An Analysis of Convergent and Divergent Teaching on High School Students' Understanding of Selected Lighting Principles

by

Justin Waine

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Dr. Kenneth Welty

The Graduate School

University of Wisconsin-Stout

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The Graduate School
University of Wisconsin-Stout
Menomonie, WI

Author: **Waine, Justin T.**

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Abstract

This study was designed to study students' understanding of selected lighting principles when completing a convergent laboratory activity or a divergent laboratory activity. The participants included were 60 high school students taking technology education courses at Ellington High School in Connecticut during the spring of 2010.

Under the auspices of action research, the study was a quasi-experiment with a pretest-posttest nonequivalent multiple-group design. The participants first took a pretest which included important concepts about lighting. Next, they were divided into two groups where one group was given a convergent laboratory activity that was very structured and teacher-directed. The other group was given a divergent laboratory activity that was open-ended and student-centered. After the laboratory activities were completed, each group took a posttest to demonstrate what they had learned.

The results of the pretest, posttest, and laboratory activities were analyzed using descriptive statistics. Simple frequencies and percentages were used. The study found that students who completed the convergent laboratory activity performed better on assessment items that address basic concepts such as shadows, hard light, and soft light. However, the participants that completed the divergent laboratory activity scored higher and performed better on the laboratory tasks and assessment items that targeted advanced concepts related to portrait lighting.

The Graduate School
University of Wisconsin Stout
Menomonie, WI

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Chapter I: Introduction

The goal of technology education is to help students obtain technological literacy. International Technology Education Association (ITEA) defined technological literacy as "the ability to use, manage, assess and understand technology" (ITEA, 2007, p. 7). There are many strategies that technology education teachers use to help their students obtain technological literacy. Two of those ways are through convergent and divergent teaching. Convergent teaching tends to focus on the teacher transmitting the information that they know to the students (Bar-Yam, Rhoades, Sweeney, Kaput & Bar-Yam, 2002). Those students are typically assessed by a formal written test where the only right answer is the one that the teacher gave them. In contrast, divergent teaching focuses on the student and is very student-centered (Bar-Yam, et al., 2002). The student uses many resources to find a solution to the problem. The students are actively involved in their own learning and assessment occurs using a variety of evaluation tools including student and teacher observations (Bar-Yam, et al., 2002). It is important to see which teaching strategy generates the most learning and retention with the students relative to the content being taught.

Learning effective lighting techniques for a photograph can be a difficult subject for students enrolled in a communication technology class to learn. In a convergent approach, a teacher may describe the basic elements of lighting such as key light, fill light, and back light with a step-by-step approach on a worksheet. The presentation may show the students exactly where to position the lights to properly light a person for a photograph. When a divergent approach is taken, the students may experiment with many different ideas until they find the best way that the key light, fill light and back light need to be positioned to take a properly lit

photograph. When the students are assessed on these selected lighting principles, it is interesting to see which strategy allows the students to construct and retain the most possible information.

Statement of the Problem

Technology education in public schools today is aimed at teaching students how to be more technological literate and to introduce them to possible careers after high school. Being a technological literate person is essential in today's world. The study of communication technologies, including photography lighting principles, is part of Ellington High School's effort to address the technological literacy needs of its students. However, little is known about how high school students' best learn about certain concepts such as lighting -- whether it is through convergent or divergent instructional strategies. Therefore, the purpose of this study is to look at how convergent and divergent instruction affect student learning regarding selected principles of lighting. More specifically, the study addresses the following questions:

1. What effect does the completion of a convergent lab activity have on students understanding of selected lighting principles?

2. What effect does the completion of a divergent lab activity have on students understanding of selected lighting principles?

3. What are the differences of students understanding of selected lighting principles with the students who completed the convergent lab activity versus the students who completed the divergent lab activity?

Purpose of the Study

This study is designed to examine the effects that convergent and divergent instruction have on high school students' understanding of selected lighting principles during the spring of 2010.

Definition of Terms

For the purpose of this study, the following terms were used as defined:

Back light. Usually placed behind the subject and used to illuminate the person's hair. It also separates the subject from the background to provide a three-dimensional look. This light could be positioned at either 11:00 or 1:00.

Convergent instruction. Traditional methods of teaching where the teacher transmits the necessary information to the students.

Convergent thinking. A way of thinking where the learner draws on their prior knowledge to answer the set of questions.

Convergent lab activity. A hands-on learning activity where students were given instruction on how to properly light a person in a photograph and set up the lights in a step-by-step process. The students were presented with multiple choice questions to answer as they proceeded through this activity.

Diffused light. Light that bounces or reflects or passes through a surface such as an umbrella, which spreads the light out and creates a soft shadow.

Discovery learning. A learning theory where the learner draws on their past experience and existing knowledge to discover new facts and relationships to be learned. Students are able to interact with the world to explore and manipulate objects and perform experiments. In this study, students manipulated and arranged the supplied lighting equipment in order to properly light a person for a photograph.

Divergent instruction. A method of instruction where the students are asked to produce as many solutions to the problem as they possibly can. This method is very student-centered.

Divergent thinking. A way of thinking where the learner looks at a problem and produces as many possible solutions to the problem as they can.

Divergent lab activity. A hands-on learning activity where students were given a set of lights and asked to come up with the solutions for properly lighting a person for a photograph. The students were asked open-ended questions along the way based on their experience.

Fill light. A secondary light positioned on the opposite side of the key light and is used to light the rest of the person's face. It also reduces the shadows caused by the key light. This light could be positioned at either 5:00 or 7:00.

Gels. Lens or paper that can be placed on a light to either dim or diffuse the light or change the color of the light if it is a colored gel.

Hard light. A small, focused beam of light that shines on a specific area. This type of light creates a hard shadow that is very crisp, well defined and easy to make out the details of the object or subject.

Key light. The main light used to light a person's face. The purpose of a key light is to highlight the form and dimension of a subject. This light could be positioned at either 5:00 or 7:00.

Light reflectors. A light reflector is used on a light to reflect the light onto an object or a person. In this study, an umbrella was used as a light reflector.

Properly lit person. A properly lit person has the following three types of light on them: key, fill and back. When a person is properly lit, their face and hair will be evenly illuminated with no shadows or dark spots on their face.

Selected lighting principles. Includes shadows, light reflectors, hard and soft light, key, fill and back light, gels and a properly lit person.

Soft light. A larger light that shines over a wide area. The shadow created from a soft light source that is very blurry and hard to make out the details of the object or subject. Depending on the light itself, the shadow might also be almost non-existent.

Types of light. The two types of light that were examined in this study are hard and soft light.

Limitations of the Study

This study only included students who were enrolled at Ellington High School in Ellington, Connecticut, and therefore, the results may not relate to other populations.

Assumptions of the Study

The researcher assumed the convergent and divergent learning activities used in this study represented two discrete approaches that were consistent with the basic tenets of each approach. It was also assumed that the assessment tools were valid.

Chapter II: Literature Review

The purpose of this study is to look at how convergent and divergent instruction affects students' understanding of selected lighting principles. The following review of literature provided a theoretical foundation for this study. It includes divergent learning, discovery learning, inquiry based instruction, convergent learning, instructional theory into practice, and lighting.

Divergent Learning

Questions that call for an opinion, a hypothesis or an evaluation are classified as divergent questions (Moore, 2009). These types of questions should be used frequently in the classroom because they encourage and promote students individual thinking. In fact, this type of learning and thinking has been associated directly with creative thinking (White, 1990) because of the amount of thinking required to solve a problem in divergent ways. The students are encouraged to think outside the box and explore various different solutions. This type of approach encourages students to be more actively engaged in the learning process since it requires a broader response than just a simple one word or brief answer (Moore, 2009).

Divergent learning is classified as being student-centered and flexible, where the students are completely involved in their own learning (Tomar & Sharma, 2005). The students decide how to complete the assignments given by the teacher and what approach to take with them. Divergent thinking involves taking a topic and breaking it down into its individual parts (Zent, 2001). A divergent project may include a portfolio, a commercial to advertise a product, or other special projects that promote more than one answer to the problem that is given (Tomar & Sharma, 2005).

Kwon, Park, and Park (2006) looked at how divergent teaching can be applied to mathematics. Traditionally, especially in mathematics, students are taught that there is only one correct solution to a problem. Kwon et al. (2006) looked at the three components of divergent thinking, which includes flexibility, fluency, and originality. It was discovered that through the use of open-ended problems in mathematics, coupled with open-ended questions, can greatly increase divergent thinking skills. These types of questions were found to be particularly good for differentiated classrooms because they can be designed to encourage all students to use and demonstrate mathematical creativity (Kwon et al., 2006).

Discovery Learning

Divergent instruction is often equated with discovery learning. There are many definitions of discovery learning, two of which are applied to this study. One common definition of discovery learning is when the learner is presented with the tools and information to solve a problem and then the learner is to make sense of them (Bardin, n.d.). Discovery learning uses inductive reasoning by starting with specific information and asks the learner to generalize what they have just learned and apply it to other situations (Merrill Education, n.d.). It is the job of the instructor to present the learners with many examples until they discover the interrelationships between them.

According to Bardin (n.d.), another definitions that is commonly used for discovery learning is the learner uncovers something based on an activity that has been designed by the instructor to facilitate the discovery. In order to use discovery learning using this method, the teacher presents examples of what does not fit and examples that do fit the concept in question (Merrill Education, n.d.). Discovery learning encourages the learner to relying on his or her past

experiences and prior knowledge to help him or her discover the new knowledge, skills, and truths to be learned (Bardin, n.d.).

There are many advantages to discovery learning in the classroom. Bruner (1967) says it motivates students by actively involving them in the learning process. Instead of learners just reading about a specific topic, they are actually taking the materials and tools provided by the teacher and creating their own example to illustrate the concepts. They conduct experiments to test the information and then draw conclusions based on how those experiments performed. According to Bruner (1967), it also helps students develop and enhance their problem solving and critical thinking skills. Discovery learning also creates an individual learning experience for the students because they learn what they need to in order to accomplish the task given by the teacher and it also encourages the students to go much deeper (Bruner, 1967). They may end up learning much more than the teacher intended. This, in turn, would give the students an even deeper understanding of the particular concepts or topics that they were studying.

Inquiry Instruction

Divergent teaching relates directly to inquiry instruction, which is currently at the forefront of science education reform (Bell, Smetana & Binns, 2005). The National Science Education Standards stated inquiry instruction involves students in a variety of active learning activities which emphasizes questioning, data analysis, and critical thinking (Bell et al., 2005). Colburn (2000) describes inquiry instruction as a process where students are actively engaged in essentially open-ended and student-centered hands on activities. In this process, the students are encouraged to do their own research to solve their own problems and to answer questions for themselves. The teacher may choose to give the students the data and the activity would still be considered inquiry based if the students are analyzing and drawing their own conclusions based

on the data. The main goal of inquiry instruction is to help students improve their inquiry skills (Bell et al., 2005).

Colburn (2000) and Bell et al. (2005) described four levels of inquiry. The lowest level of inquiry is called a confirmation activity. The students are presented with the questions and the procedure and the results of the activity are known in advance (Bell et al., 2005). This type of inquiry helps to reinforce a concept that the students have already learned. In structured inquiry, students are given a step-by-step procedure with diagrams for the activity. Students may manipulate the objects in the activity and record their observations (Colburn, 2000). The next form of inquiry is called guided inquiry, where the students are given various materials and are asked to find as many solutions as possible to a problem that has been posed. The procedures are given and the students read them to understand how to begin the activity. They may be asked to manipulate their findings and record what they find out as a result of their manipulation (Colburn, 2000). The teacher presents the students with a list of questions that they need to answer (Bell et al., 2005). The highest level of inquiry is called open inquiry, where the students are given the materials and instructed to find answers using those materials. The methods, problems, and solutions are left up to the student to figure out (Bell et al., 2005). Students cannot be expected to start off with the highest level of inquiry. They need to practice in the lower levels before moving to the higher levels of inquiry (Bell et al., 2005).

Convergent Learning

Convergent learning is when the students are taught that there is only one correct answer to a problem or question (Moore, 2009). Questions such as true and false or yes and no can also be classified as convergent questions because they only solicit one answer. Questions asked in a

convergent manner are very important because they target the preliminary information that students need to address a more complex question (Moore, 2009).

Convergent teaching is mostly centered on the teacher directly transmitting the knowledge to the students (Tomar & Sharma, 2005). This style of instruction is extremely teacher-centered and very structured. It is also the most familiar type of teaching to students and teachers. The ability to learn the information presented is assessed using standardized tests (Tomar & Sharma, 2005). Convergent thinking involves taking the different pieces of a particular topic and putting them back together in an organized, structured, and understandable fashion (Zent, 2001). Zent (2001) argues convergent thinking is an essential part of the outlining and organizing process.

Instructional Theory into Practice

Convergent learning and teaching relates directly to Madeline Hunter's Instructional Theory into Practice (ITIP) model. This model was very popular in the nineties and was considered a teacher decision making model, where the teacher made all of the decisions regarding what the students will be learning (Wessman, n.d.). The teacher first starts by deciding, based on the content standards and grade level, what information the students will be learning and therefore, what will be taught. They also decide what the student will do to demonstrate what they have learned (Wessman, n.d.). Finally, the teacher also decides, based on research and current methods in education, how to deliver that content to the students (Wessman, n.d.).

According to Hunter (1994), the lesson first needs to be developed with an instructional objective in mind. The objective must be based on Bloom's taxonomy of learning domains, which includes cognitive, affective, and psychomotor activities (Bloom, 1956). After the objective is set, an anticipatory set must be completed in order to get students engaged in the

lesson (Hunter, 1994). The lesson objectives are then stated to students so they have an idea of what the teacher expects they will know or be able to do by the end of the lesson. The teacher, in a direct instruction format, teaches the students the main concepts or skills that they have determined are important for the students to know. Students are invited to participate in the lesson by asking questions and answering the questions posed by the teacher. Examples and diagrams are used as much as possible during the lesson (Hunter, 1994). During the lesson the teacher may also check for student understanding by interpreting their reactions and responses to questions asked. At some point in the lesson, students are encouraged to engage in discussions, to solve problems or to demonstrate a skill (Hunter, 1994). At this point in the lesson, the teacher can determine whether or not the students understand the material and can re-teach it if necessary. Once students have demonstrated understanding of the particular topic, then the teacher can assign independent practice to strengthen their skills and knowledge in that particular area (Hunter, 1994). Hunter (1994) notes that it may take several lessons for the students to become ready for guided or independent practice on the material that they have just learned.

The Relationship between Convergent and Divergent Teaching

In today's educational environment, there tends to be a push more towards convergent teaching (Tomar & Sharma, 2005) because of the need to have high scores on standardized tests. Tomar and Sharma (2005) argue that both a convergent approach and a divergent approach are needed. The convergent teaching gives students the background knowledge in order to complete the divergent project or activity. Both of these approaches need to be used since there are some students that may perform very well in a convergent setting but not well in a divergent setting, and vice-versa. In a classroom where only convergent teaching is happening, some students may attain the knowledge given by the teacher while others may fall by the wayside or given some

sort of remediation with limited results (Bar-Yam, et al., 2002). Tomar and Sharma (2005) called this style of teaching guided-divergent, meaning that it is more structured and less flexible than divergent teaching but less narrow and limiting than convergent teaching.

Rintelman (2007) found that middle school technology education students performed better on the convergent laboratory activity than the divergent laboratory with the topic of mechanisms. The results of his study suggested middle school students tend to follow a more teacher prescribed path to answering the questions rather than a student centered one. This path to understanding is consistent with convergent teaching and learning (Rintelman, 2007). Middle school students tend to be more concrete thinkers than abstract thinkers, which is why they sometimes have trouble using inquiry instruction to understand certain concepts (Colburn, 2000). The students who completed the divergent laboratory activity tended to be confused, found the activities difficult, and were unable to draw conclusions from their experiences. Rintelman (2007) also suggested that the types of questioning asked during laboratory activities could influence the results. On the convergent laboratory the students were asked multiple choice questions and on the divergent laboratory they were asked open ended questions. Middle school students in general were found to have more difficulty answering the open ended questions versus the multiple choice questions (Rintelman, 2007).

Lighting

It is important for all students to develop a sense of technological literacy. More specifically, they need to understand how technology works and how to manipulate for the task at hand (ITEA, 2007). Lighting a photographic subject and understanding how light works are technological, scientific, and artistic concepts. From a technological perspective, they include systems, resources, requirements, optimization and trade off, processes, and controls. These

subordinate concepts are embedded in lighting activities and integral to addressing national standards for the study of technology (International Technology Education Association, 2007).

Lighting involves controlling both light and shadows. Shadow control is perhaps one of the most important basic concepts in lighting (Zettl, 2007). We are usually unaware of shadows unless we see them on a hot day or they interfere with what we want to see. Both shadows and light are necessary to show the shape and texture of a person's face or an object (Zettl, 2009). Light and shadows can also suggest a particular mood to a photograph or movie. It is also important to understand the concepts of hard, soft, directional, and diffused light (Zettl, 2007). The photographic principle or triangle lighting involve lighting a person with three different lights: the key light for the basic shape, the fill light which fills in the dense shadows, and the back light which lights a person's hair and separates them from the background (Zettl, 2007).

Action Research

Action research is a reflective process that is most commonly used in education that allows for inquiry and discussion (Ferrance, 2000). The purpose of action research is to improve the quality of an organization and its performance (North Central Regional Educational Library, n.d.). In education, action research is a planned systematic approach to understanding the learning process (Mertler, 2009). Researchers typically collect data and analyze it to improve their own practice. With action research, educators are given new opportunities to reflect and assess their teaching (NCREL, n.d.). Mertler (2009) says that action research is especially relevant for educators because it allows them direct access to the research findings. Action research helps to test educator's ideas in education and justify one's teaching practices (Mertler, 2009). Educators are able to address concerns and problems that are close to them and they have influence over. Ultimately, if needed, they can make changes to their practice (Ferrance, 2000).

Chapter III: Methodology

The purpose of this study is to look at how convergent and divergent instruction affects students' understanding of selected lighting principles. More specifically, it examined concepts such as shadows, hard and soft light, and how to properly light a person with portrait lighting. This chapter discusses the methodology used in this action research study.

Research Design

The study was quasi-experimental and it employed a pretest-posttest nonequivalent multiple-group design. One group completed a convergent lab activity while the other completed a divergent lab activity. The independent variable was the type of instruction that the students received. The dependent variable was the participant's understanding of selected lighting principles based on his or her posttest scores.

Participants were given a lighting laboratory pretest which consists of 23 questions (see Appendix B). After completing the pretest, half of the students performed a convergent laboratory activity and the other half performed a divergent laboratory activity. Both laboratory activities consist of 24 questions, with the convergent activity using a multiple choice format and the divergent activity using a short answer format. Once they finished their laboratory activity, the participants completed a 24-question posttest (see Appendix C). There were eight variables that were addressed and each had three questions on both instruments. In order for the students to show understanding of a specific variable, they needed to answer at least two of the three questions correctly.

Subject Selection and Description

The population for this study was students between the ages of 14 and 18 enrolled in technology education courses at Ellington High School during the spring 2010 semester. All

students were in grades nine, ten, eleven and twelve at the time of this inquiry. The students signed up the classes in question the previous year based on their interest in the subject matter. They were assigned to different sections or class periods based on their schedule.

Instrumentation

Two laboratory activities were assigned to analogous groups of students. One group was assigned a convergent laboratory activity that was teacher-directed and it asked students to respond to multiple-choice questions (see Appendix D). The divergent laboratory activity asked students to sketch their findings and find the solution to properly lighting a person using three lights (see Appendix E). The questionnaires had three sections. The first section asked participants to identify the type of light being used based on the shadows being cast on an object. The second section contained questions relating to dimming or diffusing light using lighting gels. The third section addressed triangle lighting and the respondents were asked to set up the lights in order to properly light a person. The participants were scored based on their ability to complete the laboratory activity that they were assigned.

Data Collection Procedures

A pretest was given to the students before any instruction is given. Participants involved in this study were told that their participation was voluntary and that their answers would be kept confidential and they would not be associated with to them in any way. Participants were then given a convergent lab activity or a divergent lab activity to complete. When they finished the activity, they took a posttest to assess what they have learned. The researcher gathered all the instruments when everyone was finished.

Data analysis.

The data collected was analyzed using simple descriptive statistics. The participant's scores on the pretest and posttest were simply compared. Their performance on the laboratory activities was also compared. Simple frequencies and percentages were used to gauge changes in performance and therefore, gains in understanding.

Limitations

The researcher developed the learning activities and assessment instruments in the context of everyday instruction at Ellington High School. Consequently, steps were not taken to establish their validity using resources or techniques that are beyond those used to facilitate curriculum, instruction or assessment within the school district.

Chapter IV: Results

The purpose of this study was to examine how convergent and divergent instruction affect student learning about selected principles of lighting. The research was quasi-experimental in nature and it employed a pretest-posttest nonequivalent multiple-group design. Both a convergent and a divergent laboratory activity were used to teach the participants selected lighting principles. The participants were given a pretest and a posttest to gather information about what they had learned.

The Sample

The subjects for this study were high school students in grades nine through twelve enrolled in technology education courses at Ellington High School in Ellington, Connecticut. A total of three full classes and two partial classes were engaged in the study during the spring semester of 2010. A total of 60 students participated in the study.

Table 1

Sample Demographics

	Grade Level			
Gender	Ninth	Tenth	Eleventh	Twelfth
Male	11	13	8	1
Female	8	8	9	2

Convergent Laboratory

The first research question addressed by this study dealt with how the completion of a convergent laboratory activity affects students understanding of selected lighting principles. After the students were given a pretest, the researcher presented them with a convergent laboratory activity that was teacher-guided and asks students to experiment with the three lights

that were provided. While completing the activity, they were asked to respond to several multiple choice questions. Once the activity was completed, students took a posttest to assess what they had learned. Table two shows the number of students who performed the convergent laboratory that demonstrated knowledge of each concept by answering at least two out of three items correctly on the pretest and posttest.

Table 2

Concepts of Lighting - Convergent Laboratory

Theme	Pretest	Posttest	Percent Increase
Shadows	20 (67%)	30 (100%)	49%
Hard/Soft Light Properties	8 (27%)	27 (90%)	238%
Light Reflectors	8 (27%)	12 (40%)	50%
Gels	6 (20%)	21 (70%)	250%
Key Light	7 (23%)	14 (47%)	100%
Fill Light	16 (53%)	16 (53%)	0%
Back Light	16 (53%)	25 (83%)	56%
Properly Lit Person	9 (30%)	21 (70%)	133%

All of the students showed improvement between the pretest and the posttest with the exception of the fill light, which remained the same. Participants demonstrated an increase in their knowledge of lighting concepts and techniques by showing a gain from the pretest to the posttest across almost all of the themes with a fifty percent increase or higher.

Divergent Laboratory

The second research question addressed by this study dealt with how the completion of a divergent laboratory activity affects students understanding of selected lighting principles. After

the students were given a pretest, the researcher presented them with a divergent laboratory activity that was student-centered and asks students to experiment with the three lights and other equipment that was provided. While completing the activity, they were asked open-ended questions and asked to experiment with different lights and lighting configurations. Once the activity was completed, students took a posttest to assess what they had learned. Table three shows the number of students who performed the divergent laboratory that demonstrated knowledge of each concept by answering at least two out of three items correctly on the pretest and posttest.

Table 3

Concepts of Lighting - Divergent Laboratory

Theme	Pretest	Posttest	Percent Increase
Shadows	24 (80%)	27 (90%)	13%
Hard/Soft Light Properties	7 (23%)	28 (93%)	304%
Light Reflectors	11 (37%)	11 (37%)	0%
Gels	10 (33%)	17 (57%)	70%
Key Light	8 (27%)	23 (77%)	188%
Fill Light	7 (23%)	22 (73%)	214%
Back Light	12 (40%)	19 (63%)	58%
Properly Lit Person	4 (13%)	27 (90%)	575%

All of the students showed improvement on all of the themes with the exception of the light reflectors which remained the same. Participants showed an increase in knowledge of the concepts of lighting especially on hard and soft light properties, key light, fill light and a properly lit person, which were all well over one hundred percent improvement.

Convergent and Divergent Laboratory Performance

The third research question addressed by this study dealt with how the completion of a convergent versus a divergent laboratory activity affected students understanding of selected lighting principles. The students were asked to complete either a convergent laboratory activity or a divergent laboratory activity. The convergent laboratory included multiple-choice questions while the divergent laboratory asked open-ended questions that could have more than one answer. Table four shows the number of students who performed the laboratory activities that demonstrated knowledge of each concept by answering at least two out of three items correctly.

Table 4

Performance on Laboratory Activities

Theme	Convergent	Divergent
Shadows	30 (100%)	30 (100%)
Hard/Soft Light Properties	30 (100%)	19 (63%)
Light Reflectors	29 (97%)	20 (67%)
Gels	29 (97%)	28 (93%)
Key Light	22 (73%)	24 (80%)
Fill Light	22 (73%)	29 (97%)
Back Light	23 (77%)	23 (77%)
Properly Lit Person	23 (77%)	27 (90%)

The participants performed well on both of the laboratory activities. The students who completed the convergent laboratory scored higher with the first four categories of shadows, hard and soft light, light reflectors and gels. The students who completed the divergent laboratory

scored the same on the back light theme and higher on the key light, fill light and being able to identify a properly lit person.

Chapter V: Discussion

The purpose of this study was to look at how convergent and divergent instruction affect student learning on selected principles of lighting. The study also looked at the differences between the participants who completed the convergent laboratory and those who completed the divergent laboratory.

The study was a quasi-experiment with a pretest-posttest nonequivalent multiple-group design. This study used two laboratory activities and a pretest and posttest to collect the data. The participants in this study were 60 ninth, tenth, eleventh and twelfth graders enrolled in the technology education courses at Ellington High School in Ellington, Connecticut.

Participants were first given a pretest to assess their current understanding of the selected lighting principles. Then half of the participants (30 students) were given a convergent laboratory packet to complete. The instructions were very teacher directed and guided the students in a step-by-step procedure. It also asked them to answer multiple choice questions along the way based on their experience. The other half of the participants (30 students) was given a divergent laboratory packet. It was very student directed and asked the students to experiment with tools and techniques to understand the selected lighting principles. Included in the divergent packet were open ended questions which students were asked to answer as they proceeded through the activity. Upon completion of the two laboratory activities, a posttest was given to the participants to assess their content knowledge. The results were analyzed using simple descriptive statistics using frequencies and percentages to determine which group had performed better on the posttest and the laboratory activities.

Discussion

The first research question asked how a convergent laboratory activity affected the students understanding of selected lighting principles. The findings were consistent with previous research that the completion of a convergent laboratory ultimately improved students understanding of a particular subject matter (Rintelman, 2007). The participants improved from the pretest to the posttest on all of the categories with the exception of the fill light which remained the same. The convergent laboratory activity was designed in a manner that required the students to follow a specific set of procedures to find answers to questions that were posed by the instructor (Bardin, n.d.). The laboratory activity was designed in accordance with the Instructional Theory into Practice model (Hunter, 1994). It was design so everything the instructor wanted the students to learn was included (Wessman, n.d.). There was little room for experimentation and interpretation because the instructor decided how the students would experience key ideas and how they would demonstrate what they learned (Wessman, n.d.).

The second research question asked if a divergent laboratory activity affected students understanding of selected lighting principles. Overall, it was found that students who completed the divergent laboratory made tremendous gains from the pretest to the posttest, with the exception of the light reflectors which remained the same. This was consistent with previous research that showed students performed better on a divergent activity than those who did not (Kwon et al., 2006). Significant gains were posted in almost all of the themes with over seventy percent increase. The divergent laboratory activity was designed in a manner that required students to utilize the tools and materials provided to complete a lighting task through discovery learning (Bardin, n.d.). The participants were asked to discover how to properly light a person in an aesthetically pleasing manner. They then proceeded to complete an open-ended activity to

find the solution to that particular problem (Colburn, 2000). Bell et al. (2005) called this an open inquiry activity. The participants tried multiple scenarios using the equipment provided and they were ultimately able to identify a properly lit person using divergent thinking.

The third research question dealt with the differences between participants who completed the convergent laboratory activity versus students who completed the divergent laboratory activity. The findings were consistent with previous research that suggests students do better on an actual laboratory activity when they are given multiple-choice questions to answer rather than open-ended questions (Rintelman, 2007). The performance on the laboratory activities indicated the students were able to make sense of the concepts by experimenting with the tools and materials that they were given. This is consistent with discovery learning (Bardin, n.d.). In both activities, the students were engaged in some form of inquiry. Those who completed the convergent laboratory completed a structured inquiry activity where they were given the materials and asked to record their observations (Bell et al., 2005). However, those who participated in the divergent laboratory activity completed an open inquiry activity where they experimented and found the solution to properly light a person (Colburn, 2000).

Conclusions

Based on the findings of this study, the following conclusions were drawn:

1. High School students perform better on laboratory activities that are spelled out in a step-by-step fashion when it comes to concepts that are not complex. The convergent laboratory activity was structured in a way where it specifically told students what to do with the lights and what to look for. In the divergent laboratory activity, some students appeared to be lost until one member of their group took on the role of the teacher and told them what to do.

2. High school students perform better on open-ended laboratory activities that involve investigating challenging concepts. In this case, understanding how to properly light a person using three lights is quite complex. The results of this study suggest students performed better and remembered more information when they were allowed to conduct experiments and make their own judgments about which equipment to use.
3. Divergent instruction needs convergent instruction in order to ensure mastery of a particular topic. For example, if the students were not told during the divergent laboratory activity that one light had to be positioned on the left side of the camera and one on the right in a symmetrical manner, they would have never figured it out. However once they had that information, they were able to find other solutions to the lighting problem.
4. The results on both the laboratory activities and the posttest suggest the participants who completed the convergent laboratory activity had greater mastery of basic concepts. In contrast, when it came to the advanced concepts, participants who completed the divergent activity scored higher on both the laboratory activities and the posttest.
5. Convergent instruction helps students understand a particular topic and the basic information, but just that type of instruction alone does not ensure retention.

Recommendations

Based on the findings and conclusions of this study, the following recommendations were made:

1. Convergent approaches should be used to introduce the foundational knowledge needed to solve problems.
2. Discovery learning is especially appropriate for helping students learn complex concepts assuming they already posses the relevant foundational knowledge.

3. The instructions necessary for the students to complete a divergent activity must be spelled out as much as possible without providing the right answer.

Based on the findings and conclusions of this study, the following recommendations for further were proposed:

4. Additional studies should be conducted to validate these findings. More specifically, similar studies on lighting and other topics should be conducted to determine students' ability to benefit from convergent and divergent laboratory activities.
5. Studies need to be conducted to determine the impact of these teaching techniques on different age groups. High school, middle school and elementary students should be studied to determine the extent to which younger students are able to complete and benefit from convergent and divergent laboratory activities.
6. Studies should also be conducted to examine the extent to which individual students use convergent and divergent thinking. The activities completed during this study, with the exception of the pretest and posttest, were done in small groups of three or four. It would be interesting to see if all students are able to engage in divergent thinking.

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Appendix A: Consent Form

Consent to Participate in University of Wisconsin – Stout Approved Research

Title:
An analysis of convergent and divergent teaching on high school student's understanding of selected lighting principles.

Investigator:
Mr. Justin Waine
UW-Stout Graduate Student

Advisor:
Dr. Kenneth Welty
Professor – UW-Stout

Description of Study:
The purpose of this study is to compare two different approaches to teaching students about lighting.

This study will take place during class time and the concepts are in keeping with the current curriculum. Your child's participation in this study will in no way affect his or her grade.

The study is confidential, meaning your child's name will not be included on any documents. Participation in this study will include completion of a pretest, posttest and a laboratory activity. If at any time you choose to withdraw your child from this study, you may do so without any consequence.

This study has been reviewed and approved by the University of Wisconsin – Stout's Instructional Review Board (IRB). The IRB has determined that this study meets the ethical obligations required by federal law and University policies. If you have questions or concerns regarding this study, please contact the Investigator or Advisor. If you have any questions, concerns or reports regarding your child's rights as a research subject, please contact the IRB Administrator.

Investigator: Mr. Justin Waine
(860) 896-2352 x 175; jwaine@ellingtonschools.net

Advisor: Dr. Kenneth Welty
(715) 232-1206; weltyk@uwstout.edu

IRB Administrator:
Sue Foxwell, Director, Research Services
152 Vocational Rehabilitation Bldg.
UW-Stout
Menomonie, WI 54751
715-232-2477
foxwells@uwstout.edu

Statement of Consent:

By signing this consent form you agree to participate in the project entitled, an analysis of convergent and divergent teaching on high school student's understanding of selected lighting principles.

_____
Signature Date

_____
Signature of parent or guardian Date

Appendix B: Lighting Laboratory Pretest

Directions: Answer the questions based on your past knowledge and best guess.

1. What type of light is casting the shadow on this object?

   a. Hard
   b. Soft
   c. Fill
   d. Background

2. What type of light is casting the shadow on this object?

   a. Hard
   b. Soft
   c. Fill
   d. Background

3. When an object is lit with this light, what type of shadow would it create?

   a. Hard
   b. Soft
   c. Fill
   d. Background

4. Why would that light produce a _____ (whatever answer you chose above) shadow?

   a. The beam is more focused
   b. The beam is more spread out
   c. The light is physically small
   d. The light is physically large

5. This light is considered a ….

   a. Bank Light
   b. Scoop Light
   c. Hard Light
   d. Soft Light

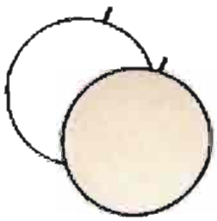
6. Why is that considered a _____ (whatever answer you chose above) light?

    a. The beam is more focused
    b. The beam is more spread out
    c. The light is physically small
    d. The light is physically large

For questions 7-11, refer to the following images:

I. 

II. 

III. 

7. Which of the following devices can be attached to the lights?
    a. I only
    b. I and II
    c. II and III
    d. I, II and III

8. Which of the following devices can be used to reflect light?
    a. I only
    b. I and II
    c. II and III
    d. I, II and III

9. Which of the following devices can be used to dim or diffuse the light?
    a. I only
    b. I and II
    c. II and III
    d. I, II and III

10. Which of the following devices can be used to change the color of the light?
    a. I only
    b. I and II
    c. II and III
    d. I, II and III

11. Which of the following devices can be used primarily in a three-point lighting setup?
    a. I and II
    b. II only
    c. II and III
    d. I, II and III

For questions 12-14, refer to the following images:

I. 

II. 

III. 

IV. 

12. Which one of the images is lit by the key light only?
    a. I
    b. II
    c. III
    d. IV

13. Which one of the images is lit by the fill light only?
    a. I
    b. II
    c. III
    d. IV

14. Which one of the images shows a person that is properly lit?
    a. I
    b. II
    c. III
    d. IV

For questions 15-18, refer to the following images:

I. 

II. 

III. 

IV. 

15. Which one of the images shows a person that is properly lit?
    a. II
    b. III
    c. IV
    d. None

16. Which one of the images is lit by the back light only?
    a. I
    b. II
    c. III
    d. IV

17. Which image needs to reposition its fill light?
    a. I
    b. II
    c. III
    d. IV

18. Which images are lit by the key light only?
    a. I and II
    b. I and IV
    c. II and IV
    d. III and IV

19. The back light can be used to light the: _____.
    a. Background
    b. Hair
    c. Lower back
    d. Rest of face

20. In a triangle or three point lighting setup, the key light should be positioned where?
    a. Opposite the camera
    b. On the left side of the camera
    c. On the right side of the camera
    d. Behind the camera

21. In a triangle or three point lighting setup, the fill light should be positioned where?
    a. Opposite the camera
    b. On the left side of the camera
    c. On the right side of the camera
    d. Behind the camera

22. In a triangle or three point lighting setup, the back light should be positioned where?
    a. Opposite the camera
    b. Opposite the main light
    c. Opposite the secondary light
    d. Next to the camera

23. A properly lit person:
    a. Has a dark spot on the right side of their face
    b. Has a dark spot on the left side of their face
    c. Has no dark spots on their face
    d. Has a dark spot on the top of their head

Appendix C: Lighting Laboratory Posttest

Directions: Answer the questions based on what you learned from the lighting activity.

1. How would you describe a shadow that is produced by a hard light source?
    a. Details are difficult to see, the object could be very blurry
    b. There is no shadow produced by a hard light source
    c. Well defined and easy to make out the details of the object
    d. The shadow is there but almost non-existent

2. How would you describe a shadow that is produced by a soft light source?
    a. Details are difficult to see, the object could be very blurry
    b. There is no shadow produced by a soft light source
    c. Well defined and easy to make out the details of the object
    d. The shadow is there but almost non-existent

For questions 3-6, refer to the following images:

I. 

II. 

III. 

IV. 

3. Which light(s) would produce a well defined, easy to see shadow?
    a. I and IV
    b. I and II
    c. II only
    d. III and IV

4. Which light(s) are considered a hard light?
    a. I and II
    b. I and III
    c. II and III
    d. IV only

5. Which light(s) are considered a soft light?
    a. I and II
    b. I and III
    c. III only
    d. IV only

6. Which light(s) could the umbrella be attached to?
    a. I only
    b. II only
    c. I and II
    d. II and III

7. What is the major difference between a soft light and a hard light?
    a. Soft light needs to be closer to the object while hard light needs to be further away
    b. Hard lights tend to be larger and soft lights tend to be smaller
    c. Hard lights are more spread out while soft lights are more of a concentrated beam
    d. Soft lights are more spread out while hard lights are more of a concentrated beam

8. What does the umbrella do in lighting?
    a. Focuses the light
    b. Blocks the light
    c. Narrows the beam of light
    d. Reflects the light

9. Where would you primarily want to use an umbrella?
    a. Outside to reflect the sun
    b. On an interview
    c. Indoors to make up for the lack of light
    d. On an object to eliminate the fill light

10. You would typically place a colored Gel on a:
    a. Key light
    b. Fill light
    c. Background light
    d. Back light

11. What is the primary purpose of a colored Gel?
    a. Change the color of the background
    b. Change the color of a person's hair
    c. Change the color of a person's face
    d. Bring out more of that color on a person's face

12. What is the primary purpose of a non-colored Gel?
    a. Intensify the light
    b. Dim or diffuse the light
    c. Brighten the light
    d. Darken the light

13. When doing an interview, you would want to eliminate the: _____ on a person's face.
    a. Dark Spots
    b. Hard Light
    c. Soft Light
    d. Fill Light

14. How would you best describe a key light?
    a. A light used to light the person's hair
    b. A light used to light the person's entire head
    c. The main light that lights most of the person's face
    d. The secondary light that lights the rest of the person's face

15. How would you best describe a fill light?
    a. A light used to light the person's hair
    b. A light used to light the person's entire head
    c. The main light that lights most of the person's face
    d. The secondary light that lights the rest of the person's face

16. A back light would be used to light the _____.
    a. Person's hair
    b. Person's nose
    c. Person's entire face
    d. Background

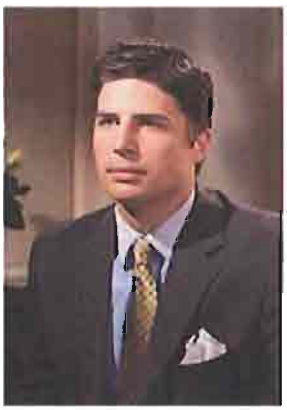
17. When using triangle or 3 point lighting, the key light should be positioned at what clock position?
    a. 6:00 or 12:00
    b. 5:00 or 7:00
    c. 4:00 or 8:00
    d. 3:00 or 9:00

18. When using triangle or 3 point lighting, the fill light should be positioned at what clock position?
    a. 6:00 or 12:00
    b. 5:00 or 7:00
    c. 4:00 or 8:00
    d. 3:00 or 9:00

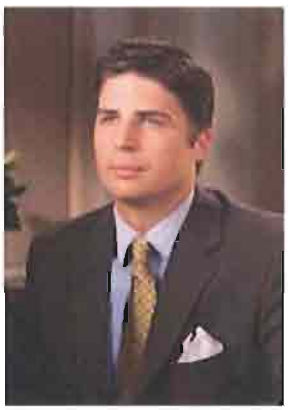
19. When using triangle or 3 point lighting, the back light should be positioned at what clock position?
    a. 9:00 or 3:00
    b. 10:00 or 2:00
    c. 11:00 or 1:00
    d. 12:00 or 6:00

For questions 20-23, refer to the following images:

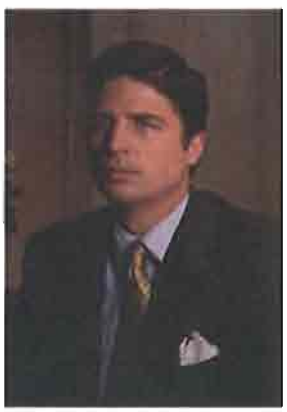
I.



II.



III.



IV.

20. Which of the images illustrates lighting by a key light only?
    a. I
    b. II
    c. III
    d. IV

21. Which of the images illustrates lighting by a fill light only?
    a. I
    b. II
    c. III
    d. IV

22. Which of the images illustrates lighting by a back light only?
    a. I
    b. II
    c. III
    d. IV

23. Which of the images illustrates proper lighting with all three lights?
    a. I
    b. II
    c. III
    d. IV

24. What should be done to the image below to make it so the person is properly lit?

    a. Decrease the key light
    b. Decrease the fill light
    c. Increase the key light
    d. Increase the fill light

Appendix D: Convergent Lighting Laboratory Packet

Today we are going to learn about lighting. Follow the directions below and answer the questions as you proceed through the activity.

Section I: Pro-Light / Rifa / V-Light & Shadows

Use the Pro-Light. Set it up on the stand and open the barn doors. Aim the light at the same coffee can. Plug in the power cord and turn on the light.

Make sure the room is completely dark. Aim the Pro-Light at the news desk with a coffee can on top of it.

1. How would you describe the shadow that you see with the Pro-Light?
    a. The shadow is there but almost non-existent
    b. The shadow is blurry and hard to see the details of the object (called a soft light)
    c. There is no shadow at all
    d. The shadow is well defined and easy to make out the details of the object (called a hard light)

Use the Rifa light with the diffusion tent. Set it up on the stand and pull the power cord back until it snaps into place. Make sure the diffusion tent is placed on each of the four corners. Plug the power cord into the light and turn it on.

Make sure the room is completely dark. Aim the Rifa light at the news desk with a coffee can on top of it.

2. How would you describe the shadow that you see with the Rifa Light?
    a. The shadow is there but almost non-existent
    b. The shadow is blurry and hard to see the details of the object (soft light)
    c. There is no shadow at all
    d. The shadow is well defined and easy to make out the details of the object (hard light)

Now, use the V-Light. Set it up on the stand and open the flaps.

Make sure the room is completely dark. Aim the V-Light towards the coffee can. Plug in the power cord and turn on the light.

3. How would you describe the shadow that you see with the V-Light?
    a. The shadow is there but almost non-existent
    b. The shadow is blurry and hard to see the details of the object (soft light)
    c. There is no shadow at all
    d. The shadow is well defined and easy to make out the details of the object (hard light)

Now, attach the umbrella to the V-Light. Aim the V-Light away from the coffee can and make sure the open part of the umbrella is facing towards the coffee can. Turn the light on.

4. How would you describe the shadow that you see with the V-Light **AND** umbrella?
    a. The shadow is there but almost non-existent
    b. The shadow is blurry and hard to see the details of the object (soft light)
    c. There is no shadow at all
    d. The shadow is well defined and easy to make out the details of the object (hard light)

5. What does the umbrella do to the light?
    a. Focuses it
    b. Reflects it
    c. Intensifies it
    d. Shoots the light through the umbrella

6. How does the umbrella _____ (answer you chose above) to the light?

a. Spreads the beam out
b. Narrows the beam
c. Sharpens the beam
d. Multiples the amount of light going into the umbrella

7. What is the major difference between the shadows cast by the Pro-Light and the Rifa?
   a. Shadows with the Rifa light are easier to see
   b. Shadows with the Pro-Light are harder to see
   c. Shadows become more defined when using the Pro-Light
   d. Shadows become more defined when using the Rifa Light

8. What is the major difference between the shadows cast by the V-Light and the Rifa?
   a. Shadows with the Rifa light are easier to see
   b. Shadows with the V-Light are harder to see
   c. Shadows become more defined when using the V-Light
   d. Shadows become more defined when using the Rifa Light

9. Why do you think that is?
   a. The Pro-Light focuses the beam of light more on an object (hard light)
   b. The Rifa Light focuses the beam of light more on an object (soft light)
   c. The Rifa Light is too small to light the object
   d. The Pro-Light is too small to light the object

Section II: Lighting Gels

Now, you are going to experiment with the Pro-Light and the various Gels. Take the foggy Gel and attach it to the front of the Pro-Light. Turn the light on and aim it towards the coffee can.

10. What does the foggy Gel do to the shadow on the coffee can?
    a. Makes it easier to see
    b. Makes it harder to see
    c. Changes the color of the can
    d. Eliminates the shadow completely

Remove the foggy Gel and then attach the blue Gel to the coffee can.

11. Which one of these options would be the best use of the blue (or other colored) Gels?
    a. Change the color of the person's face
    b. Change the background
    c. Change the color of the setting
    d. Change the color of a specific object (such as a chair)

12. What is the purpose of a non-colored lighting Gel?

a. Intensify the light
b. Brighten the light
c. Diffuse or dim the light
d. Darken the light

Section III: Triangle Lighting / 3 Point Lighting

Now we are going to use a method called triangle lighting with the Pro-Light, Rifa and V-Light. Triangle lighting is the easiest way to light a person for an interview.

Have one of your group members sit in the chair. First, take the Rifa Light and set it up at a 45 degree angle on the best side of the subject. This should be at either 5:00 or 7:00. Raise up the Rifa Light to eyelevel with the subject.

The person should look like:

This is called a Key light.

13. Which one of these options best describes what the key light did?
    a. The key light lit the entire face
    b. The key light lit most of the person's face
    c. The key light lit a small part of the person's face
    d. The key light lit the person's hair and entire head

Use the V-Light with the umbrella. Position it on the opposite side of the Rifa, which would either be 5:00 or 7:00. Have the light shoot away from the person being lit.

The person being lit with the V-Light and Pro-Light should look like:

This is called a Fill light.

14. If you turn the key light off, which one of these options best describes what the fill light is doing?
    a. The fill light lit the entire face
    b. The fill light lit most of the person's face
    c. The fill light lit a small part of the person's face
    d. The fill light lit the person's hair and entire head

15. If you turn the key light back on, which one of these options best describes what both the key and fill light are doing?
    a. The key and fill light lit the entire face
    b. The key and fill light lit the person's face on the right side
    c. The key and fill light lit the person's face on the left side
    d. The key and fill light lit the person's hair and entire head

16. Why would it be a better idea to use the Rifa as the key light as opposed to the V-Light with the umbrella?
    a. The Rifa covers a larger area
    b. The V-Light covers a larger area
    c. The Rifa light has a stronger beam
    d. The V-Light with umbrella has a stronger beam

Lastly, we will set up the Pro-Light. The Pro-Light goes opposite the Key Light behind the person. The Pro-Light is also set up at a higher angle than the key light. This is called a Back light.

17. The back light should be set up at what clock position?
    a. 12:00 / 6:00
    b. 11:00 / 1:00
    c. 9:00 / 3:00
    d. 7:00 / 5:00

18. If you turn the key and fill lights off, which one of these options best describes what the back light is doing?
    a. The back light lit the entire face
    b. The back light lit the person's face on the right side
    c. The back light lit the person's face on the left side
    d. The back light lit the person's hair

19. Why was the Pro-Light chosen as the back light?
    a. It is physically small
    b. It is the strongest/brightest of the available lights
    c. It is the weakest/least bright of the available lights
    d. It is physically large

20. If you turn the key and fill light on, which one of these options best describes what the key, fill and back light are doing?
    a. The key, fill and back light lit the entire face
    b. The key, fill and back light lit the person's face on the right side
    c. The key, fill and back light lit the person's face on the left side
    d. The key, fill and back light lit the person's hair and entire head

21. Which one of these lights is considered the strongest?
    a. Key light
    b. Fill light
    c. Back light
    d. Background light

22. Which one of these lights is the second strongest?
    a. Key light
    b. Fill light
    c. Back light
    d. Background light

23. Overall, when lighting a person, the following is true:
    a. You should try to create a shadow that is easy to see (hard light)
    b. You should try to create a shadow that is hard to see (soft light)
    c. The face should be evenly lit
    d. The hair should be dark

24. If the lights are set up in the correct position and there is still a problem with the lighting, the best solution would be to:
    a. Change the angle
    b. Move the light closer or further away
    c. Raise the light
    d. Lower the light

Appendix E: Divergent Lighting Laboratory Packet

Today we are going to learn about lighting. Follow the directions below and answer the questions as you proceed through the activity.

You will be given the following equipment:

(1) Pro-Light
(1) Rifa Light
(1) V-Light
(1) Umbrella
(1) Fog Lens
(2) Lighting Gels

Section I: Pro-Light / Rifa / V-Light & Shadows

Set up each of the lights and shine it on the coffee cans. Describe in a few words what each shadow looks like and then draw a simple sketch of what the shadow looks like from each light:

1. **Pro** Light

Sketch:

Description:

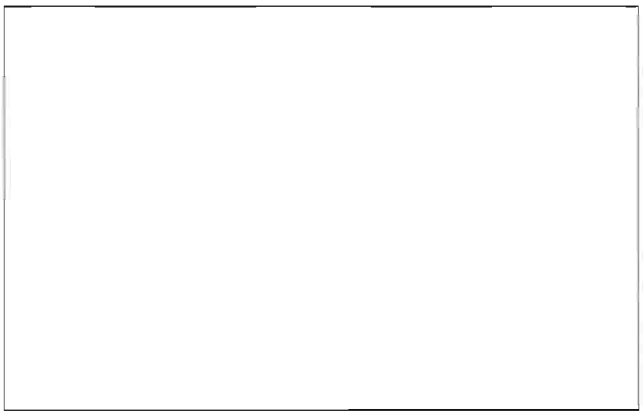
2. **Rifa** Light

Sketch:

Description:

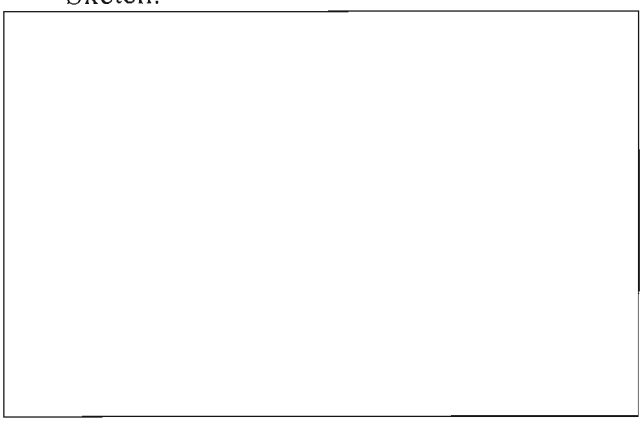
3. **V**-Light

Sketch: Description:



4. **V**-Light with **Umbrella**

Sketch: Description:



5. Which of the lights (could be more than one) produce a hard light, that is they create a shadow with a very distinct, easy to see outline?

6. Why do you think that is? (Hint: look at the light itself)

7. Which of the lights (could be more than one) produce a soft light, which is they create a shadow that you can see but the details are very blurry?

8. Why do you think that is? (Hint: look at the light itself)

9. What does the umbrella do to the shadow?

10. How does the umbrella _____ (answer you chose above) the light?

Section II: Lighting Gels

Use the fog lens and the two gels provided to answer the following questions.

11. What effect does the fog lens have on the light coming from the Pro-Light?

12. What effect does the clear gel have on the light coming from the Pro-Light?

13. What could the blue gel be used for?

Section III: Triangle Lighting / 3 Point Lighting

The goal of this section is to figure out how to evenly light a person using the three lights. There are two lights that will light the person's face. A key light is the main light. A fill light is the secondary light. In order for the person to be properly lit, there must be **no shadows or dark spots on the person's face**.

The key light and fill light need to be positioned at a certain clock time. One needs to be positioned on the right side of the clock (from 1:00 to 5:00) while the other needs to be positioned on the left (from 11:00 to 7:00).

The camera is to be positioned at 6:00 while the person is considered 12:00. The lights need to be set up symmetric with each other: that is, if you set up a light at 11:00, the other one must be at 1:00. If you set it up at 10:00, the other light must be at 2:00, and so on.

Keep going with that formula until you find the right solution. Sketch your ideas below and then try them. Use a **P** for Pro-Light, **R** for Rifa Light and **V** for the V-Light.

Then, when you have the entire face lit, the back light, used to for the person's hair, goes opposite of the key light and behind the person. For example, opposite 6:00 would be 12:00.

Sketch #1:

Sketch #2:

Sketch #3:

Sketch #4:

14. The key light, the strongest light was positioned at what clock time?

15. What part of the face did the key light illuminate?

16. Why did you choose the _____ light as the key light?

17. The fill light was positioned at what clock time?

18. What part of the face did the fill light illuminate?

19. Why did you choose the _____ light as the fill light?

20. The back light should be set behind the person opposite the key and at a higher angle. What clock time is it positioned at?

21. What part of the person did the back light illuminate?

After you finish, answer the following questions:

22. What is the relationship between the key light and the fill light (Hint: think about what the purpose is of the key and fill lights)?

23. Describe the person's face. Are there any dark spots?

24. Take a picture of the person with the lighting solution you came up with.