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Creative Visual Aids Effectively Supporting the Student-Centred Learning (SCL) Approach on Science Learning

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ABSTRACT

This research aimed to find out whether creative visual aids (CVAs) are able to support the effectiveness of using a student-centred learning (SCL) approach for teaching and learning science. This research was performed between 20th July and 7th August 2016 at Araullo High School, Manila, Philippines. The participants were three pre-service student teachers from Philippine Normal University; 168 students from four sections of 7th-grade science at Araullo High School, taught using CVAs; and 88 students from two sections of 7th-grade science at Araullo High School, taught using common visual aids (VAs). Four CVA sections and two VA sections were selected randomly from 31 parallel sections of 7th-grade science. Data consists of qualitative and quantitative data. Scores for the quantitative data for the 1st quarter pre-test and post-test were analysed using a descriptive statistical method. The qualitative data (observation, documentation, field notes and interviews) were verified using triangulation methods. Video recording was also used to make documents. Results of this research showed that CVAs effectively supports SCL for science.

Keywords: Creative visual aids, SCL, pre-service student teacher

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INTRODUCTION

Abraham Maslow describes the hierarchy of human needs as a pyramid shape. There are five aspects to Maslow's hierarchy; (1) physiological, (2) safety, (3) love/ belonging, (4) self-esteem and (5) self-actualization. Physiological needs, as the most basic needs, are at the bottom and

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self-actualisation is at the top. The need for self-esteem corresponds to achievements in education and learning (Jerome, 2013). Education is a component of human needs. Education is fundamental, as education is one of the systems that supports life. Based on that statement, the quality of education must be developed.

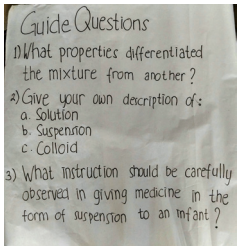
There are many ways that the quality of education could be developed; one of them is the application of different approaches. A system of instruction that places the student at its heart is the student-centred learning (SCL) approach. The approach facilitates students to participating actively and enquiring independently. Students' abilities can be developed through many activities in SCL such as substituting active learning experiences in learning through lectures; giving assignments to solve open-ended problems, and problems requiring critical or creative thinking; and encouraging students to learn from one another and coaching them in the skills they need to do so effectively. They can be involved in simulations and role plays, and use self-paced and or cooperative (team-based) learning. In other words, they are placed at the centre of the learning process and provided with opportunities to learn independently. Positive attitudes towards the subject being taught can lead, through properly implemented SCL, to increases in motivation to learn, greater retention of knowledge, deeper understanding and more (Collins III & O'Brian, 2011).

Therefore, Posamentier and Krulik (2009) stated that in order for students to have the skills needed for their future lives, learning must be directed to activities that encourage them to learn actively, in terms of the social, physical and psychological aspects. The main and most well-established assignment of a lecturer is guiding students to study in a meaningful way and to learn to solve problems appropriately. In the Philippines, especially in the 21st century where there are more demands such as skill development and many others, SCL is believed to be more effective. To achieve the purpose of SCL in teaching science, which has many abstract concepts, it is necessary for the teacher to use visual aids (VAs) to help students understand the concepts more easily.

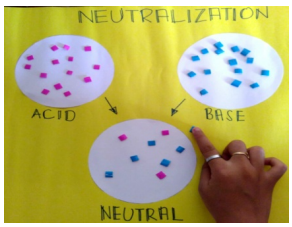
VAs are instructional devices such as charts, maps, models, film strips, projectors, radios and televisions, which are used in the classroom to encourage learning and make it easier and more motivating (Shabiralyani, Hasan, Hamad, & Iqbal, 2015). VAs such as charts, diagrams, tables and pictures play a big role in students' understanding and imagination while learning. VAs will help students to understand the material more easily when learning science, which has mostly abstract concepts. Darma's (2011) research result proves that VAs can increase the effectiveness of the teaching-and-learning process because students will be more attracted to the process by the presence of VAs.

In SCL, it is necessary to modify a VA in order to increase its function as an instructional device. Therefore, the modified VA will be able to induce positive

emotions in the students, give them a joyful learning experience and facilitate them to participating actively. The research results on colour and shapes show that saturated and warm colours can cause an increase in pleasure and excitement; meanwhile, featuring shapes that are round and baby-like can induce positive emotions (Plass, Heidig, Hayward, Homer, & Um, 2014). Based on this, the VAs that are used commonly in teaching chemistry subjects [Figure I (A)] have been modified by the authors in terms of the colours, shapes and designs. The modified VAs here are called *creative visual aids* and abbreviated as CVAs. CVAs refers to creative products (Kanematsu & Barry, 2016) that are VAs which have never existed and been used before. A CVA should comply with requirements such as (1) the background colour should be different from the content colour, which can consist of either dark and light, or light and dark colours, respectively; (2) the CVAs should have full-coloured figures, not be monochrome; and (3) the CVAs should have foldable parts that the teacher can use to increase the students' curiosity and participation. Figures 1 (B1), (B2) and (B3) are examples of the CVAs made and used in this research. In this research, we would determine whether CVAs can more effectively support SCL in science than VAs. We will also reveal the perspective of pre-service student teachers on using CVAs in the process of teaching and learning science, planning and preparations made before implementing the students' learning process, media that have been prepared, process for the students' to learn science and assessment that will be done.



(A)



(B1)

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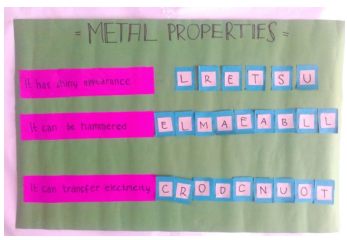

(B3)

Figure 1. (A) An example of a common visual aid (VA); (B1) Creative visual aid (CVA) for describing the neutralization that occurs between an acid and a base; (B2) CVA for describing the differences in characteristics between a solution, colloid and suspension; and (B3) CVA for describing a metal's properties

MATERIALS AND METHOD

This research used a mixed-method approach (Figure 2) and was performed between 20th July and 7th August 2016 at Araullo High School, Manila, Philippines. The qualitative and quantitative data were collected simultaneously.

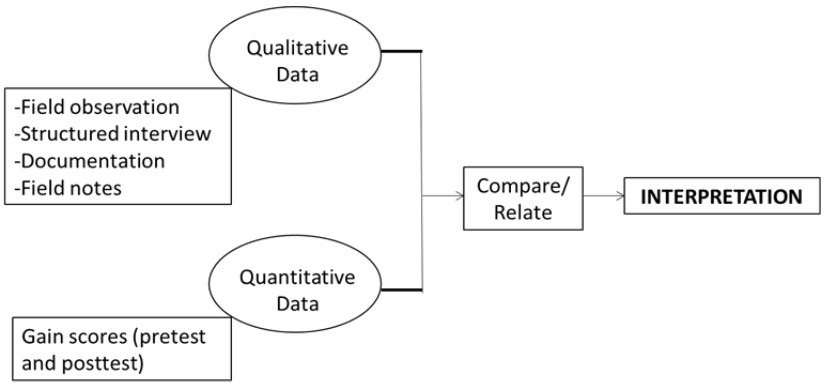

Figure 2. Mixed-method approach diagram

The participants are three pre-service student teachers and, from Araullo High School, 168 7th-grade science students in the CVAs sections (which consist of 51 students from Garcia Section, 42 students from Pythagoras Section, 37 students from Einstein Section and 38 students from Gates Section), and 88 students in the VAs sections (which consist of 45 students from Guerrero Section and 43 from Humabon Section) (Table 1). The four CVA and two VA sections were selected randomly from the 31 parallel sections of 7th-grade science at Araullo High School (Figure 3).

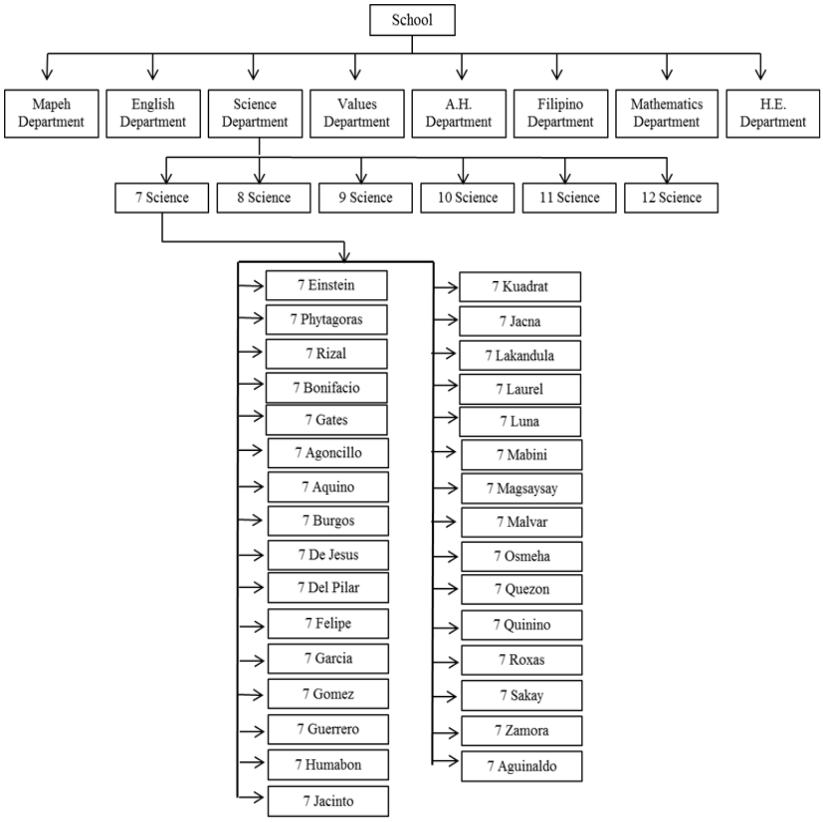

Figure 3. Araullo High School's classroom distribution. The 7th grade science students were divided into of 31 parallel sections

Pre-test and post-test data were taken from the teaching-and-learning process for the Chemistry class. The contents of the test instruments were validated by two teachers at Araullo High School. The interview and observation protocols were examined by two experts on the teaching-and-learning process. A total of 25 meetings were observed and documented using a video recorder. The observation was carried out for the teaching-and-learning process in both CVAs and VAs classes from the preparation, during the process and until the assessment. Structured interviews, each of which consists of five questions, were conducted as face-to-face interviews with the student teachers to collect their perspectives on the teaching-and-learning process for science, strategies and problem solving methods. Field notes were taken on the teachers' strategies, preparation and problem solving for the teaching-and-learning process based on student behaviour. Multiple-choice tests, both pretest and posttest, were used to show the effectiveness of the CVAs in supporting the SCL approach for science.

This research used descriptive statistics to analyse the pre-test and post-test data. The pre-test and post-test scores for the 1st quarter (quantitative data) were compared to prove the approach's effectiveness. The qualitative data (observation, documentation, field notes and interviews) were verified to increase their validity by incorporating several viewpoints and methods, as described by Blaikie (1999); Yeasmin and Rahman (2012).

RESULT AND DISCUSSION

Pre-Service Student Teacher Perspectives on the Teaching-and-Learning Process for Science

Based on the observations and interviews with the three pre-service student teachers, some statements commonly appear.

a. Teaching science has to use a technique that is not only interesting but can also maintain students' attention.

b. To make students love and learn science is to make them do science.

c. The learning process must always involve the students. They have to be the star of the discussion. It is important that they find out what has to be discovered at their own pace, and the teacher should not spoon-feed the answers to them.

d. Most concepts in science are abstract, especially in Physics, Chemistry and Biology. In this regard, creativity in making and choosing the right VAs would help students and teachers in understanding abstract and microscopic science concepts.

e. If it is hard to teach science without proper representation, then it would also be hard to learn science without it.

Based on the above statements, teaching science needs CVAs, which is what was meant by 'proper representation' before. This reinforces the research conducted by Shabiralyani et al. (2015), but Shabiralyani research uses VAs, while CVAs were used in this research. All of the three pre-service student teachers agreed that the use of CVAs in the teaching-and-learning process would increase the motivation of both teachers and students, decrease teachers and students time in preparing lessons, avoid dullness, and increase the direct experience of observing the things.

The Planning and Preparation of the Pre-Service Student Teachers

Planning is one of the hardest parts of teaching science. Most science concepts are abstract. It is a teacher's responsibility to make the students visualise the concepts that are taught. The teacher must come up with learning activities that are relevant to the concept taught by the teacher. In the planning and preparation part, the pre-service student teachers always prepare (a) a lesson plan, (b) VAs, (c) an assessment and (d) an assignment.

Milkova (2012) stated that a lesson plan is the instructor's road map of what the students need to learn and how to do it effectively during the class time. It is necessary to identify the learning objectives that the class needs to meet before starting

the lesson, then design appropriate activities for learning and develop strategies to obtain feedback on student learning. Three key components that are addressed and integrated into a successful lesson plan are: (a) student learning objectives, (b) activities for teaching/learning and (c) strategies to check on student understanding. From the interview results, all of the student teachers agree that the planning and preparation for the teaching-and-learning process are important, since planning and preparation play a key role for teachers to conduct a great teaching-and-learning process.

The preparation performed by the student teachers corresponds to the application of the cybernetic principles (Table 2), which is the step described by Sani (2015). The student teachers believe that planning and preparation for science learning should be creative, since every student has a different learning capacity. The student teachers find planning to be one of the hardest parts of teaching science. Most science concepts are abstract; therefore, as teachers, they feel responsible for making it easier for the students to understand the concepts by visualizing them with creative media. The teachers must come up with learning activities that are relevant to the concept they want to teach.

Table 2
The correlation between the application of the cybernetic principles and student teachers' planning and preparation

Student Teachers' Planning and Preparation	The Steps of the Cybernetic Principles (Sani, 2015)
Preparing the aspect of the lesson plan that consists of defining learning objectives	Determining the learning objectives
Preparing the aspect of the lesson plan that consists of references and media	Determining the topics
Preparing the aspect of the lesson plan that consists of key ideas and their materials	Reviewing the information inside the topics
Preparing the aspect of the lesson plan that consists of the method and approaches	Determining the proper approaches
Preparing the aspect of the lesson plan that consists of defining the learners' activities	Composing the topics systematically
Completing the teaching-and-learning process by using creative visual aids and involving the students in every step	Presenting the topics and guiding the students systematically

The Science Teaching-and-Learning Process. The strategies used for teaching and learning science are discovery- and SCL-based approaches. In a discovery-based approach, experiments are mostly carried out, and the teacher acts as a facilitator. The students perform the experiment or activity given, and are provided with guide questions to be answered. These guide questions are supplied by using CVAs, and the questions can only be answered when the experiment has been carried out. Through

the guide questions, the students are able to discover the concepts behind the activity or experiment they were asked to perform. The concepts are provided by using CVAs as the key ideas. In this SCL approach, the teacher keeps asking questions to the students to provoke their thinking skills during the teaching-and-learning process. The teacher needs to learn the art of questioning; the method of questioning is combined with the use of CVAs. This way, the students are also able to find answers at their own pace. Students are treated as individuals in an SCL environment, with ideas and issues that deserve attention and consideration, and are also treated as co-creators in the learning process Froyd & Simpson, 2000; McCombs & Whisler, 1997). The observation sheet and results are shown in Table 3.

Table 3
Observation sheet and results

Observation Items	Data Collected
Do the students actively co-operate in the teaching-and-learning process?	a. Einstein: They are so active and show their interest in the CVAs used by the student teacher. They always raise their hand to try to answer questions. Almost all of them do that. b. Pythagoras: They are as active as Einstein students, who like to raise their hand when the teacher asks them questions to try to answer questions first. c. Gates: The students in Gates have a big interest in the teaching-and-learning process. They usually answer questions raised by the teacher; they even ask the teacher a question sometimes. d. Garcia: The students usually try to answer enthusiastically the questions asked by the teacher. They try to be the first person who answers it. e. Guerrero: The students are active, but compared with the experimental classes Guerrero is quieter. f. Humabon: The students have the same characteristics as Guerrero; they do not instantly raise their hand as easily as the experimental classes do.
What is the atmosphere of the class like?	Overall, the experimental classes have more interactive lessons and students show that they are interested in the process of teaching and learning in class. It feels like they are really 'in' and enjoy this process because it feels like they are playing a game. The control classes have an active classroom condition, but several students do not pay attention to the lesson. They are busy with themselves.
How do the students show their interest in the CVA used by the student teacher?	Almost all of the students in the experimental classes want to be involved with the teaching-and-learning process at that time; they try answering the questions asked by teacher, asking a question to the teacher and figuring out the problem given by teacher. It is almost the same with the control classes, but, emotionally, they do not completely pay attention as well as the experimental classes do.
What is the students' capability to understand the lesson?	Students in the experimental classes are generally more active than the students in the control classes. By comparing the result at the end of the lesson, in the question-and-answer session, the students in the experimental class usually answer the questions correctly and are more active in asking a question. But the students in the control classes are more reluctant to answer and ask fewer questions.

In using the VAs, students exhibit different levels of enthusiasm. They were more excited about using the CVAs than the common VAs. The common VAs used previously only visually represent the subject matter in the form of paper charts, as illustrated in Figure I (A). In this case, for a VA, students are not involved in its use and do not facilitate the concept's construction because the VA it is ready-made. The three student teachers as observers were all in agreement that using a CVA is more enjoyable than using a VA. In classes with CVAs the students participate actively and enquire independently. CVAs equipped with colours and shapes can induce positive emotions. Moreno's (2006) cognitive affective theory of learning with media (CATLM) is relevant to this, based on the fact that the theory of the cognitive engagement of learners is affected by motivational factors that mediate learning. Meaningful learning will occur when the student makes a conscious effort in cognitive processes such as selecting, organising and integrating the new information with their existing knowledge. Those things are also facilitated in learning using CVAs. Therefore, in this research, it is possible that the gain scores (the score difference between pretest and posttest) obtained from the learning using CVAs are higher than those from using VAs (Table 1) .

Table 1
Result for gain scores for the 1st quarter at ST 2

Section	Total Student	Pre-test Score	Post-test Score	Gain Score	
Einstein	37	48.486	62.000	13.514	CVA Sections
Pythagoras	42	40.047	53.857	13.810	
Gates	38	42.000	55.921	13.921	
Garcia	51	20.019	36.000	15.981	
Total students	168	Average of gain scores		14,306	
Guerrero	45	30.000	34.822	4.822	VA Sections
Humabon	43	29.465	30.628	1.163	
Total students	88	Average of gain scores		2,992	

The gain scores obtained from the assessment for the 1st quarter, handling CVAs and VAs are shown in Table 2. The average of the gain scores obtained in the CVA sections is 14.306 and in the VA section is 2.991. This research result shows that CVAs are more effective for supporting SCL for science than VAs.

Assessment of the Teaching-and-Learning Process that Indicates the SCL Syntax and Characteristics. The assessment was conducted as a pen-and-paper test with multiple choice questions. However, teachers will sometimes administer a practical exam to increase students' activity. This practical exam can stimulate students to give feedback and to improve their learning ability. This type of assessment is referred to as a formative assessment. Using a formative assessment, the development of capacities and attitudes used in lifelong learning can be promoted (Nicol & Macfarlane-Dick, 2006). Therefore, students' involvement that shows SCL syntax is a key to effective instruction.

The term '*syntax*' is from the Ancient Greek '*syntaxis*', a verbal noun that means "arrangement" or "setting out together" (Van Valin & Lapolla, 1997). Student-centred-learning syntax is a syntax that shows the arrangement of the teaching-and-learning process flows. Firstly, the teacher will introduce only the main topic of today's lesson. Then, for the rest of the lesson, the teacher can only be the facilitator for the process. All of the learning-system components are given in a way that is more centred on the student. For example, the environment should support the students' movement, critical thinking, emotions and creativity. 'Environment' here refers to the learning method, learning mode, media, assignment and also the assessment. Both the assignment and the assessment should clearly ask for student participation, which can be the tool for the teacher to determine the students' level of attention, cognitive ability, affective ability and skills, during the entire teaching-and-learning process, up to and including the evaluation process. The assessment and assignment can be of a paper-and-pen test design, or a skill-based assessment and assignment.

The validity of the data is proven using the triangulation method shown in Figure IV, which confirms that the quantitative data (gained scores) have a positive result; this can tell us that the use of CVAs has increased the students' understanding of science. The qualitative data (observation, documentation, field notes and interviewed) raise the same point that using VAs can increase students' curiosity, level of attention and imagination for many of the concepts taught by the teacher so that they can understand the subject more easily.

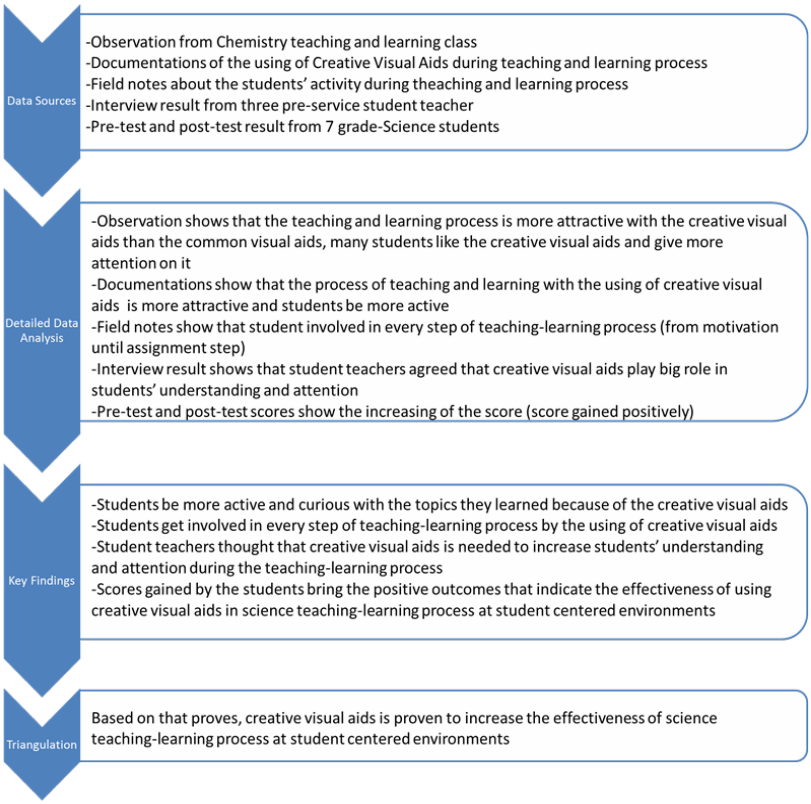

Figure 4. The results of the triangulation method on the use of creative visual aids (CVAs) at Araullo High School

CONCLUSION

Based on the data analysis using a descriptive statistics method and the triangulation method, creative visual aids (CVAs) are able to effectively support the student-centred-learning (SCL) approach in teaching and learning science. Especially in the teaching of chemistry-related subjects at Araullo High School, Manila, Philippines in 2016, the gain scores, field observations and student teachers' interview results have revealed that CVAs are more effective in supporting the SCL approach for teaching and learning science than common visual aids (VAs).

The results of the study by Shabiralyani et al. (2015) demonstrated that the VAs could stimulate students' cognition and thinking ability. In this research, the use of CVAs has strengthened control and encouraged body movement. The teaching-and-learning process can be made more effective by using CVAs. In this case, the students and teachers have done something that has caused them to gain knowledge through using their intellects.

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