning the STS approach to the rate of reaction subject. The results showed that over 94.1% of them were interested in learning the 'rate of reaction' subject via the STS approach. 23 out of 28 students stated that the 'rate of reaction'subject became more difficult than previously imagined and did not want to apply the STS approach in other subject. But overall, the students were interested in studying the 'rate of reaction' subject using STS approach with excellent category.

The fact that the STS approach significantly influenced the students' scientific literacy skills ($p<0.001$) make students have the scientific literacy skills (Smitha and Aruna, 2014). In addition, the results of thoroughness showed the value of the experimental and control groups, who completed the post-test (>75), were 22 and 14 respectively. This is in a parallel with the STEM (Science Technology Engineering, and Mathematics) project, showing higher scores in geometry, probability, and problem solving (Han, Rosli, Mary, and Capraro, 2016).

The results of social skills indicated no effect of the STS approach on the students' social skills ($p>0.963$). This means that the STS approach did not have a significant effect on students' social skills. The average results of pre-questionnaire of the experimental and control groups were in the moderate category, whereas those for post-questionnaire were in the excellent category. The same category in the experimental and control groups may come from the student-centered approach used in both.

Suggestions

In light of the results, it can be deduced that the STS approach positively affected the students' scientific literacy and social skills. Further, they have an opportunity to understand a science-technology-society cycle and transfer their newly gained knowledge to daily life. Such a learning process indirectly fostered them to improve their social skills, i.e., cooperation, mutual respect and communication.

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Does Experiencing Fieldwork Strengthen or Dampen Indonesian Preservice Biology Teachers' Attitude and Self-Reported Behavior towards Environment?

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ABSTRACT

The current study examines the impact of fieldwork activities on Indonesian preservice biology teachers' attitudes towards the environment and self-reported conservation behavior. A total of 283 Indonesian preservice biology teachers (16% male and 84% female) participated in the study and four different instruments were used to explore the research questions. Validity and reliability of the research instruments were tested by performing Rasch model analysis. To explore the moderation effect of fieldwork on correlated variables, multiple-regressions test was conducted. The findings showed that fieldwork acted as a moderating factor in creating the relationships between Ecocentric Concern and Personal Conservation Behavior and between Human Utilization attitude and Personal Conservation Behavior. The correlation between findings and the Indonesian preservice biology teachers' curriculum are discussed.

Keywords: environmental attitudes, fieldwork, preservice biology teachers.

INTRODUCTION

Various environmental degradation such as air pollution, water pollution, forest fires, loss of biodiversity, and emergence of new diseases have occurred and have become one of the most fruitful topics in various fields including education and psychology (Chekima et al., 2016; Morag and Tal, 2012). Environmental degradation is not a new problem, but it is a problem that tellurians have faced for several decades, especially those living in developed-industrial countries. Today, environmental problems occur not only in industrial countries, but also in almost all corners of the world. Environmental problems influence humans' attitudes and behaviors towards the environment. Humans, who are nature-selfish, are always concerned with the quality of their own lives (Intergovernmental Panel on Climate Change [IPCC], 2014) without considering their impacts on the environment and/or environmental damages. Therefore, psychologists, educators and sociologists (e.g. Boeve-de Pauw and Van Petegem, 2013; Dunlap and Jones, 2002; Todd, 2016; Vining et al., 2002) have conducted

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studies on human attitudes and behaviors towards the environment and attempted to develop programs to solve these problems.

Given the emergence of environmental degradation, most of humans have become aware of environmental problems, which are results of their attitudes and behaviors towards the environment. Hence, many communities have strived to change their environmental attitudes and perceptions. Changes in attitudes and perceptions of today's society have been led to pro-environmentalism (Leung and Rice, 2002). Pro-environmentalism is a pro-attitude or a kind of support to keep nature natural, balanced, and livable for future generations (Bratanova, Loughnan, and Gatersleben, 2012). Several studies have found that most of pro-environmentalists come from natural sciences-related communities, so their activities or even their works are directly related to nature or environment (Tal and Morag, 2013).

Several findings in environmental psychology have found that the relationship between attitudes or perception and behavior are close, whether it is actual behavior or intentional behavior in the theory of planned behavior (TPB) (Ajzen, 1991). Though, it is not entirely one's attitude can describe his behavior, but Kaiser et al. (1999) found that approximately 53% of one's intentional behavior towards the environment could be predicted from attitudes or perspectives towards the environment. Thus, their intentional behaviors could be reflected in many of their attitudes through the term 'perceived pro-environmentalism.' Behavior theory proposed by Ajzen (1991) claims that humans have control for their actual behaviors and always consider many things before they are about to behave or implement their attitudes in the form of actual activities.

There are several factors that increase the relationship between attitude and behavior towards the environment, though one's behavior towards the environment, for example conservation behavior, would be reflection and implementation of their own attitudes (Dunlap, 2008; Bechtel et al., 2006; Kollmuss and Agyeman, 2002). To improve the relation through an environmental program, using factors closely related to one's daily life can be one significant effort, because targeted society will easily implement and accept it. In the case of a biology education student or commonly referred to preservice biology teachers, before becoming a biology teacher, they most likely had done variety of outdoor learning activities in order to have better understanding of content to be learned (Bell et al., 2009; Anderson, Kisiel and Storksdieck, 2006). A study by Esra (2010) indicated that students' knowledge about environment significantly affected their attitudes toward environment by. Furthermore, Aslan (2017) also pointed that attitude toward subject content might affect their academic achievements, Güzel (2004) described attitude toward subject also could influence students' learning, for example, students' negative attitudes towards science lesson make learning difficult. Because biology is the branch of science, which its subject study is nature (Lederman, 1999), preservice biology teachers conducting outdoor learning activities, may be one of the possible factors that could stimulate their attitudes and behaviors towards the environment and nature (Morag and Tal, 2012).

In Indonesia, most of preservice biology teachers must take courses using outdoor activities in the curriculum. Besides outdoor activities, to gain deeper understanding of science concepts also improves their conservation attitudes and behaviors. Mudilarto and Pamulasari (2017), who examined outdoor learning model in middle school level in Indonesia, found that it could improve core competencies of student's learning, which includes 78% of physics knowledge competencies and 92,5% skill competencies. The most well-known and widely implemented outdoor activity as a program or an activity to improve attitude and behavior towards the environment is fieldwork (Kisiel, 2006). Fieldwork activities are often used either as direct-planned activities (field trips) or as indirect-unplanned activities conducted at daily university classes. As noted earlier, people engaged in the science community (Harraway et al., 2012) would form attitudes to protect the environment through fieldwork, whereas preservice biology teachers obtain values that make them more caring and willing to maintain the environment (Knapp and Barrie, 2001; Tal and Morag, 2013; Ballantyne et al. 2007). Therefore, some researchers (e.g. Morag and Tal, 2012) mention that fieldwork is one form of environmental education.

There has been no evaluation on impact of fieldwork activities, commonly used by most Indonesian universities affiliated with educational fields on their preservice biology teachers' curriculum, on preservice biology teacher's attitude and behavior towards the environment, especially conservation behavior. Conservation behavior and attitude related-conservation are two key factors for Indonesian citizens, given that Indonesia is the richest country in natural biodiversity and known as a mega biodiverse country. Indonesia has the largest tropical forests contributing oxygen on Earth. Thus, Indonesians should preserve biodiversity to keep national balanced nature and sustainability of the Earth. In this case, preservice biology teachers will be future environmental teachers in Indonesian schools and therefore, play a key role in maintaining conservation attitudes and behaviors of Indonesian students that will be future Indonesian citizens. Therefore, the curriculum implemented by preservice biology teachers is crucial in preparing future biology and environment teachers. This study explores the impact of fieldwork activities on the Indonesian preservice biology teachers' curriculum of the relationship between conservation behavior and conservation-related attitude. For more details about fieldwork activities and courses related to fieldwork studied by Indonesian pre-service biology teachers, a brief description about Indonesian pre-service biology teacher's curriculum is described below.

Indonesian Pre-service Biology Teachers' Curriculum (Environmental Related Courses)

Prior to becoming middle school or high school biology teachers, Indonesian university students have to engage in four-year university life affiliated with the departments of biology and biology education. Those that graduate in biology and biology education in Indonesia hold a B.S or B.Ed as academic titles, and may apply for jobs as biology teachers. To prepare professional and competent biology teachers, most public universities that focus on educational fields have a curriculum not much different with others. In the first year, most preservice biology teachers will take introductory science courses divided into four introductory courses: biology, physics, chemistry and fundamental mathematics. Besides, they will enroll in basic educational related courses such as educational psychology, and a mandatory environmental science class for preservice biology education. In this environmental science course, they will be introduced to common and known environmental problems, cause of those problems, and ways to manage problems.

In the second year, they will enroll to more biology and educational classes, either mandatory classes such as biochemistry, curriculum and learning, or additional classes such as nutritional science and parasitology. In the second year, they have to enroll to plant anatomy class, animal structure class, botanical class, and entomology class. They have to engage in small fieldwork to collect plant or animal samples before they attend class and investigate samples. Like the second year, in the third year they have to enroll to courses that require outdoor learning activities, such as botanical science class and ecology class. Remaining classes are related to educational disciplines such as research and seminars in biology education and biology learning evaluation. The fourth year of the Indonesian preservice biology teachers embraces to learn advanced levels of biological sciences such as human and animal physiology and implement what they have learned into practicum as student teachers at high schools and middle schools.

Research Questions

Based on the background mentioned above, the following research questions guided the current study:

1. Does fieldwork improve the Indonesian pre-service biology teachers be more environmentally friendly attitude?
2. To what extent educational years impact pre-service biology teachers' environmental attitudes and behaviors?

METHODS

Population and Sample

Within survey research design, the current study gathered the data. A total of 285 pre-service biology teachers that enrolled to an Indonesian public university focusing on education majors were surveyed. All participants were affiliated with the department of biology education. Those pre-service biology teachers were in the first (22%), second (25%), third (29%) and fourth (24%) year of the study. The sample of the current study comprised of 16% male students and 84% female students, and most of them were Muslim (98%) and approximately 2% of participants were Christian and Catholic. We did not collect age data because the Indonesian students enrolling undergraduate programs (from the first to the fourth year of the study) have consistently ranged from age 19-23. Besides gender and religion, the current study also collected whether they came from small (village and coastal area are included) or large cities. Over half of them (57%) originally came from small cities and the rest of them (41%) came from large cities. Moreover, 2% of participants' origins were unknown, because they did not fill in origin home in the questionnaire form.

Instruments

Two different instruments namely Environmental Attitude Inventory (EAI) by Milfont and Duckitt (2010) and Environmental Attitudes of the University Scale (EAU) by Fernandez-Manzanal, Rodríguez-Barreiro and Carrasquer (2007) were used to collect data. However, since these instruments have several constructs, the current study only used related constructs that were in line with its research questions. Three out of eleven contructs in the EAI, namely Personal Conservation Behavior, Human Utilization and Ecocentric Concern, and only one construct out of five constructs in the EAU instrument were employed in the current study. All instruments were bipolar Likert-type with 1-6 scale (1 = Strongly Disagree, 6 = Strongly Agree). The negative statement responses were reversed when coding data.

Before conducting statistical analyses, reliability and validity of the instruments were tested. The reliability issue (Cronbach's alpha) was tested through SPSS version 23 software and item fit indices with Rasch analyses were examined through WINSTEP software. Moreover, for the reliability issue the current study also reported the reliability computed from Rasch analysis, person and item reliability. Person reliability refers to what traditional internal consistency is, however item reliability refers to how effectively the items diversely measure participants' abilities (Linacre, 2012). The interpretation of those three reliabilities is same, and current study follows DeVellis (2002) interpretation of the reliabilities. For interpretation of item fit, we used the benchmark of reliable instruments more than 0.6 and item fit indices 0.5-1.5 for outfit and infit MNSQ assumed as productive measurement (Wright and Linacre, 1994). Based on our benchmark, our instrument is appropriate for further statistical analyses. Reliability and validity of each variable are provided in the following section and a brief-short description of each variable is elucidated as well.

a) Personal Conservation Behavior

Personal conservation behavior variable is a kind of self-reported behavior. This variable measures how one perceives conserving resources in daily behavior (Milfont and Duckitt, 2010). Pre-service biology teachers achieving high scores in this variable indicated that they conserved resources to protect the environment in daily behavior, whereas low scores indicated a lack of interest in conserving resources in daily behavior (Milfont and Duckitt, 2010). The original instrument of Personal Conservation Behavior consisted of 10 items (five negative, and five positive items). Because of an internal consistency issue, we deleted one item, thus we used nine items in this study from the original instrument. Our nine-item instrument had internal consistency (Cronbach's alpha) at the value of 0.696 and person and item reliability were found to be 0.65 and 0.98 respectively. The fit of each item ranged from 0.67 to 1.25 for infit MNSQ and 0.64 to 1.26 for outfit MNSQ (see Appendix 1).

b) Human Utilization of Nature

Human use of the nature variable measures one's attitude in perceiving nature as a priority, especially regarding economic development. Pre-service biology teachers achieving high scores in this variable indicated strong beliefs in assuming economic development with a higher priority than protecting the environment, while achieving low scores in this variable indicated protecting environment with a higher priority than using nature for economic development (Milfont and Duckitt, 2010). Similarly, with the previous variable, this variable originally consisted of 10 items, but because of an internal consistency issue, we deleted one item, thus we used nine items in this study. Our nine-item Human Utilization of Nature instrument had internal consistency (Cronbach's alpha) at the value of 0.714 and person and item reliability were found to be 0.70 and 0.97 respectively. The fit of each item ranged from 0.74 to1.17 for infit MNSQ and 0.75 to 1.15 for outfit MNSQ (see Appendix 1).

c) Ecocentric Concern

Ecocentric concern is a variable that related to nostalgic concern and sense on losing environmental properties from damaging the environment. Achieving high scores in this variable indicated a concern about environmental loss, while low scores indicated absence of concern about the environment (Milfont and Duckitt, 2010). Like two previously mentioned variables, this variable originally consisted of 10 items, and because of an internal consistency issue, we deleted one item, thus we used nine items in this study as well. The ecocentric concern instrument had internal consistency at the value of 0.714 and person and item reliability were counted to be 0.70 and 0.97 respectively. The fit of each item ranged from 0.79 to 1.52 for infit MNSQ and 0.83 to 1.27 for outfit MNSQ (see Appendix 1).

d) Perceptions of Fieldwork as Environmental Education

This variable was adapted from a twenty-item EAU instrument measuring university students' attitude towards the environment. There were five scales or dimension in EAU and one of them was fieldwork or field trips perception. We selected seven items related to fieldwork perception from EAU. This fieldtrip perception measured pre-service biology students' perceptions towards fieldwork activities (Fernandez-Manzanal, Rodríguez-Barreiro and Carrasquer, 2007) and perceptions of the significance of improving one's environmental attitudes and behaviors. Fernandez-Manzanal, Rodríguez-Barreiro and Carrasquer (2007) developed this instrument with reasoning that direct experience (fieldwork) on the environment or nature engaging in people emotionally and increasing their awareness of the environment. Achieving high scores in this variable indicated fieldwork was assumed to be a form of environmental education and vice versa. The fieldwork perception instrument had internal consistency at the value of 0.832 and person and item reliability were 0.80 and 0.99

respectively. The fit of each item ranged from 0.70 to 1.28 for infit MNSQ and 0.66 to 1.33 for outfit MNSQ (see Appendix 1).

Data Analyses

We conducted Rasch analysis to explore item fit of each item for all four instruments. When Rasch analysis was completed, we obtained a set of composite scores of participants termed as person ability in each variable. This set score was no longer in the form of ordinal scale, but in the form of interval scale, thus we used it for further statistical analyses. We conducted Rasch analysis through WINSTEP software version 3.92.1.

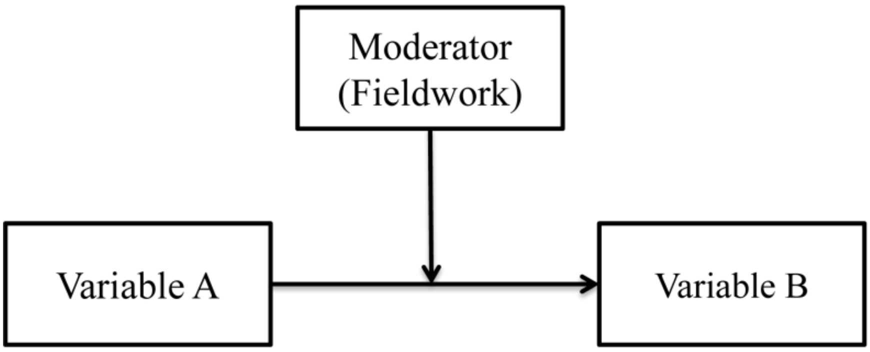

Figure 1. Conceptual Diagram for Moderating Variables (Hayes, 2013)

For the statistical analysis, we firstly conducted Pearson's correlation test to assess the relationship of variables. We used results from Pearson's correlation test as the basis for multiple regression tests. To assess the moderator effect, we conducted the moderator test developed by Andrew F. Hayes (2013, www.afhayes.com) through SPSS extended package called "PROCESS" on multiple regression test. We hypothesized that field trip was the moderating effect in the relationship between two attitude variables (Human Utilization of Nature and Ecocentric Concern) and self-reported conservation behavior (Personal Conservation Behavior). We used the model proposed by Hayes (2013) represented in Figure 1. Once we conducted the PROCESS we obtained the effect of each level of moderating factor on the targeted relationship. Following analysis, we did analyses of variance (ANOVA) test to explore differences between all educational years for each variable. For further interpretation of the existing mean differences of all educational years we conducted Tukey post hoc test with Bonferroni methods as adjustment for multiple comparisons. All statistical tests were conducted using SPSS 22.

Limitations

Although this study was refined with Indonesian pre-service biology teachers' curriculum, it had several limitations that may be considered for further studies. First, our limitation was related to the fieldwork variable, as we mentioned before that our fieldwork variable was not the real fieldwork activities, nevertheless pre-service biology teachers' perceptions had experienced and already obtained fieldworks activities in their courses. Secondly, even though we found the relationship between all four variables; we could not directly explain their relationship in the form of a model supported with statistical analysis. Understanding one's attitude and behavior towards environment is very complex in generating a psychological model supported with statistical analysis (Barr, 2007). Therefore, we encourage other researchers on environmental education and science education to add relevant variables that may be significant to generate a psychological model that can present the connection(s) between pre-service biology teachers' attitudes and behavior towards the environment.

FINDINGS

Relationships among Attitude, Behavior towards Environment and Fieldwork Perception

As seen in Table 1, the results of Pearson's correlations showed that all variables were correlated. Personal Conservation Behavior was negatively correlated with Human Utilization of Nature in the medium level (r (285) = −0.379), while it was positively correlated in the medium-high level and in the medium level with Ecocentric Concern (r (285) =0.453) and Fieldwork perception (r (285) =0.391) respectively. Human Utilization of Nature was negatively correlated with Ecocentric concern (r (285) =−0.588) and Fieldwork perception (r (285) =−0.431) in the high and medium-high level respectively. Last, Ecocentric concern was positively correlated in the medium-high level with Fieldwork perception (r (285) =0.485).

Table 1. Pearson's Correlation Test Results among Four Variables

Variables		(1)	(2)	(3)	(4)
Personal Conservation Behavior	(1)	1			
Human Utilization of Nature	(2)	−0.379**	1		
Ecocentric Concern	(3)	0.453**	−0.588**	1	
Fieldwork Perception	(4)	0.391**	−0.431**	0.485**	1

** $p < 0.01$, * $p < 0.05$, 'no mark' refers to 'non-significant'

Testing Fieldwork as Moderating Effects

Based on previous correlation results, all variables were significantly correlated in middle until high level correlation. The multiple regression results were especially on identifying moderating effects. We conducted multiple regression tests twice. In the first test, we examined the effect of fieldwork on the relationship between Human Utilization of Nature and Personal Conservation Behavior, and in the second test on Ecocentric Concern and Personal Conservation Behavior.

Table 2. Multiple Regression Human Utilization as Independent Variables

Model	Unstandardized Coefficients		T	p-value	R^2	F	p-value
	B	Std. Error					
Constant	1.051	0.054	19.617	0.000	0.246	25.718	0.000
Fieldwork (2)	0.160	0.033	4.825	0.000			
Human Utilization (1)	−0.274	0.089	−3.067	0.002			
Interaction (1 and 2)	0.085	0.035	2.456	0.015			

Table 3. The Effect of Moderator on the Relationship between Human Utilization and Personal Conservation Behavior

Level of Moderator	Effect (β)	Std. Error	t	p-value
Low (1SD below Mean)	-0.430	0.133	−3.233	0.001
Medium (Mean)	-0.274	0.089	−3.067	0.002
High (1SD above Mean)	-0.119	0.080	−1.491	0.137

As observed in Table 2, significant value appeared in the Interaction model (t (285) = 2.456, $p < 0.05$) indicating that Fieldwork was the moderating factor of the relationship between Human Utilization of Nature and Personal Conservation Behavior. Human Utilization of Nature, Fieldwork and interaction between both variables significantly predicted Personal Conservation Behavior (β= 1.051, t (285) = 19.617, p< 0.01). Predicted variables also explained a significant proportion of variance in Personal Conservation Behavior (R^2=0. 246, F (3,281) = 25.718, p< 0.01). As can be seen in Table 3, the effect (β) moderator was an increase from low level to high level of Fieldwork. Results are displayed in Figure 2.

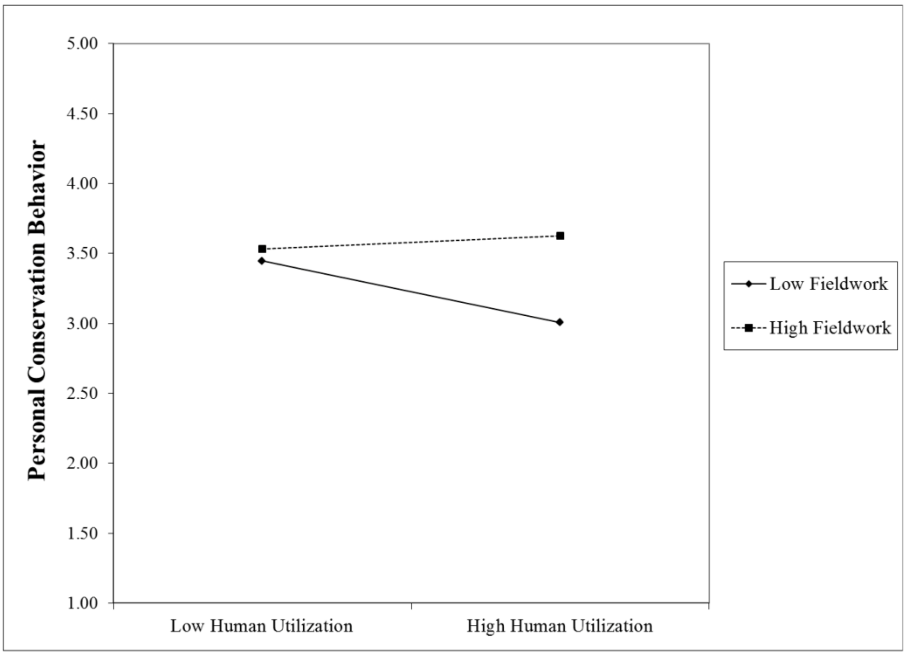

Figure 2. Regression Plot for Personal Conservation Behavior and Human Utilization Moderated by Fieldwork Perception

Table 4. Multiple Regressions for Ecocentric Concern as Independent Variables

Model	Unstandardized Coefficients		t	p-value	R^2	F	p-value
	B	Std. Error					
Constant	1.049	0.051	20.723	0.000	0.272	31.526	0.000
Fieldwork (2)	0.123	0.033	3.734	0.000			
Ecocentric Concern (1)	0.292	0.064	4.587	0.000			
Interaction (1 and 2)	−0.056	0.024	−2.345	0.020			

Table 5. The Effect of Moderator on the Relationship between Ecocentric Concern and Personal Conservation Behavior

Level of Moderator	Effect (β)	Std. Error	t	p-value
Low (1SD below Mean)	0.394	0.087	4.500	0.000
Medium (Mean)	0.292	0.064	4.587	0.000
High (1SD above Mean)	0.190	0.065	2.919	0.004

As seen in Table 4, significant value appeared in the Interaction model (t (285) = −2.345, $p < 0.05$), indicating Fieldwork was the moderating factor of the relationship between Ecocentric Concern and Personal Conservation Behavior. Ecocentric Concern, Fieldwork and interaction between both variables significantly predicted Personal Conservation Behavior (β= 1.049, t (285) = 20.723, $p< 0.01$). Predicted variables also explained a significant proportion of variance in Personal Conservation Behavior (R^2=0. 272, F (3,281) = 31.526, $p<0.01$). As observed in Table 3, the effect (β) moderator was a decrease from low level to high level of Fieldwork. Results are shown in Figure 3.

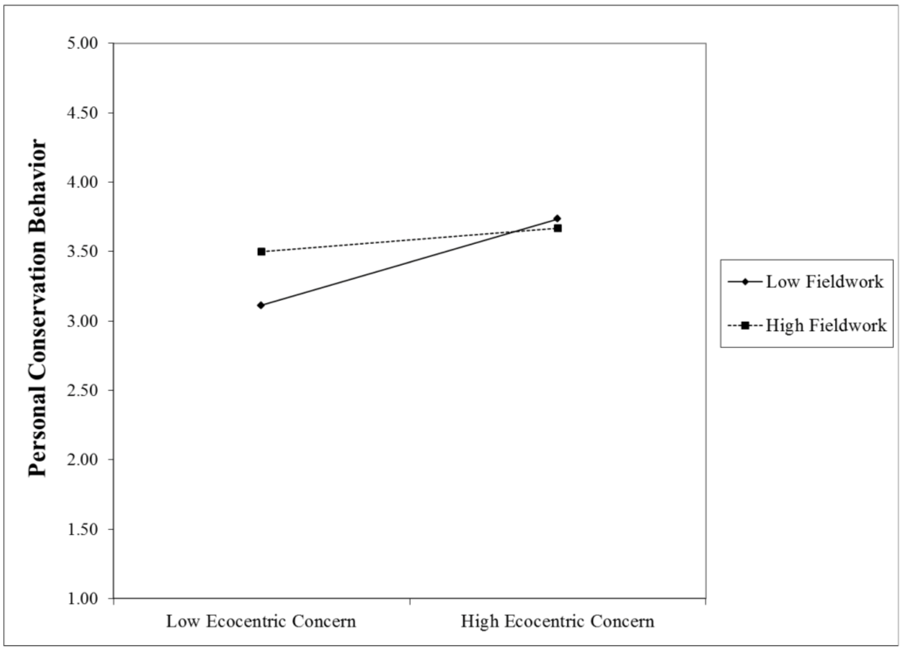

Figure 3. Regression Plot for Personal Conservation Behavior and Ecocentric Concern Moderated by Fieldwork Perception

DISCUSSION and CONCLUSION

The findings indicate that all involved variables were significantly correlated in medium level to medium-high level. Positive correlations were found between three variables: Ecocentric Concern, Fieldwork Perception and Personal Conservation Behavior, while these variables were negatively correlated with Human Utilization of Nature. Regarding the Planned Behavior theory proposed by Ajzen (1991), we assumed that self-reported conservation behavior was the outcome from attitude and perception towards the environment that are Ecocentric Concern and Human Utilization of Nature. So, we inferred that higher scores of the Indonesian pre-service biology teachers' attitudes, concerns and senses towards environmental loss would increase frequencies of their daily conservation behaviors. This inference was aligned with the Human Utilization Variable, correlated negatively with Personal Conservation Behavior, indicating that lesser scores on Human Utilization, attitude towards economic development, and not considering preserving balance of the environment, would increase daily behavior on conserving resources used in daily activities. These polarity differences indicated that the four variables were in accordance with the theory.

The literature review has reported that there are several factors and environmental education efforts or programs that could increase one's attitude and behavior towards the environment (Boeve-de Pauw and Van Petegem, 2013; Todd, 2016). In this study we used one of the significant factors associated with pre-service biology teachers, fieldwork activities assumed by most environmental experts as a key factor in improving one's attitude and behavior towards the environment (e.g. Fernandez-Manzanal, Rodríguez-Barreiro and Carrasquer, 2007; Tal and Morag, 2013). This study used fieldwork as a moderating factor in correlation between attitude (Human Utilization of Nature and Ecocentric Concern) and self-reported behavior towards the environment. We scrutinized the impact of fieldwork on the correlation between attitude (Human Utilization of Nature and Ecocentric Concern) and self-reported behavior towards the environment. It should be reiterated that the fieldwork variable we used in this study is the perception of pre-service biology teachers towards fieldwork as a form of environmental education. Fieldwork is significantly accepted as a moderating factor in the relationship between Human Utilization of Nature and Personal Conservation Behavior, as well as correlation between Ecocentric Concern and Personal Conservation Behavior. However, the effects of fieldwork on those two relationships were not as positive as expected (see Figures 2-3). As seen in Figure 2 and Table 3, the low level of fieldwork appeared a negative strong correlation between Human Utilization of Nature and Personal Conservation Behavior than the effect of fieldwork in the higher level. Figure 3 also showed that a lower level of fieldwork resulted in a stronger effect on the relationship between Ecocentric Concern and Personal Conservation Behavior, while a higher level of fieldwork negatively impacted the relationship between those variables. This indicates that fieldwork activities, conducted by the Indonesian pre-service biology teachers, decreased their attitudes and conservation behaviors. Findings are not aligned with Fernandez-Manzanal, Rodríguez-Barreiro and Carrasquer's (2007) and Tal and Morag's (2013) statements. That is, fieldwork or other outdoor activities that directly contact nature increase one's attitude and behavior towards the environment.

Regarding the current study's results, there was a problem with the Indonesian pre-service biology teachers' curriculum, especially in implementation of fieldwork. As aforementioned, fieldwork activities conducted by the Indonesian pre-service biology teachers are concentrated in the second year and third year, and fieldwork mechanism in most of the courses, for example botany, is conducted before students attend class or a laboratory because they have to conduct fieldwork to identify species of plants that relate to the topic they will learn in class. When they collect samples of plants, they often collect it excessive amounts of samples, and thus pre-service biology teachers with experienced fieldwork will have the perception that fieldwork is not a kind of environmental education than pre-service biology teachers that haven't acquired that kind of experience. As seen in Figure 4, the second year, third year, and fourth year students had lower perceptions of fieldwork as a form of environmental education as compared with the first year students that have not experienced the fieldwork. In addition, the inappropriate sampling mechanism on fieldwork activities may have affected pre-service biology teachers' attitudes on using natural resources and their Ecocentric Concern as well. On the Human Utilization variable, the second and third year students had higher scores than the first year students assuming that using more natural resources would not affect the environment. Based on post-hoc ANOVA tests, as compared to pre-service biology teachers, that have not engaged in the fieldwork activities (the first year), the second and third year students were significantly different.

A similar pattern was exhibited on the Ecocentric Concern variable, whereby the mechanism of fieldwork conducted by the Indonesian preservice biology teachers decreased their nostalgic sense and concern towards environmental damage. This result indicated those that had experienced fieldwork would lose their feeling and sense when environmental and natural properties were damaged. It is also supported by ANOVA post-hoc results indicating that there was a statistical difference between the first-year and third-year students experiencing and engaging in fieldwork in terms of Ecocentric Concern. Similarly, the same pattern was found in the Personal Conservation Behavior. Based on ANOVA post-hoc testing the first year students, who had significantly higher conservation behavior than the second and third year students, and the fourth year students, who had already passed and did not have any fieldworks again, showed significantly higher Personal Conservation Behavior than the third year students.

Based on findings and discussions, the mechanism of fieldwork, which was implemented as a part of Indonesian preservice biology teachers' curriculum, has pitfalls at having maximum effect on their attitudes and behaviors towards the environment. Evaluating and implementing better environmental education, especially fieldwork, calls a need for the Indonesian higher education policymakers to ameliorate pre-service biology teachers' curriculum. Given that pre-service biology teachers maybe environmental educators in Indonesian in the future, equipping them with the best experiences to improve their attitudes and behaviors is imperative and crucial due to their impact would be broad from students to future Indonesian citizens. Other international higher institutions (outside of Indonesia) having pre-service biology teacher program should enable students to experience fieldwork in providing a better understanding and environmental view. However, lecturer or instructor needs to provide some kinds of restrictions and procedures on how large samples can do fieldwork. Giving full authority to pre-service teachers should make them likely take the sample as many as they can, and lead them to hurt their environmental attitudes.

Acknowledgement

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Appendices

Appendix 1. Reliability and Item Fit Results

Variables	Item Code	Cronbachs' Alpha	Item Measure	Infit MNSQ	Outfit MNSQ	Person Reliability	Item Reliability
Personal Conservation Behavior	PCB2	0.696	0.56	1.11	1.25	0.65	0.98
	PCB3		−0.46	1.18	1.05		
	PCB4		0.29	1.15	1.18		
	PCB5		−0.96	1.25	1.16		
	PCB6		0.45	1.05	1.16		
	PCB7		0.03	0.70	0.81		
	PCB8		−0.13	0.81	0.80		
	PCB9		−0.30	0.67	0.64		
	PCB10		0.51	1.25	1.26		
Human Utilization	HU1	0.714	−0.82	1.14	1.15	0.70	0.97
	HU2		0.27	0.95	0.92		
	HU3		0.51	1.17	1.13		
	HU4		0.13	0.95	0.99		
	HU5		0.12	0.87	0.90		
	HU7		−0.65	1.04	1.07		
	HU9		−0.18	0.74	0.75		
	HU10		0.15	0.95	0.98		
Ecocentric Concern	Eco1	0.763	0.74	1.09	1.24	0.72	0.98
	Eco2		−0.62	1.52	1.27		
	Eco4		0.10	0.89	0.93		
	Eco5		0.23	0.88	0.96		
	Eco6		0.35	0.79	0.83		
	Eco7		0.64	1.02	1.09		
	Eco8		−0.78	1.48	1.19		
	Eco9		−0.80	1.32	1.12		
	Eco10		0.13	1.21	1.17		
Fieldwork Perceptions	FW1	0.832	−0.07	0.86	0.84	0.80	0.99
	FW2		0.38	1.05	1.08		
	FW3		0.96	1.28	1.33		
	FW4		−0.61	0.86	0.80		
	FW5		−0.22	0.70	0.66		
	FW6		−0.52	1.21	1.12		
	FW7		0.07	1.16	1.17		

Appendix 2. Tukey's Pairwise Comparison Post-hoc Results

Dependent Variable	(I) Year	(J) Year	Mean Difference (I-J)	Std. Error	p-value
Personal Conservation Behavior	Year 1	Year 2	0.557	0.143	0.001
		Year 3	0.730	0.137	0.000
		Year 4	0.322	0.143	0.151
	Year 2	Year 3	0.173	0.132	1.000
		Year 4	-0.234	0.138	0.544
	Year 3	Year 4	-0.407	0.133	0.014
Human Utilization of Nature	Year 1	Year 2	-0.023	0.146	1.000
		Year 3	-0.489	0.141	0.004
		Year 4	-0.193	0.147	1.000
	Year 2	Year 3	-0.466	0.135	0.004
		Year 4	-0.169	0.142	1.000
	Year 3	Year 4	0.297	0.136	0.180
Ecocentric Concern	Year 1	Year 2	0.333	0.191	0.498
		Year 3	0.641	0.184	0.004
		Year 4	0.227	0.192	1.000
	Year 2	Year 3	0.308	0.177	0.503
		Year 4	-0.106	0.185	1.000
	Year 3	Year 4	-0.414	0.178	0.125
Fieldwork Perception	Year 1	Year 2	0.158	0.319	1.000
		Year 3	0.649	0.307	0.214
		Year 4	0.546	0.320	0.537
	Year 2	Year 3	0.491	0.296	0.589
		Year 4	0.388	0.309	1.000
	Year 3	Year 4	-0.103	0.297	1.000

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Adapting the Teachers' Efficacy and Attitudes towards STEM Scale into Turkish

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ABSTRACT

The aim of this study is to adapt the Teacher Efficacy and Attitudes Toward STEM Scale into Turkish. The Turkish version was adapted to 570 science teachers drawn from varied experiences and science disciplines. Firstly, the Turkish STEM scale was validated through translation and back-translation procedures. Secondly, exploratory and confirmatory factor analyses were conducted to examine its construct validity. The results confirmed that the Turkish STEM scale possessed the same seven-factor structure in its original version and showed good model fit indexes. The Cronbach alpha co-efficients were ranged from 0.88 to 0.96. To sum up, this study showed that the Turkish version of the STEM scale had a good validity and reliability for measuring science teachers' efficacy and attitudes towards STEM.

Keywords: Attitudes, Science Teacher, Teacher Efficacy, STEM

INTRODUCTION

Today's rapid scientific and technological developments necessaites critical thinking, problem-solving skills, and co-operation, called the 21st century skills. STEM education, which has been relased in 2001, is one of the most emphasized qualifications (Zollman, 2012). STEM education is an integrated educational approach of science, technology, engineering and mathematics (Gonzalez & Kuenzi, 2012). Today, many countries and educators have been working on STEM education (Banks & Barlex, 2014).

There are many important reasons why countries and educators work on STEM education (Hacıoğlu, Yamak & Kavak, 2016; Suprapto, 2016). For example, STEM education improves students' problem-solving skills, critical thinking skills, science-mathematics-technology literacy, and has a positive impact on the results of the PISA / TIMSS (American Institute of Physics [AIP], 2015; Ata-Aktürk, Demircan, Şenyurt & Çetin, 2017; Banks & Barlex, 2014; Han, Rosli, Capraro & Capraro, 2016; Thomas, 2013; Riskowski, Todd, Wee, Dark & Harbor, 2009) Furthermore, because STEM education contributes to the economic and technological development of any country, it is effective in meeting the demanded skills of the 21st century business world (Furner & Kumar, 2007). Therefore, continuous changes in

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the STEM-related educational systems and 5-year strategy plans have been created. In 2009-2010, for instance, President Barack Obama mentioned that the US did not do well enough in the PISA / TIMSS, thus he published a strategy plan given the importance of STEM education. The results of the PISA exam revealed that the United States was the 30th in 2009, 28th in 2012, and 15th in 2015 between the countries involving in the PISA. Likewise, because Turkey has participated in the PISA, related curricula have been revised given the PISA's results (Department of Education, 2012). The revised curricula and strategy plans load many roles and tasks on teachers, who will teach STEM education (Özer & Gelen, 2008). Teachers should have many qualifications/competencies to meet the requirements of STEM education. Demirel (1999) emphasizes to three qualifications of knowledge; professional knowledge, general culture and general aptitude knowledge. Yıldırım (2017) states that teachers' competencies to effectively integrate STEM education into classes should cover content knowledge, pedagogical content knowledge, and context knowledge of STEM. Besides, teachers need to have the 21st century skills and an integrated knowledge. Hence, a teacher's qualifications are important in teaching a subject.

If teachers would like to get students to gain the 21st century skills, use them in the technology class, improve their leadership skills and have a high level of self-efficiency, they need to have these competencies. Even if they have these STEM-related qualifications, their perceptions, attitudes, and beliefs towards the subjects also have a pivotal in teaching a subject. This means that a teacher's self-efficacy of STEM education is an important factor in successfully using her/his qualifications (Bandura, 1986). A teacher's self-efficiency is the belief in providing the desired learning, assuring self-confidence and lectures (Bandura, 1986; Guskey & Passaro, 1994). This means that a good teacher should have adequate skills as well as a high level of self-efficacy belief. The related literature points to some instruments assessing teachers' and pre-service teachers' self-efficacy (Bıkmaz, 2002; Çapa, Çakıroğlu & Sarıkaya, 2005; Taşkın & Hacıömeroğlu, 2010; Tepe, 2011). Furthermore, even though there have been different STEM-related scales (Yıldırım & Selvi, 2015), there is no STEM self-efficacy scale that will measure teachers' STEM self-efficacy levels. Overall, there has been no scale measuring STEM content, use of technology, the 21st century learning skills, leadership attitudes, teachers' self-confidence and self-efficacy, and STEM career awareness altogether. In addition, an adapted version of the STEM scale into Turkish will help science teachers to decide on possible improvements about STEM and science curriculum. Furthermore, adapting the STEM scale into Turkish will be worthy to measure to the extent to which teachers use technology in their classes and as well as their 21st century skills, changes in self-confidence and self-efficacy, awareness of STEM career, and classroom leadership attitudes. Therefore, the current study attempted to adapt the scale developed by Friday Institute for Educational Innovation (2012) into Turkish.

In brief, a lack a Turkish scale measuring science teachers' efficacy and attitudes towards STEM emerged the current study. The aim of this study is to adapt and validate Teacher Efficacy and Attitudes toward STEM Scale into Turkish.

METHODS

This study developed an instrument to determine pre-service teachers' Teacher Efficacy and Attitudes Towards STEM.

a) The Translation and Back-Translation of the STEM Scale into Turkish

Five steps were followed to translate the STEM scale into Turkish. These steps were (a) obtaining translation permissions from the STEM scale's authors (Friday Institute for Educational Innovation, 2012), (b) inviting bilinqual experts (five experts) to take part in an expert panel of translation and back-translation procedures; (c) translating the items into Turkish by help of an expert, (d) conducting the pilot-study with 9 science teachers (e) framing and shaping the final version of the scale.

Three language experts translated the STEM Scale from English into Turkish. Each item of the STEM Scale was examined to decide obscured and incorrectly translated ones (e.g. “Use technology to access online resources and information as a part of activities (correct expression)”, “Use technology to access online resources and information as a part of operations (mistranslation). Then, its translation into Turkish was completed. Back translation by one language expertshowed that there was no difference between its original and translated versions. Then, a pilot study was condycted with 9 science teachers to check any unclear and/or problematic part of the scale. Thus, the final version of the scale was produced.

b) Participants

This study was carried out with two different groups and lasted about two months. The teachers filled in the scale through the Google Docs program. A total of 100 science teachers (60 teachers from the first study group, and 40 teachers, from the second study group), who did not respond all items in the scale, were exluded from the sample of the study. The first study group consisted of 370 science teachers, and the second pne comprised of 200 science teachers. The explanatory factor analysis of the adapted scale was conducted via data from the first group. The confirmatory factor analysis was implemented to the data from the second study group. Because repeating the study or re-doing the exploratory factor analysis, or conducting a confirmatory factor analysis with the first sample, or conducting two successive confirmatory factor analyses may not validate the proposed structure, the current study used differences samples. Table 1 shows the demographic characteristics of the two study groups (samples).

Table 1. *Demographic Characteristics of Science Teachers for Two Analyses*

		First Study Group		Second Study Group	
		N	%	N	%
Gender	Male	240	64.86	150	75.0
	Female	130	35.14	50	25.0
Experience	0-5 years	72	19.46	30	15.0
	6-10 years	185	50.0	120	60.0
	11-15 years	37	10.0	20	10.0
	16-or more years	76	20.54	30	15.00
School Type	Public School	280	75.67	145	72.5
	Private School	90	24.33	55	27.5
Total		370	100.0	200	100.0

As seen in Table 1, the majority of the science teachers was females. Given their experiences, most of the teachers' experiences was between 6 and 10 years. Further, the majority of science teachers had been working in public schools in terms of the school type.

c) Data Analysis

In analyzing data of the STEM scale, descriptive and confirmatory factor analyses were performed. 370 science teachers were selected for exploratory factor analysis. Their responses to the STEM Scale were analyzed by the help of SPSS 21™ software to examine the results of its factor analysis and reliability. Confirmatory factor analysis was performed after the item and factor structure of the STEM scale was determined. Confirmatory factor analysis was run for a second sample group (200 science teachers). Explanatory, and confirmatory factor analyses of the STEM scale were performed through the second study group. Because this scale's sample group comprised of 570 science teachers, it had a "very good" rating (Comrey & Lee, 1992, p. 217). Additionally, carrying out a factor analysis needs a sample, which must be five to 10 times larger than the number of items (Tavşancil, 2002). This study's sample was five times larger than the number of items. Moreover, this study employed varimax rotation. Since varimax rotation emphasizes to easy interpretability of the factors, utilizing varimax rotation in employing an orthogonal rotation strategy may be logical (Kieffer, 1998). In the confirmatory factor analysis, the Goodness of Fit Index (GFI), the Adjusted Goodness of Fit Index (AGFI), the Root Mean Square Error of Approximation (RMSEA), the Comparative Fit Index (CFI), Standardized Root Mean Square Residual (SRMR), Incremental Fit Index (IFI), and the Normed Fit Index (NFI) were examined (Baumgartner & Homburg, 1996; Bentler, 1980; Brown, 2006; Field, 2009; Kılıç & Şen, 2014). The data from the second sample group were exposed to confirmatory factor analysis throough Lisrel software. Moreover, the correlation anaysis was run for determining the relationship(s) between subscales of the STEM scale.

d) Teacher Efficacy and Attitudes Toward STEM (STEM) Scale

The STEM scale was developed by Friday Institute for Educational Innovation (2012). A total of 257 science teachers participated in this study to deploy only an exploratory factor analysis. Exploratory factor analysis ensured a five-point Likert type within a seven-factor structure. Cronbach's Alpha values for the STEM Instruction, 21st-century learning attitudes, Science Teaching Efficacy and Beliefs, student's technology use, teacher leadership attitudes, Science Teaching Outcome Expectancy and STEM career Awareness were found to be .93 .94 .90, .90, .87, .81, and .94 respectively. Exploratory factor analysis yielded a 7-factor STEM scale with 63 items (see Table 2).

e) Constructs of STEM Scale

The STEM Scale consisted of seven sub-factors: "STEM Instruction (SI)", "21st-Century Learning Attitudes (CS)", "Science Teaching Efficacy and Beliefs (STE)", "Student Technology Use (TU)", Teacher Leadership Attitudes (TL)", "Science Teaching Outcome Expectancy (OE)", "STEM Career Awareness (SC)". The structures, abbreviations and definitions throughout seven sub-factors of the STEM scale are presented in Table 2 (Friday Institute for Educational Innovation, 2012).

Table 2. *Definitions of the constructs of the STEM scale*

Construct	Abbreviation	Key Features/Questions
Science Teaching Efficacy and Beliefs	STE	STEM teaching self-efficacy and confidence
Science Teaching Outcome Expectancy Beliefs	OE	The degree to which science teachers' actions impact their student-learning of the specific STEM subject
Student Technology Use	TU	How often do students use technology in their classes?
STEM Instruction	SI	How often do science teachers use certain STEM instructional practices?
21st Century Learning Attitudes	CS	Attitudes toward the 21st century learning
Teacher Leadership Attitudes	TL	Attitudes toward teacher leadership activities
STEM Career Awareness	SC	Awareness of STEM careers and where to find resources for further information

FINDINGS

a) Exploratory Factor Analysis

Exploratory factor analysis (EFA), which determined the factorial status of the items in the scale and the factor loadings of the items, was conducted with the first study group. Prior to an EFA, Kaiser-Meyer-Olkin (KMO) and Barlett test were utilized. The KMO value of 63 items was calculated to be 0.72 and the Bartlett test was found to be meaningful (χ^2 = 15195,485, df=1953, p < .05). Therefore, the data from Turkish science teachers were appropriate to run an EFA. The results indicated that the data were appropriate for factor analysis since KMO coefficient was greater than 0.60 and the Bartlett test was significant (Büyüköztürk, 2006).

Varimax analysis was performed for the STEM scale. Since varimax rotation emphasizes to easily interpretability of the factors, it may be logical to utilize varimax rotation in employing an orthogonal rotation strategy (Kieffer, 1998). In view of Kaiser (1960), one should consider whether a measure is more than an attribute value of 1 in a factor selection. The results of the varimax analysis performed revealed that seven factors with an eigenvalue greater than 1 were found in the STEM scale. This indicated that the STEM scale had a four-factor structure. Screen plot results for the STEM scale are shown in Figure 1.

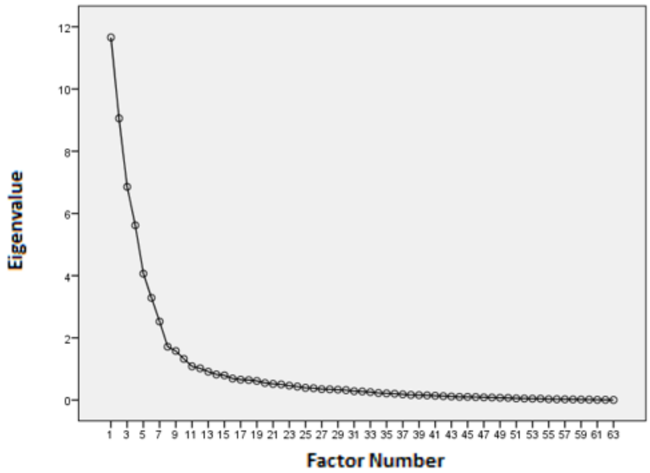

Figure 1. *Scatter Graph*

b) Reliability

The STEM scale's internal consistency coefficients, Cronbach's *α*, for each factor are presented in Table 3.

Table 3. *Internal consistency reliability coefficients of the STEM scale*

Construct	Cronbach's *α*
STEM Instruction	.95
21st Century Learning Attitudes	.94
Science Teaching Efficacy and Beliefs	.93
Student Technology Use	.94
Teacher Leadership Attitudes	.96
Science Teaching Outcome Expectancy	.88
STEM Career Awareness	.90
STEM Scale	.91

As observed in Table 3, Cronbach Alpha values of the STEM scale and its subscales were higher than 0.70 (Tavşancıl, 2002), meaning good reliability coefficients. The Cronbach's Alpha values for the entire STEM scale, STEM Instruction, 21st-century learning attitudes, Science Teaching Efficacy and Beliefs, Student technology use, teacher leadership attitudes, Science Teaching Outcome Expectancy and STEM career Awareness were found to be .91, .95, .94, .93, .94, .96, .88, and .90. The results of the exploratory factor analysis of the STEM scale are presented in Table 4.

Table 4. *Results of the exploratory factor analysis of the STEM scale*

Items	M	SD	Item-total correlation	t-value (bottom 27%, top 27%)	Rotator factor load	Common factor load
STEM Instruction (14 items)						
SI7	4.35	0.66	.64	12.492**	.88*	.86
SI6	4.10	0.76	.50	9.435**	.87*	.82
SI10	4.14	0.67	.53	8.887**	.85*	.75
SI9	4.10	0.71	.54	9.764**	.83*	.76
SI4	4.22	0.65	.57	10.453**	.80*	.74
SI13	4.14	0.68	.49	8.582**	.79*	.69
SI3	4.26	0.81	.59	11.271**	.78*	.72
SI12	4.16	0.71	.56	10.880**	.76*	.70
SI14	4.18	0.69	.43	7.265**	.75*	.66
SI2	4.23	0.65	.43	7.044**	.73*	.61
SI8	4.20	0.78	.49	9.380**	.72*	.60
SI11	4.16	0.72	.42	6.072**	.70*	.51
SI1	4.15	0.78	.37	5.646**	.68*	.53
SI5	4.02	0.85	.36	5.264**	.63*	.43
21st Century Learning Attitudes (11 items)						
CS5	4.65	0.48	.33	5.806**	.86*	.849
CS4	4.55	0.61	.32	3.458**	.86*	.803
CS6	4.42	0.64	.31	3.107**	.85*	.770
CS7	4.57	0.61	.39	3.475**	.82*	.722
CS1	4.59	0.53	.36	5.387**	.79*	.772
CS11	4.54	0.58	.37	5.666**	.76*	.669
CS3	4.58	0.51	.31	6.571**	.76*	.782
CS9	4.54	0.61	.39	3.130**	.73*	.594
CS2	4.62	0,56	.35	5.806**	.72*	.688
CS10	4.32	0.84	.32	2.968**	.67*	.643
CS8	4.71	0.50	.37	6.802**	.57*	.849
Science Teaching Efficacy and Beliefs (11 items)						
STE6	3.55	1.12	.41	7.956**	.86*	.768
STE4	3.66	1.09	.37	6.408**	.86*	.750
STE11	3.84	1.01	.37	7.131**	.85*	.748
STE8	3.36	1.17	.39	7.514**	.84*	.747
STE9	3.49	0.99	.39	6.171**	.82*	.696
STE2	3.72	1.07	.37	8.106**	.80*	.681
STE3	3.98	1.08	.33	6.754**	.77*	.636
STE1	3.99	0.96	.33	5.827**	.74*	.608
STE7	3.71	1.25	.44	7.789**	.58*	.475
STE10	4.35	0.89	.38	3.986**	.55*	.409
STE5	4.05	1.14	.38	4.653**	.54*	.359
Student Technology Use (8 items)						

TU2	4.30	0.84	.38	3.574**	.86*	.765
TU3	4.35	0.82	.36	3.189**	.85*	.755
TU7	3.98	0.87	.38	3.475**	.85*	.798
TU1	4.02	1.06	.33	4.303**	.83*	.720
TU6	4.06	0.85	.37	4.561**	.83*	.752
TU5	3.84	0.81	.35	4.506**	.78*	.721
TU4	3.51	1.05	.43	6.106**	.75*	.623
TU8	4.37	0.90	.30	3.475**	.73*	.761
Teacher Leadership Attitudes (6 items)						
TL2	4.45	0.78	.32	5.025**	.89*	.845
TL4	4.59	0.70	.43	6.554**	.89*	.883
TL1	4.59	0.69	.38	3.744**	.87*	.812
TL5	4.61	0.75	.54	7.734**	.84*	.876
TL6	4.60	0.75	.41	5.709**	.82*	.808
TL3	4.61	0.69	.36	4.692**	.81*	.761
Science Teaching Outcome Expectancy (9 items)						
OE7	4.09	0.77	.35	5.883**	.80*	.720
OE6	3.66	0.94	.35	5.932**	.78*	.637
OE4	3.60	0.97	.41	6.910**	.75*	.621
OE1	3.88	0.88	.34	5.998**	.75*	.581
OE3	4.07	0.84	.37	5.669**	.73*	.561
OE2	4.05	0.84	.36	3.747**	.68*	.525
OE5	3.39	1.06	.34	5.290**	.62*	.460
OE8	4.33	0.79	.38	6.751**	.61*	.531
OE9	4.04	0.87	.34	6.846**	.58*	.426
STEM Career Awareness (4 items)						
SC4	3.64	1.01	.38	3.758**	.85*	.816
SC2	3.09	1.00	.34	2.997**	.82*	.813
SC3	3.70	1.06	.39	2.908**	.74*	.702
SC1	3.76	0.86	.35	3.436**	.73*	.655

*****factor loads, which were lower than .30, were not shown in Table (Çokluk, Şekercioğlu, & Büyüköztürk, 2014). ** A significant difference between top (27%) and bottom (27%) groups

The percentages of the ranked variance quantities for STEM Instruction, 21st Century Learning Attitudes, Science Teaching Efficacy and Beliefs, Student Technology Use, Teacher Leadership Attitudes, Science Teaching Outcome Expectancy and STEM Career Awareness were 18.50, 14.37, 10.88, 8.91, 6.45, 5.21 and 4.00 respectively. These seven factors were at 68.353% of the total variance of the STEM scale. After factor rotation, the number of items for each factor were 14 items (factor loads for STEM Instruction ranged from 0.88 to 0.63), 11 items (factor loads for 21st Century Learning Attitudes ranged from 0.86 to 0.57), 11 items (factor loads for Science Teaching Efficacy and Beliefs ranged from 0.86 to 0.54), 8 items (factor loads for Student Technology Use ranged from 0.86 to 0.73), 6 items (factor loads Teacher Leadership Attitudes ranged from 0.893 to 0.81 for), 9 items (factor loads for Science Teaching Outcome Expectancy ranged from 0.80 to 0.58) and 4 items (factor loads for STEM Career Awareness ranged from 0.85 to 0.73) respectively. The results indicated that the STEM scale's items corrected item-total correlation ranged from 0.31 to 0.64. These values on the STEM scale were found to be appropriate for each item (Field, 2009; Büyüköztürk, 2006). Independent group samples t-test comparing the total scores of bottom (27%) and top (27%) groups for each item indicated significant differences for all items. The results displayed that the STEM scale's items corrected item-total correlation ranged between 2.908 to 12.492. The correlation between its subscales was examined to determine their relationship(s).

c) Confirmatory Factor Analysis

Findings on confirmatory factor analysis of the STEM scale are represented in Figure 2.

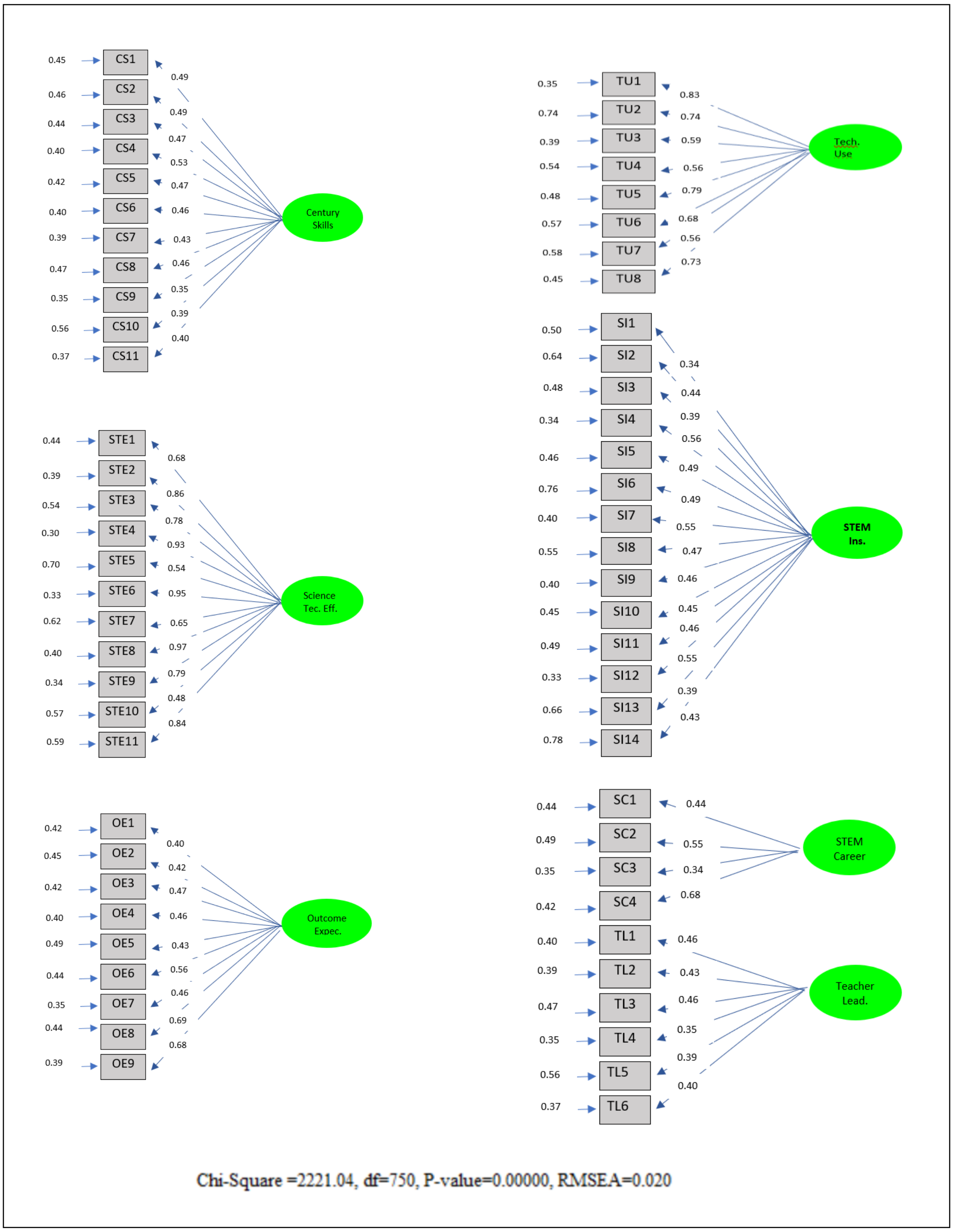

Figure 2. *CFA results of the STEM scale*

The model conformity of the STEM Scale were tested viasuch criteria as Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), Standardized Root Mean Square Residual (SRMR) and Normed Fit Index (NFI) (Kılıç & Şen, 2014). Chi-square ($\chi 2$), $\chi 2/SD$, RMSEA, GFI and AGFI are commonly used in confirmatory factor analysis. In large samples, calculated $\chi 2$/df ratio can also be used as a criterion for conformity adequacy. If calculated Chi-square (χ2)/degree of freedom (df) (χ2/*df*) ratio is (1) χ2 / *df* < 3, it can be regarded as good fit; if it is up to (2) χ2 / *df* <5, it can be regarded as sufficient (Yıldırım & Selvi, 2015).

The findings showed that model data had a good fitsince GFI and AGFI values were bigger than 0.90 (Hooper, Coughlan, & Mullen, 2008; Sümer, 2000), IFI value was bigger than 0.95 (Baumgartner & Homburg, 1996; Bentler, 1980), RMSEA value was smaller than 0.05 (Jöreskog & Sörbom, 1993; Sümer, 2000). On the other hand, because GFI value was greater than 0.85, AGFI was higher than 0.80, and the RMSEA value was smaller than 0.080, the purposed model was accepted as a model fit (Anderson & Gerbing, 1984; Hu & Bentler, 1999; Sümer, 2000). The confirmatory factor analysis results of the STEM scale are presented in Table 5.

Table 5. *Fit Indices of the STEM scale and the acceptable values for fit indices*

	χ2 / df	p-value	CFI	NFI	GFI	AGFI	IFI	SRMR	RMSEA
STEM Scale	2.96	p < .05	0.90	0.93	0.94	0.95	0.95	0.035	0.020
Acceptable values	<3	p < .05	≥0.90	≥0.90	≥0.90	≥0.90	≥0.90	<.05	<.05

The results of confirmatory factor analysis revealed a high conformity between structural equation model and scale. Also, Chi-square value was found to be significant. The value of χ2 depends on the size of the sample, and when the size of the sample increases, it provides significant results. Briefly, when chi-square (χ2) is divided by the value of the degrees of freedom (*df*), it shows that the value is less than 5(χ^2(750) = 2221.04); in other words, based on the results the model–data fit is high. In addition, if the CFI, NFI, AGFI values are (Hooper, Coughlan & Mullen, 2008; Sümer, 2000) above 0.90, it indicates that the model–data fit is high. Moreover, if the IFI value is (Baumgartner & Homburg, 1996; Bentler, 1980), above 0.95 it indicates that the model–data fit is excellent. Also, if RMSEA value is 0,020, it indicates that the model–data fit is high. Confirmatory factor analysis appeared a seven-factor STEM scaleand a high model–data fit.

DISCUSSION and CONCLUSION

This study adapted the STEM scale developed by Friday Institute for Educational Innovation (2012) into Turkish. Two different samples, a total of 570 science teachers, were employed for validity and reliability analyses of the Turkish STEM scale. Varimax analysis of the STEM scale yielded a seven-factor structure, as in its original version (STEM Instruction, 21st Century Learning Attitudes, Science Teaching Efficacy and Beliefs, Student Technology Use, Teacher Leadership Attitudes, Science Teaching Outcome Expectancy and STEM Career Awareness). These seven factors were at 68.353% of the total variance of the STEM scale, which was higher than the acceptable value (41%) (Kline, 1994). Cronbach Alpha values of the entire STEM scale was calculated to be0.91. Cronbach's α values for each factor of the STEM scale (STEM Instruction, 21st Century Learning Attitudes, Science Teaching Efficacy and Beliefs; Student Technology Use, Teacher Leadership Attitudes, Science Teaching Outcome Expectancy, and STEM Career Awareness) 0.95, 0.94, 0.93 0.94, 0.96, 0.88 and 0.90 respectively. All Cronbach alpha values of the adapted version of the STEM scale, which were higher than 0.80, pointed to a reliable scale (Field, 2009; Kline, 1999).

As seen in the results of confirmatory factor analysis of the STEM scale, AGFI, CFI, GFI, IFI and NFI values, which were above 0.90, showed a high model and data compatibility of the STEM scale (Hooper, Coughlan & Mullen, 2008; Jöreskong & Sörbom, 1993). In addition, if the SRMR and RMSEA values are smaller than 0.05, it means that the model-data compatibility is high. In summary, the results of confirmatory factor analysis showed a seven-factor STEM scale and a high model-data compatibility (Anderson & Gerbing, 1984; Hooper et al., 2008; Hu & Bentler, 1999; Jöreskong & Sörbom, 1993).

The related literature has denoted some studies of scale development and adaptation measuring teachers' self-efficacy. Çapa, Çakıroğlu, and Sarıkaya (2005) adapted the teacher self-efficacy scale developed by Tschannen-Moran and Woolfolk Hoy (2001) into Turkish in order to measure the teachers' self-efficacy beliefs. Similarly, even though there have been some studies measuring teachers' and pre-service teachers' self-efficacy (Bıkmaz, 2002; Taşkın & Hacıömeroğlu, 2010; Tepe, 2011), there has been no scale on teachers' STEM self-efficacy. Therefore, this adapted version of the scalecan be administered to measure science teachers' self-efficacy towards STEM education, and meet the need for 'teacher self-efficacy' scale.

Limitations of the Study and Suggestions

This study was carried out with 570 experienced science teachers during the 2017-2018 schooling year period. This study adapted the STEM scale into Turkish to measure Teacher Efficacy and Attitudes toward STEM education. The Turkish version of the STEM scale can be used to measure STEM-related subject content, STEM-related subject teaching technology use, 21st century learning skills, leadership attitudes, teacher self-confidence and self-efficacy, and STEM career awareness. Therefore, the STEM scale can be used in further researches involving these variables. Moreover, because the STEM scale was administered to the science teachers, it could also be adapted into different disciplines. Given that there has been no study on measuring teachers' attitudes towards STEM, teachers' attitudes towards STEM education should be measured with this scale. Hence, the current study will fill in an important gap in the related literature.

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Developing a Scientific Learning Continuum of Natural Science Subjects at Grades 1 – 4

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ABSTRACT

This research aims at investigating teachers', principals', and school supervisors' views of scientific methods of natural science subjects at public elementary schools. Within a survey research method, the sample of the current study consisted of 135 teachers, 119 principals, and 116 supervisors drawn from public elementary schools in Yogyakarta, and seven regencies in the Central Java Province. The instruments developed by researchers were validated through expert's judgements. Findings showed that the teachers', principals', and school supervisors' views could be used for developing a learning continuum of "natural science" subjects in Grades 1 – 4. This continuum purposing to measure scientific methods of "natural science" subjects was constructed via a blue print of confirmatory tests using convergent and divergent patterns.

Keywords: learning continuum, natural science subjects, scientific methods

INTRODUCTION

The Indonesian Educational Authority has released the 2013 curriculum for Indonesian school system suggesting the use of scientific method in learning "natural sciences". Some workshops or training activities for elementary school teachers have been prepared to achive their professional development of newly released curriculum. Science processes and products should be integratedly taught. Biology curriculum in Turkey was mainly carried out in primary schools until 1950s and then revised/developed in the following years in the peiod of republic. A constructivist approach has been adopted into the curriculum through a spiral and integrated approach since 2000s (Kurt & Kurt, 2015.

As stated by Northwest Evaluation Association (2001), a learning continuum (i.e., which enhances a teacher's ability to provide the targeted instruction for individually or group learning) has a strategic role in the teaching activities, i.e. Such a learning continuum involves in material selections, sharing resources, planning curriculumschool improvement and individual education, monitoring student learning progress, and informing parents. Northwest

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Evaluation Association (2015) states that a learning continuum measures such academic progresses as skills, awards, mastery tools to easily accomplish four main tasks.

European Commission (2001) claims that a learning continuum can be used as a guideline for formal, informal, and non-formal learning activities. Indonesia is not well-performed for integrating a learning continuum into a curriculum. The 2013 Curriculum (Minister of Educational and Culture, 2016) including Natural Science subjects at Elementary School has not presented a learning material coherence for science processes and science products at the nature of learning continuum.

The 2013 Curriculum expects students to (a) ask the questions: what, why, and how?, (b) observe the Natural Science objects using their five senses, and (c) report their observations using a clear language. For the next level, it equips students with (a) observing the Natural Science objects using five senses and simple tools, (b) making notes and presenting observation data, (c) reporting their observation results in verbal and written forms, and (d) describing the "natural science" concept. Instead of performing these competencies, elementary school students, for the next levels, are also expected to (a) present their observation data via tables and graphs, (b) draw conclusions and report their observation results in the verbal and written forms, and (c) explain the concepts and principles of Natural Sciences (Minister of Education and Culture, 2016). The mastery of scientific methods will be dependt on pedagogical content knowledge consisting of (a) planning and management, (b) cognitive expertise, and (c) measuring and assessing learning process (Wan Husin, Fairuz, Syukri, & Halim, 2015).

As mentioned above, teachers do not have a clear understanding of the scientific methods and time allocation in teaching and assessing students' achievements. Also, teachers may not have any clear step in preparing instructional materials for assessing the scientific methods from the easiest to the most difficult ones. This paper presents some exporatory experiences to initiate the development of learning continuum within the scientific methods of natural science subjects. Such exploratory experiences will be useful for others in developing the related learning environment.This research aims at formulating the scientific methods taught and assessed in the Natural Science subjects at elementary schools. Hence, the current study will show a learning continuum, whichis easily understood and assessed by the elementary school teachers. Also, it will help themprepare instructional and assessment materials of their 'scientific method' competencies.

LITERATURE REVIEW

a) The Essence of Science Teaching

This section presents the main literatures used in preparing the learning continuum of scientific methods in natural science for the elementary schools in Indonesia. The Indonesian schools only have little experience in developing such documents.

Bloom's taxonomy contains three domains, namely (a) cognitive (b) affective, and (c) psychomotor. Meanwhile, revised version of Bloom's taxonomy comprises of four domains (Dettmer, 2006): (a) cognitive, (b) affective, (c) sensorimotor (a psychomotor substitute), and (d) social. Those four domains shoud be considered as a unity in learning in the classroom. The unity concept of learning ties one domain to another through theearning activities. The creative ability is a part of the cognitive domain.

Thinking process involves several mutually stages, i.e., (a) deductive and inductive processes, (b) product and association, and (c) convergent and divergent thinkings (Garry, 1970). Convergers are naturally demonstrated towards one end of the spectrum and divergers to the other end (Hudson, 1966 cited in Alamolhodaei, 2001). Also, he dissagreed with the belief of many psychologists "divergent thinkers are potentially creative while convergent ones are potentially uncreative." Moreover, the convergence/divergence dimension is a measure of bias, not the level of ability. Divergent and convergent thinking ideally complement to each other. Conversely, the convergent thinking occurs systematically at formulating basic ideas to organize ideas and information. Divergent and convergent thinking integrate into critical/analytical thinking (Conny Semiawan, 1997).

Ideational learning, recommended by Dettmer (2006), bases on the ideas of the learners, and initiates creativityt. Pollman (1973) showed that there was no strong correlation between the IQ scores of Lorge Thorndike and creativity test scores of Torrance models. Ferrando, Prieto, Ferrandiz, and Sanchesz (2005) indicated a low correlation between creativity and intelligence. Learners with high IQ are not always creative. In view of Cromie (2007), few studies revealed a cleardirect correlation between IQ and creativity. Some studies pointed that an increase in creativity is in line with that of an IQ up to 120. In point of Kim's (2005) view, a meta-analysis of 447 correlation coefficients showed that a lot of creativity test scores had nothing to do with IQ scores, but many did.

Creative processes consisted of four stages: (a) preparation, (b) incubation, (3) illumination, and (4) verification (Gary, 1970). Meanwhile, There are seven stages of creative processes, namely (a) orientation or problem formulation, (b) preparation and data collection, (c) analysis, (d) initiation or identification of alternatives, (e) incubation and eluminationi, (f) synthesis, and (g) evaluation. These information sources to develop "scientific method" skillsinspire to prepare the learning continuum to be used in the Indonesian elementary schools.

A creative problem solving process begins with an "anticipation" phase (Torrance, 1979). The next phase compares desirable expectations with undesirableones. This phase occurs in the mind to face difficulties, integrate , re-check, elaborate and sort varied existing knowledge. Thus, a process of convergent and divergent occurs. Then, the last phase involves the ability in going beyond the existing barriers.

Critical thinking skills consist of three aspects, namely: (a) identifying the important things under discussion, (b) reconstructing the arguments, and (c) evaluating the reconstructed arguments (Bowell & Kemp, 2002). Critical thinking skills incorporateto (a) classify, (b) make assumptions, (c) predict and hypothesize, (d) summarize, interpret data to draw conclusions, (e) measure, (f) design an investigation to solve a problem, (g) observe, (h) make a graph, (i) reduce the experimental errors, (j) evaluate, and (k) analyze (Carin & Sund, 1989). Thus, critical thinking involves various aspects of thinking. Critical thinking skills can be developed by divergent open-ended questions stimulating high order thinking. The mastery of divergent thinking skills will enhance the students' capacities to make a decision as a form of convergent thinking (Collette & Chiappetta, 1994).

According to Aldridge (1993), science is a scientific method process consisting of observing, classifying, measuring, interpreting data, inferring, communicating, hypothesizing, developing models and theories, and predicting. Meanwhile, Brum and McKane (LeBoffe & Wisehart, 1989) depicts that science is a scientific method process consisting of: (a) observation, (b) formulation of a hypothesis that can be tested inductively, (c) a deductive experiment design with the formulation of the control and the experimental groups, (d) testing hypothesis, (e) the analysis of the experimental data, (f) drawing the experimental conclusions, (g) accepting, rejecting or changing the hypothesis, which may yield to a theory and rule, and (h) sharing the research results. Natural sciences may be equated with the scientific methods. Therefore, learning science may not neglect the ability to make observations, formulate accountable hypotheses, perform induction and deduction, design and carry out experiments to prove the hypothesis. Observation skills possesses the lowest position in the scientific processes (Rezba, Sparague, Fiel, Funk, Okey, & Jaus, 1995). The higher-orderskills include "measuring and classifying" processes, while doing experiments is the highest skill. Bryce, McCall, MacGregor, Robertson, and Weston (1990) classifed science process skills into basic process and integrative skills. The implementation of scientific methods in elementary schools has been viewed as the investigative form since 1970s (Brewer, Garland, & Marshall (1972).

The teaching and learning processes of science should rely on the scientific processes involving such science process skills as (a) observing, (b) collecting the data, (c) measuring, and (d) organizing and classifying the data (Towle, 1989). Aktamiş and Ergin (2008) showed that the science process skills increased students' achievements and scientific creativity levels. However, no meaningful progress appeared at their attitudes towards science as compared to the teacher-centered methods.

Revising any curriculum, like Indonesia, generally occurs in all developing and developed countries. With regard to this, Dickson and Kadbey (2013) stated that significant educational reforms have taken place in Abu Dhabi of the United Arab Emirates since 2007. Teacher-centered instruction and heavily textbook-based instruction have been replaced with practical and student-centered approaches. These approaches have also been carried out in the teacher preparation institutions. However, the schools are not always responded positively to the efforts of local authorities. For example, some differences in science learning were observed between groups of schools in high and low performance based on some developed countries' TIMSS 2007 scores (Ceylan & Akerson, 2013). Indeed, the high performance schools have conducted many inquiry-oriented activities while the lower performance schools have performed teacher-oriented ones. Again, the literature review uses basic information to develop the learning continuum of scientific methods in natural sciences for the Indonesian elementary schools.

b) The Principles of Assessment and ıts Effects on Education

Assessment can be defined as the process of collecting and organizing data to meet the different educational needs (Hart, 1994; Miller, 2008). Data are formally obtained through exams, essays and homeworks. They are informally collected through observations or interactions, too (Muijs & Reonald, 2008). An educational assessment is defined as a formal attempt to determine student's status of educational variable(s) (Popham, 2005).

An assessment is supposed to align with the curriculum's goals and materials (Puckett and Black, 1994). This means that standards, content, assessment, and learning strategies are complementary suitable for each other. Therefore, assessment is a part of a learning activity (an assessment of learning) (Drake, 2007). Assessment also serves to advance learners in learning (assessment as learning). Therefore, fully test-oriented learning will not give a positive effect for the learner's advancement (Drake, 2007). Assessments of the student's mastery on the entire materials are called confirmatory assessmentsobtaining a standardized test (Frazier & Sterling, 2009). Science education covers pre-service teachers' assessments. Pre-service teachers are able to present their conceptions about the nature of science through many different representative ways, i.e., drawing, writing, or diagrams (Colagrande, Martorano & arroio, 2016). A learning continuum of scientific methods in natural sciences makes strategies and assessments usefull to guide learning and teaching. Therefore, preparing a learning continuum for elementary school curriculum is a basic strategy in improving the quality of education in Indonesia. Hopefully, some critics may solve long-term educational problems in Indonesia.

METHODOLOGY

The current research, which was conducted in the 2016-2017 schooling year, reviewed the literatures to grasp ideas of scientific methods at elementary science education. The researchers developed a draft of the Learning Continuum (LC) given Subali's (2009) suggestions on the first-hand experiences in science teaching-learning. The draft LC was then reviewed by 10 science teacher educators from the Yogyakarta State University and Sebelas Maret University. Interrater reliability (agreement percentage) was so high for these science student teachers. They were mostly between about 40% and 80%, while some indicators got as low as 20% agreement. This becomes the basis to put scientific methods into the LC. Given their critics and suggestions, the researchers made corrections to refine the draft of the scientific method in the LC.

The results of 10 science teacher educators wee also viewed as a judgment to align items with indicatorsi. This process ensured content validity (Lissitz & Samuelsen, 2007). The refined draft was used as the final instrument to collect data from teachers (who taught nature science subject to grades 1-4), principalss, and supervisors in 12 regencies and/or cities in Yogyakarta and Central Java.

Based on the refined LC, the researchers developed a Likert-scale to validate and collect the sample's views of relevant aspects. This is only limited to the scientific methods including basic and process skills. Each participant was asked to select an element of the scientific methods taught and assessed at grades 1-6.

The sample of the research was purposively drawn from two Regional Technical Implementation Units (RTIU). From each RTIU, one Elementary School teacher was selected as a sample from each grade, therefore; each school sample was one each first, second, third, and fourth grade teachers. Thus, the number elementary school teachers was four teachers (first, second, third, and fourth grade teacher, each) from 12 regencies and/or cities in two RTIUS. The school principals were from 12 regencies and/or cities in RTIUs, while two supervisors from each RTIU participated in the study.

The data collection lasted from May to June 2016 by help of a field coordinator to pass questionnaires out to the participantsand collect them back. The data were exposed to descriptive statistical analysis. The data were intended to indicate the sample's tendencies of the refined LC, and assessments in scientific methods for elementary students.

RESEARCH FINDINGS AND DISCUSSIONS

The results of the study presented thesample's views of the LC and assessments of scientific methods. Tables 1- 7 present the formulation of the learning continuum dealing with basic skills. Tables 8- 10 indicate the formulation of learning continuum in related process skills.

Each table describes a respondent mode of percentage stating an element of scientific method at a certain grade. The percentage of each group is presented in the appendix. The highest number of choice selected by the group is presented as a mode in each table. In the last column of each table, grades and scientific methods were arranged consecutively into a learning continuum.

Table 1 presents the teachers', principals', and supervisors' views of observation skills, that must be taught and assessed in the elementary schools. As seen in Table 1, all observation skills were recommended to be taught and assessed from the first grade, except for "identify the impact of technology on nature, a region, or images" at the third grade.

Table 1. The teachers', principals', and school supervisors' views of observation skills, which have to be taught and assessed

Observation skills	Modus of choices	Recomendation for the LC
1. Identify the names of the living things or non-living things based on sounds they hear	8 G1	G1
2. Select a comperative phenomenon when they are faced with two kinds of the living or non-living creatures to identify differences	8 G1	G1
3. Choose observable species, whose bodies are varied colors, shapes, and levels	8 G1	G1
4. Match a real living or non-living thing with the picture or vice versa to know the diversity of appearance	8 G1	G1
5. Identify circumstances equally having full potential risks when making observations in the school with everyday situations at home.	6 G1	G1
6. Identify the impact of technology on nature, a region, or images	4 G1 3 G3	G1
7. Select and match the object of the observation in the form of the living or non-living things with pictures	8 G1	G1

Table 2 presents the sample's views of the data/information collection skills, which have to be taught and assessed. They recommended to teach and assess them from the third or fourth grade.

Table 2. The teachers', principals', and school supervisors' views of the data/information collection, which have to be taught and assessed

The data/information collection skills	Modus of choices	Recomendatio n for the LC
1. Complete a chart, graph or histogram of the phenomenon on the living or non-living things	6 G1 2 G3	G1
2. Present data in a tabular form completed with labels	5 G3 2 G4	G3
3. Make a histogram of the phenomenon on the living or non-living things completed with labels	4 G3 3 G4	G3
4. Make a summary of some paragraphs/chapters to review the phenomenon on the living or non living things	5 G4 2 G5	G4
5. Write a paper containing information about the observations results of the phenomenon on the living or non living things completed with its title.	5 G4	G4
6. Determine the information about the characteristics of a living or non living thing presented in charts, graphs or histograms	6 G3	G3
7. Make charts, graphs or histograms of the phenomenon on the living or non living things	3 G4 3 G3	G4
8. Determine body or parts of the living or non- living bodies to be drawn accurately	5 G4 2 G3	G4

Table 3 presents the sample's views of the following instructional skills, which have to be taught and assessed. They suggested to teach and assess them from the third and/or fourth grade.

Table 3. The teachers', principals', and school supervisors' views of the following instructional skills, which have to be taught and assessed

Following instructional skills	Modus of choices	Recomendation for the LC
1. Prepare equipment or arrange the steps to observe the phenomenon on the living or non-living things after the teachers give written explanation	4 G3 3 G4	G3
2. Prepare equipment or arrange the steps to observe the phenomenon on the living or non-living things after the teachers perform demonstration	4 G4 2 G3	G4
3. Prepare equipment or arrange the steps to observe the phenomenon on the living or non-living things after the teachers give oral explanation	3 G4 3 G3	G4
4. Prepare equipment or arrange the steps observe the phenomenon onthe living or non-living things after reading written procedures in the student worksheets.	4 G4 4 G3	G4

Table 4 presents the sample's views of classification skills. They recommended to teach some of them from from the first grade or some from the third and/or fourth grades. .

Table 4. The teachers', principals', and school supervisors' of the classification skills, which have to be taught and assessed

Classification skills	Modus of choices	Recomendation for the LC
1. Determine the base to separate the living or non-living things or parts of his body based on his body characteristics in reference to the data presented in books or given by the teachers	5 G1 2 G3	G1
2. Determine the base to put them together the living or non-living things or parts of his body based on his body characteristics in reference to the data presented in books or given by the teachers	5 G3 2 G1	G3
3. Determine the base to separate the living or non-living things or parts of his body based on his body characteristics in reference to the data of observations results	6 G3	G3
4. Determine the base to put them together the living things or non-living things or parts of his body based on his body characteristics in reference to the data of observations results	4 G3 2 G4	G3

Table 5 presents the sample's of measurement skills, which have to be taught and assessed. They suggested to teach and assess them from the fourth grade, but instruct some of them from the third or fifth grade. Escpecially, the skill "Estimate the size similarity of the two bodies or body parts of the living or non-living things roughly" was recommended from the first, third, or fifth grades.

Table 5. The teachers', principals', and school supervisors' views of measurement skills, which have to be taught and assessed

Measurement skills	Modus of choices	Recomendation for the LC
1. Find the causes of inaccuracies in measuring the characteristics of the living or non-living things bodies using tools	3 G4 3 G3	G4
2. Find a mistake in using grid to estimate the area of a surface of the body/parts of the living or non-living things	4 G1 2 G3 2 G4	G1
3. Find the causes of inaccuracies in reading the scale of thermometer to measure temperature of the living or non-living things	5 G4 3 G3	G4
4. Determine the measurement instruments in accordance with the characteristics of the living or non-living things to be measured	6 G4	G4
5. Find the causes of inaccuracies in measuring the temperature of the living or non-living things using a digital thermometer	6 G4	G4
6. Find the causes of inaccuracies in measuring characteristics of the living body using up and down scales	6 G4 2 G5	G4
7. Find the causes of inaccuracies in reading the meter scale or measuring tape when measuring the characteristics of the living or non-living things	7 G4	G4
8. Estimate the size similarity of the two bodies or body parts of the living or non-living things roughly	4 G4 2 G3 2G5	G4

Table 6 diplays the teachers', principals', and school supervisors' views of manipulation movement skills, which have to taught and assessed. They suggested to teach and assess them from the fourth or fifth grade. There were two skills suggested for the third or fourth grade: "Find the ways to move solid or liquid in an experiment related to the phenomenon on the living or non-living things " and “Find out how to use the hand skills to create works that are associated with the phenomenon on the living or non-living things”.

Table 6. The teachers', principals', and school supervisors' views of the manipulation movement skills, which have to taught and assessed

Manipulation movement skills	Modus of choices	Recomendation for the LC
1. Find the ways to move solid or liquid in an experiment related to the phenomenon on the living or non-living things	3 G3 3 G4 2G1	G3
2. Find the things that cause errors in using lope to observe the phenomenon on the living or non-living things	4 G4 3 G3	G4
3. Find the things that cause errors in using a thermometer to measure and observe the phenomenon on the living or non-living things	8 G4	G4

4. Find the things that cause errors in squashing material derived from the living or non-living things	5 G4 2 G5	G4
5. Find out for how to use the body/organs of the living body as measurement tools	4 G4 4 G5	G4
6. Find out how to use the hand skills to create works that are associated with the phenomenon on the living or non-living things	5 G4 2 G5	G4
7. Find the things that cause errors in using a microscope to observe the phenomenon on the living or non-living things	5 G4 2 G5	G4

Table 7 presents the sample'sprocedure/technique/tool skills of the implementation, which have to be taught and assessed. They suggested to teach and asses them from the fourth or fifth grade. There were only two skills recommended for the fifth grade.

Table 7. The teachers', principals', and school supervisors' views of procedure/technique/tool skills of the implementation, which have to be taught and assessed

Procedure/technique/tool skills of the implementation,	Modus of choices	Recomendation for the LC
1. Find out the causes of errors in using a stop clock or stopwatch	4 G4 2 G3	G4
2. Find the things that cause the malfunction of a pipette to move the solution in the experiments associated with the phenomenon on the living or non-living things	4 G5 3 G4	G5
3. Choose the ways to reduce errors in the experiments associated with the phenomenon on the living or non-living things.	5 G4 3 G5	G4
4. Find the things that cause the malfunction of a liquid chemical test paper on the testing of materials derived from the living or non-living things	6 G5	G5
5. Find the causes of error in mixing the solution of the materials used in the experiment associated with the phenomenon on the living or non-living things	5 G5 2 G4	G5
6. Find the ways to avoid the mistake of using a measuring spoon to move the substance	3 G4 3 G5 2 NO	G4
7. Find things that cause errors in filtering to obtain the extract from a living or non-living thing	5 G5 2 NO	G5
8. Find out the things that cause an error in using magnifying lenses to observe the phenomenon on the living or non-living things	7 G5	G5
9. Find the secure working steps in using flammable laboratory equipments	4 G5 3 G4	G5
10. Find the things that cause the error in determining the type of equipment that will be used to observe the phenomenon on the living or non-living things	5 G4 2 G5	G4
11. Find the type of equipment to be used in accordance with the tasks assigned by the teachers	4 G4 3 G5	G4

Tabel 8 presents the sample's inference skills, which have to be taught and assessed . They offered to teach and assess them from the fourth grade. There was only one skill from the first-grade; "Find the differences between the body shape of the living or non-living thing presented in the picture".

Table 8. The teachers', principals', and school supervisors' views of inference skills, which have to be taught and assessed

Inference skills	Modus of choices	Recomendation for the LC
1. Formulate conclusions in accordance with the information presented in textbooks	7 G4	G4
2. Formulate conclusions that suit with the observed data	6 G1	G1
3. Formulate conclusions based on observational data on living or non-living things	7 G4	G4
4. Find the differences between the body shape of the living or non- living thing presented in the picture	6 G4	G4
5. Formulate conclusions based on data from observations of a living or non-living thing	6 G4	G4
6. Formulate hypothesis in a new investigation of symptoms in a living or non-living thing	7 G4	G4

Table 9 shows the sample's views of prediction skills, which have to be taught and assessed. They suggested to teach and assess them from the fourth grade. There was only one skill suggested from the fourth or fifth grade: "Predict the process changes that occur in the body of living or non- living thing if being given certain conditions".

Table 9. The teachers', principals', and school supervisors' views of prediction skills, which have to be taught and assessed

Prediction skills	Modus of choices	Recomendation for the LC
1. Predict the possibility that occurs when the existing living or non- living things in conditions that do not support the faced facts	7 G4	G4
2. Predict the changes on the size of body parts of living or non- living thing given a certain condition	7 G4	G4
3. Predict the changes on the size of the body or body parts of living or non- living thing given a certain condition	6 G4	G4
4. Predict the process changes that occur in the body of living or non- living thing given a certain conditions	4 G4 3 G5	G4

Table 10 reveals the teachers', principals', and school supervisors' views of the selecting procedures/techniques/tools skills, which have to be taught and assessed. They recommended these skills from the fourth grade.

Table 10. The teachers', principals', and school supervisors' views of the selecting procedure/technique/tool skills, which have to be taught and assessed

Selecting procedure/technique/tool skills	Modus of choices	Recomendation for the LC
1. Determine the working steps in an observation/measurement or select the equipment that are appropriate with the problems.	5 G4 3 G5	G4
2. Find a way to anticipate the risks and take preventive actions and suitable ways of working in experiments/investigations	6 G4 2 G5	G4
3. Choose an appropriate type of equipment to measure something to get the accurate results	5 G4 3 G5	G4
4. Choose the things that can affect the outcome of an investigation, determine the data obtained according to the results of the investigation, and decide how to present the results of the experiments	5 G4 3 G5	G4

DISCUSSION

This part compares the results of the current research with those by Subali, Paidi, and Mariyam (2016), who measured the fourth graders' achievements of science process skills on living things. The results of this study showed that almost all observation skills were recommended to teach and assess from the first-grade, with an only skill "identify the impact of technology on nature, a region, or images", which might be taught and assessed in the third grade.

Although the skill "select and match the object of observation in the form of living or non-living things with pictures" was recommended to teach and assess in the first grade, the first grade students seem to have possessed difficulties in the subjects. Subali et al (2016)found that only 19% of the fourth grader students could have answered correctly on the 'living things' subjects.

As seen in Table 2, especially the skill " accurately determine body or parts of livings or non-living things" should be taught and assessed from the first grade. But, Subali et al (2016) reported that it seemed to be very difficult for the fourth grader students because only 17% of them answered it correctly. Similar conflicted results were also available for the skill "prepare equipment or arrange the steps to observe the phenomenon on the living or non living things after reading written procedures in the student worksheet". The present study suggested to teach and asses the skill from the first grade; but Subali et al. (2016) students found it difficult for the fourth grader students. That is, when they faced with corresponding items, only about 19% of them gave correct responses.

As observed in Table 5, some of the sample under investigation referred to the third or fourth or fifth grade to teach and assess relevant skill. The skill "estimate similarity size between two bodies or body parts of the living or non-living things roughly" was recommended to be taught and assessed in the first grade.

Conflicting results between the suggested and identified skills appeared for the current study and that by Subali et al., (2016). This may stem from previous curricula emphasizing more cognitive aspects. .

The conflicting results presented here may actually be useful for preparing future science teachers especially for elementary education, i.e., making science teachers aware of difficulties and new requirements suggested by the 2013 curriculum. Hence, teacher preparation may focus on new materials in teaching scientific methods. This new requirements definitely will make science teachers perceive problems, which need to be solved in elementary schools. It may also warn science educators and teacher preparation institutions to get more new science teaching materials for for elementary teachers. Many years ago, the USA also encountered with similar conditions (Marzano & Haystead, 2008).

Given the sample's recommendations, there was no a rational order for them. As can be seen in all tables, the teachers', principals', and school supervisors' suggested to teach and assess them by starting from the first, third, and fourth grades. Only three skills "procedures/techniques/tools skills of the implementation," "find things that cause errors in filtering to obtain the extract from a living or non-living thing" and "find out the things that cause an error in using magnifying lenses to observe the phenomenon on the living or non-living things," which have to be taught and assessed, were recommended from the fifth grade.

Finding some skills difficult for lower grades is a contradictory issue with the nature of the learning continuum developed. Conceptually, the development of learning continuum is supposed to be compiled from the lowest to the highest degree. Moreover knowledge should be developed from the simplest to the most difficult. This principle can beapplied to all learning continuum components. Renaisance Academy (2017) defines learning continuum as a sequence of skills, that are built from one level to the next. The initial skill is a pre-request for advancing/learning other skills at the next level. In this case, learning skills are cumulative meaning that current instructional skills are added into early acquired skills.

Learning continuum by Australian Curriculum, Assessment and Reporting Authority (ACARA) (Randall, 2015) was also compiled from the simple elements into complex ones at the Australian Curricula. NWEA (2001) did the same thing on Rusch Item Test (RIT) from lowest to highest. Learning continuum was sequenced from simple to complex or from easier to most difficult (Renaissance Academy, 2016). In addition, Kessler and Galvan (2007) suggested inquiry-based chemical materials for for Grade 4, and science process skills for Grades 5-8.

Three things need to be known about the learning continuum. Firstly, learning statements give an instructional starting point to explain the skills and concepts that are mostly ready to be introduced, developed, or reinforced along a learning continuum. Secondly, test and class views supply global and student-specific information for tailoring instruction. Thirdly, MAP RIT scores are connected to skills and concepts that students are ready to learn, identify learning goals and targets. Hence, teachers can share them with students and parents to create more personalized lesson plans (NWEA, 2014).

Learning continuum, which is uninterrupted for the child from the youngest age through adolescence, is an emblematic of Montessori educational settings. In programs adhering to the standards by Association Montessori Internationale (AMI), the learning continuum develops a standardized practice, that establishes a seamless consistency approach across individual classrooms and up through grades. This consistency is supported by a rigorously monitored and integrated teacher training, that focuses on the developmental path of the child. Language development, progression of mathematics, and various other disciplines are empowered in the early years, that are directly utilized as a platform for the elementary experience and beyond.

The results of the study supported to teachers, principals, and supervisors, who gave less attention to the difficulty level. Their views of the scientific methods in the classrooms indicated that all skills had not been taught and less that half of them had instructed the scientific methods. The teachers depicted that many grade 1 students were unable to read and some 3rd grade students still had difficulties in reading. On the contrary, Elliott (2010) stated that spoken and written language are central to explore scientific phenomena, share and test ideas, and demonstrate understanding. Moreover, language usage in science learning helps students' literacy development and associated cognitive skills. Therefore, how can we insert the mastery of literacy skills in science and promote synergy between science teaching and literacy? Science can be learned most naturally and effectively in collaborative, social contexts. This can be enhanced through the use of literacy strategies that aid students to draw on real-world evidence to generate explanations, arguments and questions. From the earliest grades, students should be supported to grow positive habits, attitudes towards science learning (including collaborative approaches), and 'scientific language' competency. In addition, he mentioned that teachers could use several strategies to intimately connect the development of literacy to science. Literacy skills are required to learn and practise science effectively. Students at Grades 1-6 encounter more than 170 scientific words at the Ontario curriculum and have opportunities to incorporate them into their vocabularies. However, literacy in science is about more than just the development of familiarity with scientific vocabulary and writing genres: it is also about the use of language in inquiry and the construction of meaning.

A lack of 'fluent reading' skill causes difficulty for teachers to teach science when they need to deal with understanding, and the essence of the scientific method. In point of Barlia's (2016) view, a conceptual change determines students' success levels. Conceptual changes can be taught via addition, rearrangement, replacement, and extinction (Barlia, 2016). To master them, teachers' selected strategies are needed. Therefore, how to teach and assess the scientific method cannot be separated from teaching the objectives. The current study recommends that teachers should be aware of the importance of their students' basic knowledge and effective teaching strategies that promote conceptual change processes in learning science.

Some teachers may not probably teach due to the time factor or unavailability of laboratory tools. Moreover, , there is no special laboratory for elementary schools in Indonesia. The research by Bozdoğan and Uzoğlu (2015) reported similar results to the current study. They implied that teachers found such problems as the allocation of time, textbooks and workbooks, inability to connect to everyday life, and unit features while teaching "force and motion unit in 8th grade". In general, teachers suggest improvements to enrich and supply some facilities (i.e., an increase in class-hours, laboratory equipments) for implementing science process skills. As well as context-based science learning, technology should be utilized (video, flash, presentations, hand, etc.) in their classes to solve science-related problems in the workbooks. Also, the number of science activities in the workbooks should be improved and/or enhanced and/or enriched. The study by Yalçin (2015) showed that science teachers were aware of the importance of gaining scientific research skills, and development of positive attitudes towards scientific method. Aktamiş etal. (2016) suggest to employ inquiry-based learning strategies in primary schools (especially, science courses) in order to increase student achievement, science process skills and attitudes towards science.

The findings of this research indicated that all elements of the scientific methodsfrom grade 1 to grade 4 may serve as starting point for further studies in achieving the learning continuum of scientific method for these grades.

CONCLUSION AND RECOMENDATION

In light of the results, it can be concluded that the teachers', principals', and school supervisors' views could be used for developing a learning continuum of "natural science" subjects in Grades 1 – 4. This continuum purposing to measure scientific methods of "natural science" subjects was constructed via a blue print of confirmatory tests using convergent and divergent patterns.

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The Relationship between Jordanian Students' 21st Century Skills (Cs21) and Academic Achievement in Science

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ABSTRACT

The present research aimed to determine the relationship between Jordanian students' 21st century skills (Cs21) and academic achievement in science. The sample of the research consisted of a total of 96 eighth-grade students drawn from four rural and four urban schools in Irbid Qasaba in the governorate of Irbid. Randomly cluster sampling was used to select the sample of the study. To collect data, a Cs21 survey was adapted from the Malaysian Cs21 Instrument (M-21CSI), which was itself based on the enGauge Cs21 framework by Metiri Group and NCREL. The adapted survey was used to measure students' Cs21 and academic achievement in science in the 2015–2016 academic year. The data were analyzed by using descriptive (mean and standard deviation) and inferential statistics (simple linear regression and independent samples t-test). The findings showed that the Cs21 was a significant predictor of the students' academic achievement in science ($R = .353$, $p = .000$). The analysis also showed that urban and female students were better in acquiring the Cs21 than rural and male students. However, their parents' job types had no significant difference in the students' mean scores of Cs21. Therefore, it is recommended that the Cs21 should be integrated into all curricula to improve students' academic achievement and to train future citizens, who are ready for the challenges of the 21st century.

Keywords: Academic Achievement, Science Education, 21st Century Skills.

INTRODUCTION

a) 21st Century Skills (Cs21)

Advances in information technology (IT) have significant impacts on the politics, economy, and society of countries in the world. So, students need to be equipped with suitable skills, which effectively deal with future life complexities and today's competitive world (Alhabahba, 2016; Lemke, Coughlin, Thadani, & Martin, 2003; Poropat, 2009; Soh, Arsad, & Osman, 2010; Turiman, Omar, Daud, & Osman, 2012). Therefore, educational systems should keep up with these rapid changes to prepare students for new life challenges (Lemke et al., 2003; Soh, Arsad & Osman, 2010). The 21st century skills (Cs21) prepare young people

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for effective workers and citizens in the modern knowledge society in future (Ananiadou & Claro, 2009).

The Cs21 enable the current generation to face future challenges, which could encompass changes in industry, economy, society, technology, and information (Lemke et al., 2003). These skills get students to acquire critical thinking, problem solving, decision making and innovation (Hirsch, 2009; Silva, 2009). The Cs21 include digital literacy, inventive thinking, effective communication and high productivity. They also include skills in learning, innovation, media, technology, information, and core subjects as well as life and career skills (Lemke et al., 2003).

Even though the assessment of the Cs21 is one of the most important educational issues, how to measure the Cs21 has still been unexplored (Finegold & Notabartolo, 2010; Geisinger, 2016). Also, although the definition of the Cs21 has still been argued, the Cs21 are the skills, that make a person active, productive, and adaptable in the new [21st] century (Autor, Levy, & Murnane; 2003; Kyllonen, 2012; Levy & Murnane, 2004). Several organizations have attempted to develop frameworks of the Cs21 (Dede, 2010). For instance, NCREL and Metiri Group (Lemke et al., 2003) developed four main Cs21 domains: (1) digital-age literacy including multicultural literacy, information literacy, technological literacy, visual literacy, and scientific literacy (2) inventive thinking containing higher-order thinking and informal reasoning, self-direction, managing complexity, adaptability, curiosity, creativity, and risk taking (3) effective communication incorporating interactive communication, interpersonal skills, personal responsibility, civic responsibility, social responsibility, collaboration, and teaming (4) high productivity involving in using real-life tools, producing relevant and high-quality products, and results, prioritizing, planning, and managing.

b) The CS21 and Science Education

The general objective of science teaching is to enable students to understand all technological types, so that they can use them in their daily lives (Ministry of Education, 2016). Moreover, science education aims at developing students' problem solving skills so that they can solve their daily problems. Although the acquisition of basic science skills is essential for students, these skills are not enough to become creative problem solvers, transfer their knowledge to real-world situations, use various sources to generate innovative ideas, and to face the challenges of modern life (Soh, Arsad, & Osman, 2010). Science education plays a critical role in preparing the 21st century workforce (Bybee & Fuchs, 2006).

In this scope, teaching the Cs21 can contribute to improve science education, and science pedagogy as well as standardizing curriculum to constantly changes in new technology and globalized society (Hirsch, 2009; McFarlane, 2013). Also, educating students with the Cs21 will make a contribution to society in the 21st century and make them more productive (Volkmann, et al., 2009). Recognizing the importance of the Cs21 has led to its integration into the educational system, as enGauge Framework by Metiri Group and NCREL. They have purposed to integrate the teaching of the Cs21 into curricula, so that students can participate fully in modern life (Dede, 2010).

c) The CS21 and Academic Achievement

Academic achievement, which is the goal of the entire educational system, is the main indicator for assessing student progress in an educational system (Tabbodi, Rahgozar, & Abadi, 2015). Knowledge, which is essential for success in the 21st century, yields successful learning and achievement in any time (Mishra & Kereluik, 2011). In such traditional academic domains as science, the Cs21 skills, frequently cited as an essential for success, embrace core content knowledge and high academic achievement. In other words, excellence in any traditional academic domain is considered to be the basis for developing other Cs21 (Gardner, 2008). Many empirical studies over years have found that academic achievement is closely connected with cognitive skills (Mishra & Kereluik, 2011). Lemke et al. (2003) suggested improving students' academic achievement and the Cs21 skills, which are pre-requests for the qualified workforces. In addition, it is argued that the use of educational technology improves students' achievement (Cuban, 2001; Dede, 1998; Harter & Harter, 2004; Oppenheimer, 2003; Safari & Taheri, 2015). In addition to digital-age literacy, high productivity and effective communications, inventive thinking has been identified as an important skill for academic achievement (North Central Regional Educational Laboratory and Metiri, 2003).

d) CS21 and Jordan

There is an urgent need to assess the Cs21 in Jordan, so that deficiencies in curricula, especially science curriculum, can be revealed and addressed to properly prepare students for their current and future life skills (Bybee & Fuchs, 2006; Kyllonen, 2012). Due to rapid advances in IT and knowledge-based economy, the concept of the 'k economy' has arisen to address the gap between various curricula offered by different educational systems and the needs of the world community in the 21st century (Turiman, Omar, Daud, & Osman, 2012). Jordan, as a part of this community, started to implement technology-enriched educational reforms under the title "Education Reform for the Knowledge Economy" (ERfKE) in 2003 (Chisholm & Steiner-Khamsi, 2015; Lightfoot, 2014). Hence, such Cs21 as collaboration, communication, critical thinking, problem solving, and information and communication technology (ICT) literacy were integrated into the curriculum (Kozma, 2010). The aim of the Curriculum and Assessment Department of the Jordanian Ministry of Education is to foster sustainable economic development through well-skilled workforces and to educate population with lifelong learning experiences via their recent and upcoming requirements (Kozma, 2010).

Nonetheless, Jordan was ranked 57th among 65 countries in the Programme for International Student Assessment (PISA) assessing curricula Cs21 (PISA, 2012). In 2011, the Trends in International Mathematics and Science Study (TIMSS) showed that Jordanian eighth-grade students had the lowest results among the participant countries (Mullis, Martin, Foy, & Arora, 2012). Therefore, there is an urgent need to improve the factors that affect students' academic achievement and to integrate the Cs21 into science curriculum meeting the needs for the modern world. Also, little research has been conducted on the effect of digital literacy on student achievement (Brown, 2009).

To date, there has been no published research on the relationship between the Cs21 and academic achievement in science, but many researchers have examined the relationship between students' digital literacy and academic achievement (Brown, 2009; Pagani et al., 2016; Prensky, 2005). These studies have revealed that the use of technology improves students' academic achievement. On the other hand, some studies showed a positive relationship between thinking skills (e.g., creative thinking and critical thinking) and academic achievement (Anwar, et al., 2012; Bowles-Terry, 2012; Naderi et al., 2010; Zirak & Ahmadian, 2015). This research will explore the relationship between Jordanian students' Cs21 skills and academic achievement in science or elicit variations in the Cs21 for Jordanian students.

CONCEPTUAL DEFINITION

a) Digital-Age Literacy

The digital-age literacy is the most predominant skills needed to negotiate the complexities of digital lifestyle (Belshaw, 2012). Digital-age literacy is defined as the "ability to use digital technology, communications tools and/or networks to access, manage, integrate, evaluate, and create information in order to function in a knowledge society" (Educational Testing Service, 2002, p.2). For this research, digital-age literacy is defined as the needed skills and capabilities to effectively deal with the complexities of life. This effectiveness facilitates scientific literacy, technological literacy, visual and information literacy, multicultural literacy, global awareness, using technology in interpersonal, collaborate communication, and productivity of an individual's ability to use and manage technology.

b) Inventive Thinking

Inventive thinking is defined as "an ability to effectively solve non-typical (creative) problems in various domains avoiding a large number of trials and errors" (Sokol, et al., 2008, p.36). In this research, inventive thinking, which involves in curiosity, self-direction, creativity, risk taking, adaptability, sound reasoning and higher-order thinking, is defined as being able to creatively deal with complex learning.

c) Moral Values

Moral values are defined as an exceptional fundamental spiritual development of a person (Aramavičiūtė & Martišauskienė, 2014; Covey, 2007). In this research, moral values reflect the Jordanian society's basic values and norms (named Jordanian identity) while using technology.

PURPOSE OF THE STUDY

The primary aim of this research is to identify the relationship between Jordanian students' academic achievement in science and Cs21. The secondary aim of this research is to determine these students' demographic differences in terms of the Cs21.

RESEARCH QUESTIONS

This research attempts to answer the following research questions:

1. Is there any relationship between the Jordanian students' Cs21 and academic achievement in science?
2. Is there any significant difference between male and female students' Cs21 skills?
3. Do students from rural and urban school locations impact the students' Cs21 skills?
4. Do students' parents' jobs (educational and non-educational) influence their Cs21 skills?

This research is expected to integrate the Cs21 into the Jordanian government's curricula in general and serve for science curriculum at the primary school level purposing to equip students with these skills. Also this research will play a crucial role in training students with the expertise, knowledge, and skills that they need to be productive citizens and workers and to face the challenges of globalization. Moreover, the results will give Jordanian educational leaders valuable feedback that can be used to inform educational policy on such areas as professional development for teachers, curriculum development, accountability, and assessment. In addition, this research will pave the way for other researchers to further improve the integration of the Cs21 into science curricula and to improve science pedagogies and related assessment tools. Also, relevant educational leaders may find this beneficial for further actions.

RESEARCH METHODOLOGY

a) Research design

Within survey research design, this research explored the relationship(s) between the Cs21 and academic achievement in science. That is, this study viewed the Cs21 as a predictor variable and academic achievement in science as the criterion. Hence, the current study employed a survey to generalize the data from the sample of the study to a large-size population.

b) Research sample

The target population of this prediction study consisted of public primary schools in Irbid governorate in Jordan during the 2015–2016 academic year. The accessible population was 96 government primary schools in Irbid Qasaba. A random cluster sampling technique was used for selecting the sample. Firstly, 480 primary school students from eight government schools (four each from rural and urban areas) were randomly drawn from the schools in the Irbid Education Directorate. Then, 48 students from each school were randomly selected for this research. Finally, given Krejcie and Morgan's (1970) criteria in determining a proper sample size, 384 primary school students participated in the current study. The demographic features of the sample are shown in Table 1. It was deemed that the sample of the study would represent eighth-grade students in public primary schools in the Qasaba district in the Irbid governorate.

Table 1. *The sample of the Study*

		Number of Students	Percentages
School Location	Rural	171	45
	Urban	213	55
Gender	Male	194	51
	Female	190	49

c) Instrument and procedures

One of the most used measurements in educational research is the self-rating or self-assessment. The instrument used for this research was adapted from the 'Malaysian 21st Century Skills' Instrument (M-21CSI) (Osman, Soh, & Arsad, 2010), which was, in turn, based on the enGauge Cs21 framework (Lemke et al., 2003). The M-21CSI included 106 items within five factors. This instrument was translated from English into Arabic. Then, it was pilot-studied with thirty students to take their feedbacks. The pilot-study showed that the students had a problem in responding the instrument in scheduled time due to its length. Further, they were bored with the items and mentioned that "the meaning of every item overlapped other ones". Due to these problems, the instrument was revised by selecting more related items to the factors. Afterwards, the instrument items consisted of 49 items at five factors; 13 items in digital-age literacy, 19 items in inventive thinking, 5 items in effective communication, 5 items in high productivity and 7 items in spiritual values.

Then, the instrument was sent to a group of experts (two science educators and two education technologists) for content validation. They suggested to insert items at the "effective communication and high productivity" factors to the digital-age literacy factor as well as adding more 7 items to the 'spiritual values' factor and renaming it to moral values. The instrument was improved based on their suggestions (see Table 2). A three-point Likert scale (Disagree--1 point-- to Agree--3 point) was employed to collect data.

Table 2. *Factors of the Instrument*

Subscale No.	Factors
1	Digital-Age Literacy
2	Inventive Thinking
3	Moral values

A group of four experts examined this instrument to check content validity (Osman et al., 2010). Later, the instrument was exposed to a factor analysis. The results of factor analysis emerged three factors, explaining 30.74 percent of the overall variance (see Table 3).

Table 3. *Factors and percentages of variance*

Factors	% of variance	Cumulative %
Digital-Age Literacy	20.542	20.542
Inventive Thinking	10.201	30.743
Moral values	9.712	40.455

The reliability of each factor was calculated by Cronbach's alpha co-efficient. In addition, a pilot study was conducted to obtain the reliability index of the instrument. As seen in Table 4, the reliability (Cronbach's alpha) values ranged from 0.78–0.83 for three factors, while that for the entire instrument was found to be 0.81. This means a high level of internal consistency for the scale. In the case of the original M-21CSI, reliability (Cronbach's alpha) values ranged from 0.74–0.92 for five factors (Osman, Soh, & Arsad, 2010).

Table 4. *Cronbach's alpha (α) values of the factors and entire scale*

Factors	Cronbach's alpha values
Digital-Age Literacy	.81
Inventive Thinking	.78
Moral values	.83
Total	.81

d) Data analysis

Descriptive statistics were used to obtain the mean scores and standard deviations. Simple linear regression was used to determine whether the Cs21 scores have any influence on the scores of academic achievement in science. Finally, an independent samples t-test was used to compare between two groups' Cs21 skills at .05 of significance level for all tests.

FINDINGS

The findings showed that mean scores of academic achievement in science and Cs21were 83.96 (±13.96) and 132.84 (±12.78).

As observed in Table 5, the results of a simple linear regression analysis of the Cs21 scores acted as a predictor of academic achievement in science. The Cs21 scores significantly predicted academic achievement in science (r = .353, F = 54.29, p = .00 < 0.05). An increase in a total of the Cs21 scores revealed that academic achievement in science is expected to increase by .385 times.

Table 5. *The results of the Simple Linear Regression Analysis for Productiveness of the Cs21 Scores*

Variable	B	Standard Error(B)	Beta	t	P
Cs21 Score	.385	.052	.353	7.363	.000

As can be seen from Table 6, mean score of rural students' Cs21 was 128.60 (±13.47), while that for urban students was 136.24 (±13.47). Also, mean score of male students' Cs21was 128.75 (±14.66) whilst that for female students was 137.02 (±13.07). On the other hand, mean score of father jobs' Cs21 was 134.51 (±16.05) for educated ones while that for was 132.43 (±13.41) for non-educated ones. Finally, mean score of mother jobs' Cs21 was 132.30 (±14.06) for educated ones whereas that was 132.98 (±13.98) for non-educated ones.

Table 6. The *Students' Cs21 Scores of School Location, Gender, Father's Job, and Mother's Job*

		Mean score	Std. Deviation	t	df	P
School Location	Rural	128.60	13.47	-5.22	382	.000
	Urban	136.24	13.47			
Gender	Male	128.75	14.66	-6.06	382	.000
	Female	137.02	13.07			
Father's Job	Educated	134.51	16.05	1.167	382	.244
	Other	132.43	13.41			
Mother's Job	Educated	132.30	14.06	-.393	382	.695
	Other	132.98	13.98			

The independent samples t-test of the Cs21 scores showed that mean score of the Cs21 of students at urban areas was statistically higher than that for rural areas (t = -5.22, p = .000). Also, there was a statistically significant difference between female and male students' mean scores of the Cs21 (t = -6.06, p = .000). However, there was no statistical difference between mean scores of educated and non-educated fathers' jobs ones (t = 1.167, p = .244). Likewise, there was no significant difference between mean scores of educated and non-educated mothers' jobs (t = -.393, p =.695).

DISCUSSION

To predict the effect of the Cs21 scores on the eighth-grade students' academic achievement in science, a simple linear regression was carried out. .

The results demonstrated that the students' Cs21 scores were significant predictors of their academic achievements in science. These findings are in line with previous ones (Anwar, et al., 2012; Bowles-Terry, 2012; Brown, 2009; Naderi et al., 2010; Pagani et al., 2016; Prensky, 2005; Zirak & Ahmadian, 2015), reporting that academic achievement is positively related to digital literacy, critical thinking, and creative thinking. Also, Turiman et al. (2012) argued that students' mastery of the Cs21 would improve their academic performances.

This may stem from students' abilities of the Cs21. That is, they might understand scientific concepts, acquire knowledge of scientific processes, share information effectively by using various types of media, solve their real-life problems, and manage their time and make decisions. Moreover, they might learn science material individually or collaboratively by analyzing, evaluating, and collecting information from new resources (Lemke et al., 2003).

Innovate and creative students are also able to apply a wide range of knowledge and skills to effectively produce, evaluate, present, and clarify new ideas (Mishra & Kereluik, 2011). Students, who have acquired critical thinking, problem solving, communication, and ethical awareness, have the ability to discuss information and make creative decisions. They can also solve problems in achieving their desired aims effectively, communicating verbally and writing and using various forms of technology and social media. Moreover, they should be able to adapt to live in different cultures and societies and share their feelings with others by acquiring the necessary knowledge and skills (Mishra & Kereluik, 2011).

The results of this research supported the idea "integrating the Cs21 into students' science curricula will have a positive effect on developing their academic achievement in science." The students' Cs21 scores may act as predictors of their potential academic levels. So, it could inform school principals and teachers impressions about their new students' science knowledge, skills, and attitudes, which need to be taken into consideration at the beginning of any new academic year.

A significant difference between mean scores of the Cs21 of the students from rural and urban depicts that the students from villages have difficulties in using technology (Lu & Overbaugh, 2009). Moreover, education service, e.g., teachers' qualifications, buildings, instruments, educational supervision, managers etc, are also better at anywhere closer to the city center. A significant difference between the female and male students' means scores of the Cs21 means that females are better at acquiring the Cs21 than males. These results do not indicate any different academic capacities regarding gender, but give some information on the effects of societal gender stereotyping (Albadi, 2014; Nwosu & Ibe, 2014). In Jordan, females have few opportunities to spend time outdoors because of cultural restrictions, so they have more time to spend on schoolwork and use media to share information. This cultural background may explain the significant difference in the effect of the Cs21 on gender.

In addition, no significant difference between mean scores of the students' Cs21 of educated and non-educated parent jobs reveals that whatever their parent jobs are well-educated; these do not affect their children's Cs21 scores. It has been argued that students' self-directed learning skills are associated with their ages (Morris, 1995). So, since eighth-grade students are more self-reliant in their academic learning activities than younger ones, parental roles are restricted to create a good learning environment for core learning activities. Therefore, the parent jobs and their own academic experiences may not have an effect on their children's acquisitions of the Cs21.

This research made a contribution not only to research on the prediction of academic performance in science, but also to practice the applicability of this instrument. Hence, teachers will be able to get valuable feedbacks of their students' deficiencies and progresses in acquiring the Cs21. Thereby, adjustments will be made to improve their achievement levels throughout the academic year. In other words, the Cs21 survey instrument can be used as a diagnostic test.

CONCLUSION

Because this research adapted a valid and reliable Cs21 instrument into the Arabic, it can be easily used to measure the Jordanian students' Cs21 levels. Since it also examined the relationship between the Jordanian eighth-grade students' Cs21 and academic achievement in science, a significant relationship between the Cs21 and academic achievement in science was found. Namely, the Cs21 significantly predicted academic achievement in science. Also, gender and school location significantly influenced the Cs21 scores, whereas there was no significant difference for the effect of the educated and non-educated parent jobs on the Cs21 scores. Therefore, the current research suggests that the Cs21 is one of the factors contributing to higher academic achievement in science. Therefore, it is recommended that the Jordanian Ministry of Education integrate the Cs21 into its curricula, which play an important role in students' academic achievements and their progresses in all subjects, help them to keep up with this complicated century.

Finally, because this research had some limitations of characteristics and skills of the sample, future studies should be conducted with a large- sample size from different governorates and grades. However, even though the sample was selected from one governorate, no significant difference between mean scores of the students from urban and rural areas appeared. To identify further differences, further researches should focus on how family incomes impact their Cs21 scores and academic achievement levels. Further studies could also examine the effects of the Cs21 on other types of academic achievement.

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Improving Students' Metacognitive Skills through Science Learning by Integrating PQ4R and TPS Strategies at A Senior High School in Parepare, Indonesia

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ABSTRACT

Metacognitive skills can be developed through the implementation of appropriate learning strategy. This research of pretest-posttest nonequivalent control group design was designed to compare the effects of PQ4R, TPS, PQ4R-TPS, and conventional learning on the metacognitive skills of senior high school students class X in the first semester of 2013 in Parepare, Indonesia. The research samples consisted of 240 students, selected using random sampling technique. The metacognitive skills were measured by an essay test developed by the researchers, validated by experts, and empirically validated before the instrument was used, by trying out the instruments at 40 students of class XI. The research findings show that PQ4R-TPS learning strategy is significantly more potential in empowering students' metacognitive skills compared to the other learning. PQ4R-TPS learning strategy needs to be implemented, accustomed to, and continuously trained to the students in order to improve their metacognitive skills.

Keywords: metacognitive skills, PQ4R learning, sains learning, TPS learning.

INTRODUCTION

Metacognitive skill is one of the high-level thinking skills that students require to face the challenges ahead. Corebima (2009) stated that the empowerment of thinking and metacognitive skills is needed in order that the students became independent learners. Independent learners organize themselves to be more actively trying to develop themselves and to determine the learning objectives, to motivate themselves and to find purpose with the strategy that has been planned (Jahiddin, 2009). In addition, Thamraksa (2005) stated that students having good metacognition could monitor and directed their own learning process, had the ability to control the information, and implemented learning strategies to solve various problems.

Metacognition generally gives an emphasis on the awareness of one's thinking about his own thinking process (Fisher, 1998). According to Flavell (1976), metacognition refers to

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metacognitive knowledge and metacognitive experiences. Metacognitive knowledge refers to the knowledge or belief about the factors controlling one's cognitive processes. Flavell (1976) classified metacognitive knowledge into 3 variables i.e., individual variable, task variable, and strategy variable. The individual variable refers to the knowledge of oneself as a thinker, meaning that all our behavior is the results of the way we think. The task variable refers to the knowledge or all information about the nature of the tasks proposed, guiding the individual in managing tasks. The strategy variable refers to the knowledge of how to do something or to overcome the existing difficulties.

According to Garner (1987), Schraw and Dennison (1994), and Peirce (2003), metacognitive knowledge plays a role in learning and problem solving. Furthermore, metacognitive knowledge consists of 3 components, i.e., declarative knowledge, procedural knowledge, and conditional knowledge.

Declarative knowledge is the knowledge about oneself, and about the strategies, skills, and learning resources needed to learn (Garner 1987), and it is a factual information known by someone (Peirce, 2003). Declarative knowledge refers to the student's ability to accurately evaluate their saved knowledge in the form of facts, rules, or other knowledge that can efficiently be used to communicate their ideas (Stuever, 2007). To understand a learning material, students need to associate their knowledge related to "about," "what," and "that" related to something.

Procedural knowledge refers to the use of anything known in declarative knowledge and its application in learning activities. Procedural knowledge is the knowledge of how to do something and how to do the stages of a particular process. In other words, procedural knowledge refers to "how" to do something.

Conditional knowledge is the knowledge related to when to use a procedure, a skill or a strategy and when those things should not be used, why a procedure takes place and under what conditions the procedure takes place, as well as why the procedure is better than the other procedures. Conditional knowledge refers to the "why" and "when" the cognitive aspects used (Garner, 1987; Peirce, 2003; Stuever, 2007).

In addition to cognitive knowledge, metacognition also refers to metacognitive experience. Metacognitive experience is the monitoring that guides the achievement of cognitive objectives. This process helps to organize and to manage the learning which consists of planning, monitoring, and evaluating cognitive activities (Livingston, 1997). Similarly, Stuever (2007) stated that metacognitive experience helped students relating new information with their prior knowledge to determine their level of understanding, then the students effectively selected and organized strategies facilitating the task. Metacognitive experience helps to organize and monitor the learning which consists of planning and monitoring cognitive activities, and evaluating the results of these activities.

Similarly, Flavell, Hammond, et al. (2000) also stated that there were two aspects of metacognition: 1) reflection of thinking about what we knew, and 2) self-control in managing how we learned. The ability to develop metacognition can make us become reflective learners, as well as the learners who acquire specific learning strategies.

In addition to metacognitive knowledge, one of the metacognition components is metacognitive skills (Desoete, 2001). These skills are required for active learning, critical thinking, reflective assessment, problem solving, and decision making (Dawson, 2008). According to Lee and Baylor (2006), metacognitive skills consist of four keys, namely planning, monitoring, evaluation, and revising.

Planning is an activity that is carefully carried out in order to organize the whole learning process. The planning activities include determining the learning objectives, learning steps, learning strategies, and learning expectations. Monitoring is an activity that regulates and monitors learning activities and learning progress. Evaluation is the activity to evaluate self-learning process that includes assessing the progress of learning activities. Revision is the activity to revise the self-learning process that includes modifying the plan of previous objectives, strategies, and other learning approaches.

Students' metacognitive skills refer to the prediction skills, planning skills, monitoring skills, and evaluation skills (Veenman, 2006). Similarly, Hammond et al. (2000), stated that metacognitive skills had an important role in many types of cognitive activities including comprehension, communication, attention, retention, and problem solving. Thus, the metacognitive skills possessed by students can help to direct their own learning. Metacognitive skill plays an important role in determining the success of learning, so teachers need to teach metacognitive strategies to students (Djuanda, 2016). The research findings by Bahri and Corebima (2015) showed that metacognitive skills had a contribution on students' cognitive learning results.

The Role of Metacognitive skill in Learning

Empowering metacognition in the classroom encourages students to develop their metacognitive awareness, for example, starting with making their learning objectives and clear performance objectives. According to Chikmiyah (2012), metacognition was an ability that significantly increased the effect of learning, which could be considered to be empowered in learning.

The empowerment of metacognition is very important for students. AAAS (American Association for the Advancement of Science) in 2011 expressed that metacognition in biology learning in the 21st century required learning how to integrate the concepts at all levels of organization and complexity, as well as synthesized information related to conceptual domain. The empowerment of students' metacognitive skills aims at enabling the students to understand how they think about biology, like how biologists think (Tanner 2012). Metacognitive skills are required when customary responses are not successful. Guidance in recognizing and practice in applying the metacognitive strategies will help students successfully solve problems throughout their lives.

Metacognition helps students to become independent learners who can manage and plan their learning process. Livingston (1997) stated that metacognition had a very important role for successful learning. Similarly, Schraw & Dennison (1994), stated that students who skillfully made an assessment of themselves were aware of their ability, performed more strategically, and were better than those who were not skillful.

According to Hammond, et al. (2000), as an educator, it is important for us to help encourage the development of students' metacognitive skills that will help them learn how to learn. The facts show that the students are not skilled, or they fail at using metacognitive skills. If one of the school purposes is to prepare students to become lifelong learners, it is important to help them use their metacognitive skills.

According to Anderson and Krathwohl (2001), metacognition is advantageous for students to: (1) be more aware of and responsible for their own knowledge and ideas; (2) be able to think and solve problems; (3) identify the various types of metacognitive in planning, monitoring and regulating their cognition; (4) determine learning strategies that can be used to search for the meaning of texts and understand the subject matter in the classroom or from books; and (5) prepare themselves for tests. Similarly, according to Keiichi (2000), metacognition plays an important role in solving problems and makes students more skillful at problem solving through their cognitive knowledge.

Teachers can empower students' metacognitive skills in the learning process. According to Lin et al. (2005), future teachers should empower students' metacognitive skills in learning at all costs. Similarly, Corebima (2010) stated that the empowerment of students' metacognitive skills could be done during the learning process, either through the habituation of metacognitive learning strategies or through the implementation of appropriate learning strategies. Metacognitive skill training can increase the students' awareness to learn, make a learning plan, control the learning process, evaluate their effectiveness, strengths and weaknesses as a student. Djuanda (2016) stated that teachers were obliged to activate the learning engaging students to reflect on their learning activities. Students should be encouraged to plan and determine the learning objectives clearly, choose the appropriate learning strategies with their learning styles, monitor and evaluate his performance accomplished.

In this regard, some of the previous research results showed that metacognitive skills could be improved by using the appropriate learning strategies. Corebima and Idrus (2006) reported that Thinking Empowerment by Questioning (TEQ) and Think Pair Share (TPS) learning strategies could improve students' thinking skills at the junior high school level. Danial (2010) also stated that there was a correlation between metacognitive skills and the concept mastery. Sepe (2010) found that Team Assisted Individualization (TAI) cooperative learning strategy improved metacognitive skills. Chikmiah (2012) stated that learning strategy significantly improved metacognitive skill and might be considered for its' empowerment in the learning activities. In addition, the research by Suratno (2009) and Muhiddin (2012) stated that Jigsaw learning strategy had an effect on students' metacognitive skills. The research results by Paidi (2008), Bahri (2010), Corebima (2010), and Tumbel (2011) also found that learning strategies had an effect on metacognitive skills.

The learning strategies that can be used to improve students' metacognitive skills include PQ4R (preview, questions, read, reflect, recite, review) and TPS strategies. These learning strategies can be integrated by considering the appropriateness of the learning syntax.

PQ4R learning strategy is considered as one of the learning strategies that has an effect on the empowerment of students' metacognitive skills. The results of the related research, like those reported by Wahyuningsih (2012), Ramdiah and Corebima (2014), Bibi and Manzoor (2011), stated that PQ4R strategy improved students' metacognitive skills.

PQ4R Learning strategy centers on the students, so that students can build their own knowledge. The research by Maesah et al. (2012) reported that the implementation of the PQ4R learning process improved students' learning results, indicated by various indicators of achievement such as achievement test. Related to the use of PQ4R the similar findings were also reported by Wahyuningsih (2012) stating that the good and correct activity of reading makes the students able to take the main points of what they read. The more main points they can understand from the reading material read, the more knowledge they gain, and it will greatly help students to establish a comprehensive understanding. Ramdiah and Corebima (2014) also reported that PQ4R strategy integrated with concept maps appeared to have higher potential in improving students' metacognitive skills.

TPS learning strategy is also potential in improving the students' metacognitive skills. The results of the previous research related to this strategy reported that TPS learning strategy helped in empowering metacognitive skill (Stuever, 2006; Miranda, 2010), and provided an opportunity for students to train their thinking skill and finally gave meaningful knowledge that could improve students' learning results Widodo (2011). Similarly, Ngozi ibe (2009) stated that TPS strategy involved the students to think independently through the procedures taking place in it.

PQ4R strategy is easy to be applied at all levels of education, and it is able to assist students improve their questioning skills and communicate their knowledge. Similarly, the TPS strategy, one of the cooperative learning strategy, can optimize students' participation and empower students' metacognitive skills. Huda (2012) stated that TPS strategy was simple, but very useful. TPS learning strategy follows the steps of thinking, discussing in pairs, and sharing the results of the discussion to all students in the classroom. The results of the discussion are a concept constructed by students.

Based on the potential of PQ4R and TPS strategy mentioned above, the integration between PQ4R and TPS, referred to PQ4RTPS, can be implemented in learning activities. Both of these strategies are potential to improve students’ metacognitive skills as they both play a role in empowering effective problem solving skills. In addition, students gain an understanding of the learning material presented, ask questions, read, connect information, create a new understanding by themselves, carry out evaluation, and make conclusions.

The empowerment of metacognitive skills in senior high schools in Parepare has not been generally carried out yet. It can be seen from the results of the survey conducted by researchers showing that the empowerment of students’ metacognitive skills is still lacking, even the teacher's knowledge related to the empowerment of thinking skills in biology learning is still limited. Djuanda (2016) reported similar findings that there were a lot of teachers who did not understand the metacognitive strategies, so that they had not taught and conducted any activities promoting the activation of students’ metacognitive strategies consciously and deliberately.

Based on the elaboration above, this research aims at determining the potential of PQ4RTPS strategy in empowering students' metacognitive skills. This information is very valuable for teachers to select appropriate learning strategies that focus not only on the cognitive learning but also on the empowerment of students' thinking skills..

METHODS

This is a quasi-experimental study designed to compare the effect of metacognitive skill of students in the first semester of Class X of senior high school in Parepare, Indonesia in 2013. The research design was pretest-posttest control group design (Fraenkel & Wallen, 2009). Four classes used in this research were treated with different learning, namely the PQ4R, TPS, PQ4RTPS, and the conventional learning. The class samples were selected by random sampling. The samples of this research consisted of 240 students of class X Senior High School in Parepare, Indonesia, having homogeneous academic ability based on the grouping test. The students’ metacognitive skills were measured by *essay* tests developed by researchers and validated by experts and empirically validated before the tests were used. The empirical validation was done by trying out the instruments at 40 students of class XI. The try out was carried out to determine the validity and reliability of the instruments. The rubric of metacognitive skills used referred to Metacognitive Achievement Description rubric consisting of 7 scales (0-7) (Corebima, 2009). The four classes were taught by using different learning strategies for one semester, and then they were given a final test. Furthermore, the data were analyzed by Ancova with a significance level of 5%, supported by the program of SPSS 20 for Windows. If the results of ancova were significant, it would be analyzed further with the post hoc LSD test. The treatment procedures based on the research design is shown in Table 1.

Table 1. *Design of quasi-experimental Research*

Pretest	**Group**	**Posttest**
T_1	X_1	T_2
T_3	X_2	T_4
T_5	X_3	T_6
T_7	X_4	T_8

T_1, T_3, T_5, and T_7: Pretest
T_2, T_4, T_6, and T_8: Posttest
X_1: PQ4R strategy, X_2: TPS strategy , X_3: PQ4R-TPS strategy, X_4: Conventional learning

FINDINGS

The results of Ancova test related to students’ metacognitive skills are shown in Table 2, and the results of post hoc test are shown in Table 3.

Table 2. *The Results of Ancova Test on the Students’ metacognitive Skills*

Source	Type III Sum of Squares	df	Mean Squares	F	Sig.
corrected Model	50642.678 [a]	4	12660.669	1.188E3	0.000
intercept	373.681	1	373.681	35.059	0.000
XMetacog	16087.206	1	16087.206	1.509E3	0.000
Strategy	851 925	3	283.975	26.643	0.000
Error	1609.454	151	10.659		
Total	601237.377	156			
corrected Total	52252.132	155			

Table 3. *The Results of post hoc Test of the Effect of Learning on Students’ metacognitive Skills*

Learning	Posttest Mean Scores	Posttest Mean Scores	Gain	Corrected Mean Score	LSD Notation
PQ4RTPS	62.356	75.914	13.558	66.293[a]	a
PQ4R	52.129	63.785	11.657	61.760[a]	b
TPS	51.904	63.167	11.263	61.308[a]	b
CONV	32	35.476	3.476	48.400[a]	c

The results of Ancova related to the students’ metacognitive skills show that learning strategies have an effect on students' metacognitive skills ($p < 0.05$). The results of LSD test show that the corrected mean score of the metacognitive skills of the students taught by using the integration of PQ4R-TPS is significantly higher than those taught by using PQ4R, TPS, and conventional learning; the corrected mean score of the PQ4R is not significantly different from the that of TPS learning.

DISCUSSION and CONCLUSION

The findings of this research reveal that the integration of PQ4R-TPS had the potential to improve students’ metacognitive skills than if it is separately implemented. The implementation of the integration of PQ4R-TPS learning strategy can improve students' metacognitive skills because of, for instance, the combination of learning syntax of PQ4R-TPS. The syntax of PQ4R learning consists of six steps, namely Preview, Question, Read, Reflect, Recite, Review which gradually guide each student to use their metacognitive skills. According to Logsdon (2007) and Rodli (2015), each step of PQ4R learning strategy encourages students to use their metacognitive skills. Similarly, the TPS learning, as a type of cooperative learning, can empower students' metacognitive skills. TPS learning consisting of the stages of thinking, paired discussion, and sharing to all students is the factor which increases the potential of PQ4R strategy so as to minimize time, to coordinate through groups, and to activate all students in the classroom.

Furthermore, the implementation of the integration of PQ4R-TPS learning contributes to the improvement of metacognitive skills, which can be seen from the learning syntax. Stage “P” (preview), as the beginning of this activity, is the stage where the students read learning material quickly by identifying titles, subtitles, or parts that are considered important. Through the preview, the students already have an idea of the things they are learning (Bibi and Manzoor, 2011). At this stage, the students already use their metacognitive skills through planning and prediction skills.

In relation to "Q" (question) stage students formulate questions developed from a simple question to the complex question. The questions include what, who, where, when, why, and how questions. The questions were developed toward the formation of declarative, structural, and procedural knowledge (Bibi and Manzoor, 2011). Moreover, formulating the questions was also done by using the previously owned knowledge (Logsdon, 2007) encouraging students to think at a higher level (Rogers, 2006).

The reading activity on the "R" (read) stage is the act of reading in more detail and comprehensive ways with the purpose of finding the answers to the questions that have been formulated (Logsdon, 2007). At this stage, the students record the important parts that become their prediction of answers to the questions formulated. This reading is the process of thinking (Khattack & Khan, 2002) because in reading we do not only read the text, but also try to understand what we read (Leipzig, 2001).

While reading, students should make a reflection or "R" (reflect). This activity encourages the development of students' horizons because the students try to understand what they are reading by connecting the reading materials with their prior knowledge, connecting sub topics with concepts, and connecting the reading materials with the existing information (Logsdon, 2007).

The next activity is "R" recite or question and answer themselves. This stage involves the students' thinking skills to recap the information that has been understood. They then formulate concepts, explain the relationship between these concepts, and write back with their own editorial (Huber, 2004).

The final stage of PQ4R strategy is a review. Logsdon (2007) stated that at this stage students wrote a summary of the information they understood. This activity encourages students to think by reviewing the learning material.

The integration of PQ4R-TPS learning strategies is believed to be more potential in empowering students' metacognitive skills, because the TPS learning continues the series of thinking activities that have been repeatedly done in the previous PQ4R strategy. The procedures of TPS learning provides the opportunity for the students to think, discuss, and share with other students (Miranda, 2010). According to Kennedy (2007), TPS strategy encourages all students to be active in the classroom through writing, thinking, listening, and speaking skills. Thus, the TPS learning strategy is very helpful in empowering the students' metacognitive skills. Stuever (2006), assumed that the students would get a lot more opportunities in the empowerment of metacognitive skills during the implementation of TPS learning strategy. The students explore their thoughts, write about what they think, and compare their ideas with the other students' ideas. When the students share their conclusions to the class, they will defend their findings and may also review their ideas.

Group activities and collaborative work are parts of the steps in TPS learning strategy. These activities have great potential to empower students' metacognitive skills. The students discuss and answer the questions together in groups, which allows students to learn and help one another address their weaknesses. Similarly, the sharing activities, both in groups and in the classroom, can improve students' metacognitive skills. Each student listens to the other students' opinions and answers, and they will have a discussion in order to find out the answers of questions, and can ultimately make a summary of their study result. According to Ofudu (2012), one of the reasons that TPS strategy can improve the learning results is that all group members have the opportunity to interact in pairs and help each other understand the reading material.

The integration of PQ4R-TPS strategy is a strategy that both trains group learning (cooperative) and reduces the individuality of the students. Students can learn more fun and can obtain good learning results. The process of thinking and cooperation activities that occur in the implementation of the integration of PQ4R-TPS strategy can improve students' metacognitive skills.

According to Hammond, et al. (2000), the ability to develop metacognition can make us become reflective learners, as well as the learners who acquire specific learning strategies. Similarly, Dawson (2008) stated that these skills are required for active learning, critical thinking, reflective assessment, problem solving, and decision making. Metacognition makes students become independent learners who can manage and plan their learning process. Livingston (1997) stated that metacognition had a very important role for successful learning.

Based on the discussion above, the integration of PQ4R-TPS learning strategy has an effect on students 'metacognitive skills. The integration of PQ4R-TPS learning strategy holds significantly more potential to improve students' metacognitive skills than the other learning strategies.

Suggestions

The integration of PQ4R-TPS learning strategy has the potential to increase the students’ metacognitive skills. The empowerment of the integration of PQ4R-TPS learning strategy needs to be implemented, habituated, and continued to be trained to students in order to improve their metacognitive skills. Therefore, it is recommended that teachers implement this learning strategy to assist students in becoming independent learners.

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