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Fading Student-Learned Scaffolding in Middle School Science Classrooms

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Abstract

The present study sought to gather evidence on the best procedure for fading student-provided scaffolds. Fifty-one students were randomly selected from a convenience sampling of 144 students in five different sections of seventh grade Life Science. Over the course of one school year, students were introduced to a paragraph writing template, which would help them to be able to write paragraphs that introduced a source, provided a citation to support a claim, analyzed that citation to state its importance and finally tie it up using a conclusion statement; this structure helped them structure a well-written proposition and support paragraphs on a given life science concept without support from the teacher. Students wrote a total of ten paragraphs during the study. With each new paragraph the scaffolding was faded to provide decreasing amounts of support to the students. A comparison of mean scores and standard deviations was used to show student performance throughout the study. Results indicated that students were able to continue to write paragraphs structured in the ICAT format even after the scaffolding was fully withdrawn.

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Chapter 1—Introduction

Researchers have been using the metaphor of scaffolding for the last 40 years to explain the process in which tutors, parents and teachers provide decreasing amounts of support to children and students in order to help them complete developmental or educational tasks (Stone, 1998). The metaphor of scaffolding is also closely tied to the Zone of Proximal Development (ZPD) that was developed by Lev Vygotsky. The ZPD, while bearing no direct relation to scaffolding, is frequently associated with scaffolding because of its relation to joint activities in which an expert tutor is involved (van de Pol et al., 2010). While researchers have been studying the process of scaffolding and the different strategies involved, it was not until the mid-to-late 1990's that researchers started to heavily research the different factors involved in scaffolding, as well as the notion that the amount of scaffolding provided needs to be decreased, as the student becomes better at performing the task.

In the present paper, the substantial research on scaffolding will be reviewed with attention drawn to the definition and history behind the metaphor itself and the history of the research conducted on scaffolding. Information will also be presented on the different environments that scaffolding can be found in. Finally, emphasis will be placed on the research related to the fading of scaffolding, or the process in which supports provided to students are decreased over time.

Problem Statement

Scaffolding in education is the process in which educators provide a "temporary framework [that] support[s] learners when assistance is needed and is removed when no longer needed" (Lajoie, 2005, p. 542). Such supports are crucial to a student's' learning because with these

scaffolding supports, a student may be able to complete a task that might be impossible for them to complete on their own (Lajoie, 2005).

Scaffolding was first developed in 1976 by Wood, D., Bruner, J. S., and Ross, G. Their research focused on the role of tutoring in problem solving in which an expert tutor supports the learning of three- to five-year-olds in a block-building task. Since 1976, an abundance of research has been conducted on scaffolding and its potential benefits (Wood et al., 1976). However, there has been very little focus on the fading, or gradual removal, of scaffolding. In fact, fading was not mentioned until the early 1990's and scant research has been conducted on the subject since then (Van de pol, 2010).

Many educators are unaware of the fact that scaffolding needs to be faded or gradually removed. The primary goal of scaffolds is originally to provide students with temporary supports and once students are capable of completing a task on their own, the supports are to be removed. Sherin, Bruce, Brian J. Reiser, & Daniel Edelson (2004), suggest that "It was assumed that the task is one that is characteristic of expert activity and that the novice will ultimately perform the task without assistance" (p. 395). While it makes sense that scaffolds need to be put into place to ensure that students are capable of reaching their own individual Zones of Proximal Development, ultimately leaving them capable of completing a task on their own, many teachers leave those supports in place so that the students always have access to them if the need arises. However, there is consensus among educators that scaffolding should ultimately be faded over time (Sherin et al., 2004).

While there is plenty of research that supports this process, very little research on the process itself is available for the classroom practitioner. As such, exploration of how he process of fading scaffolding needs to occur in core content areas such as science and math so that students can

learn to internalize the supports they have been provided. Moreover, generalization of the skill beyond the classroom wherein students perform the skill without adult interaction still remains a viable research agenda. Therefore, additional classroom analysis as to the applicability of scaffolding and subsequent fading of a learned scaffold needs to be conducted to better inform educators of implementation and monitoring in the classroom.

Purpose of the Study

The primary goal of this study will be to determine the best process for fading or removing scaffolding for seventh grade students in a science classroom. A successfully faded scaffold would result in students having internalized the supports they were provided, leading to students being able to complete the expected task without the supports in place, as compared to a situation in which no supports were provided.

Research Questions

1. Can scaffolding be faded so that students can perform a task expected of them when they are no longer provided with supports?
2. What factors contribute to a successful fading exercise?
3. What is the effect of fading, and eventual removal of scaffolding on the completion of the expected task?

Theoretical Model

Wood et al., (1976) first suggested the term "scaffolding" for the process in which an adult or expert provides help to someone who is less able to perform a task. Harris and Hodges, (1995), defined scaffolding as "…the gradual withdrawal of adult (e.g. teacher) support, as through instruction, modeling, questioning, feedback, etc., for a child's performance across successive engagements, thus transferring more and more autonomy to the child," suggesting

that over time, the supports provided by the expert need to be faded so as to ensure that students are eventually able to complete the task without support (p.226).

Many researchers (Lajoie, 2005; Pea, 2004; Stone, 1998) also suggest that there are three key characteristics that are required for scaffolding: Contingency, Fading, and Transfer of Responsibility. Contingency refers to the adjustments that must be made while the student is being supported. Fading refers to the process of slowly decreasing the amount of scaffolding provided by the expert. Transfer of Responsibility requires that, over time, the learner gradually assumes responsibility for the task, so that the responsibility of learning completely transfers from the expert to the student (Van de Pol, 2010).

The Zone of Proximal Development (ZPD) is also a crucial theory related to instructional scaffolding. Vygotsky used the Zone of Proximal Development to describe the gap between a child's ability to complete a task on their own and the potential that the same child has of completing that activity with the guidance of adults or peers. Researchers often relate the two together because an expert must remain just outside of a student's' ZPD in order for the student to be pushed to understand something that may be slightly outside their reach. In 1979, Cazden first associated scaffolding with Vygotsky's ZPD in order to suggest that scaffolding could be used in a teacher-student interaction as compared to a solely parent-student interaction as had only been discussed since Wood et al., (1976).

Researcher Background

Prior to becoming a credentialed teacher, I had heard of scaffolding, but was not really aware of what it meant or was. It wasn't until I completed my student teaching at a school in the same district as I currently work in, that I discovered and understood the true meaning of scaffolding- an instructional support that would help students to be able to complete a task even

if the task was above their capability. At the site where I did my student teaching, teachers were expected to use Constructing Meaning, an instructional approach that "emphasizes both academic English and critical literacy skills, thereby supporting English learners in acquiring the analytical language necessary to meet the demands of the Common Core," ("About CM", para. 2). One of the main scaffolds that were put in place was sentence frames and sentence starters. Students were given these sentence starters and sentence frames in almost every written assignment they were expected to complete. Throughout the year, the Constructing Meaning supports were used consistently; but there was no modification to the amount of support that provided, aside from the occasional addition of a more complicated sentence frame or starter that required a deeper level of understanding. Because there was this lack of modification or withdrawal of support over time, it appeared that the students never learned how to use the supports properly. By the end of the year, it was my interpretation that the students were not capable of writing anything on their own because they had become dependent on the support. If the students were assigned a paragraph to write on a certain subject, they would not have known how to start or what a proper paragraph should look like.

Because of this observation, I began to inquire about how scaffolds were to be properly introduced in the classroom so that students would be able to practice academic writing with support, but eventually be able to write without having the supports in front of them. As time went on, and as I began teaching in my own classroom, this inquiry evolved into a slightly different question, but an even more important one: Once students had these supports in place, how do teachers go about removing the scaffolding, so that once the supports are gone, students are still able to complete the expected task?

Definition of Terms

- **Contingency:** Refers to the adjustments that must be made while the student is being supported. In essence, the teacher must adjust the support being provided, depending on the students' current level of understanding, ensuring that the student remains within their ZPD (Lin, et al. (2012).
- **Fading:** The process of slowly decreasing the amount of scaffolding provided over time (McNeill et al., 2006).
- **ICAT Paragraph:** The scaffolding support structure that students will be provided with during the study. The ICAT is a template which breaks down a paragraph into four sections: (1) Introduction sentence (2) Citation (students will cite a text that they read or a video they watched. (3) Analysis (students will analyze the citation that they chose, stating why it is important, what it means, why it matters, or a combination of the three. (4) Tie it up/ conclusion sentence. See Appendix B for example.
- **Internalization:** A process in which an expert slowly transfers the responsibility of the task to the learner so that each time the task is completed, the learner completes more of the task until eventually it can be completed without support (Vygotsky, 1978).
- **Scaffolding:** The process that enables a child or novice to solve a problem, carry out a task or achieve a goal which would be beyond [their] unassisted efforts (Wood, et al. 1976, p.90).
- **Sentence frame:** A scaffolding device used to help students write using academic language.

- **Transfer of Responsibility:** Transfer of Responsibility requires that, over time, the learner gradually assumes responsibility for the task, so that the responsibility of learning a task completely transfers from the expert to the student (Van de Pol, 2010).
- **Zone of Proximal Development (ZPD):** Described as the gap between a child's ability to complete a task on their own and the potential that the same child has of completing that activity with the guidance of adults or peers (Vygotsky, 1978).

Summary

Chapter One has provided an overview of the purpose of this study as determining the best method for removing scaffolding supports from student use so that they are still able to complete a task. This chapter has also provided a detailed outline of theories related to this study. Background has also been provided on the researcher to enlighten the reader regarding how this study came to be.

Chapter 2—Literature Review

Since the mid-1970's, researchers have been investigating instructional scaffolding, or the "process in which a child or novice to solve a problem; carry out a task or achieve a goal which would be beyond [their] unassisted efforts," (Wood et al., 1976, p.90). Since Wood et al., (1976) first developed the metaphor of scaffolding, many other researchers have used scaffolding to explain the process of introducing a task or topic to a student and then eventually removing the scaffolding, once students have learned the scaffolding techniques provided by the teachers. Although originally created for the use of one-on-one interactions, Cazden (1979) was the first to suggest that scaffolding could be used with multiple learners at one time. Since this time, researchers have been looking deeper and deeper into the many components of scaffolding.

While researchers have been looking into the different parts of scaffolding and how to make the process work best, there has been limited focus on the process of removing, or fading, scaffolding once students had sufficient practice with a support. It wasn't until the early 1990's that researchers began to look into the process of removing scaffolding and how to best remove it so that students are capable of completing the expected task after the support has been removed.

Scaffolding

Definition and metaphor of scaffolding. In the world of construction, scaffolds are defined as "temporary frameworks of poles and planks that are used to support workers and materials during construction and modification of a building" (Lajoie, 2005, p. 542). When this definition of scaffolding is brought into the world of education, its definition is transformed into a "temporary framework [that] support[s] learners when assistance is needed and is removed when no longer needed" (Lajoie, 2005, p. 542). Greenfield (1999) describes scaffolding as it applies to the world of construction as having five characteristics, "…it provides support; it

functions as a tool; it extends the range of the worker; it allows a worker to accomplish a task not otherwise possible; and it is used to selectively aid the worker where needed" (p. 118). These same five characteristics are all vital to ensuring that scaffolding is effective in its implementation within education.

Stone (1998) provides a review of the metaphor of scaffolding and points out a few concerns with the construct. Such concerns include: that the metaphor is highly connected with middle-class, industrialized societies; that it does not take into account intellectual disabilities; and that it disregards cultural differences, especially when working with diverse groupings. Another concern is that the metaphor of scaffolding has become so broad, that it has become unclear in its definition and that the metaphor of scaffolding has now become synonymous with support (Lepper, et al. 1997; Pea 2004; Puntambekar & Hübscher 2005; van de Pol, et al. 2010). Due to the very broad nature of the metaphor, Lepper, et al. (1997) suggest a more concise version of the metaphor: "…scaffolding as the sorts of temporary structures that are used to support arches or tunnels under construction, but which later, once construction is complete, can be removed without danger of the arch or tunnel subsequently collapsing" (p.110). In education, this could be restated to mean that supports are removed a student is able to complete a task without needing additional support from the teacher. Puntambekar and Hübscher (2005), point out that while many such metaphors could be suggested and subsequently debated, that the important aspect of scaffolding that needs to be remembered is the support that an adult or expert provides to a learner until that learner is capable of performing the task independently when the support has been removed.

History

This definition of scaffolding was first suggested by Wood, et al. (1976) in relation to the tutorial process in which an adult or expert provides help to someone who is less able to perform a task. Specifically, Wood, et al. (1976) described scaffolding as an "adult controlling those elements of the task that are essentially beyond the learner's capacity, thus permitting [them] to concentrate upon and complete only those elements that are within [their] range of competence" (p.90).

Similarly, Harris and Hodges (1995), defined scaffolding as "…the gradual withdrawal of adult (e.g. teacher) support, as through instruction, modeling, questioning, feedback, etc., for a child's performance across successive engagements, thus transferring more and more autonomy to the child" suggesting that over time, the supports provided by the expert need to be faded so as to ensure that students are eventually able to complete the task without support (p.226).

Very often found in relation to the idea of scaffolding is the Zone of Proximal Development (ZPD) which was presented by sociocultural psychologist, Lev Vygotsky. In his theory, Vygotsky described the ZPD as the gap between a child's ability to complete a task on their own and the potential that the same child has of completing that activity with the guidance of adults or peers. Stone (1993) connects Vygotsky's ZPD to the scaffolding process claiming that scaffolds allow a student to reach a higher level of understanding that is within their ZPD as compared to a situation in which no supports were provided.

The link between Vygotsky's ZPD and the research conducted by Wood, et al. (1976) was first made by Cazden (1979) when she provided examples of scaffolding strategies to describe how the ZPD can be reached. Cazden also argues that since adults can scaffold

children's learning in a multitude of ways, that the idea of Vygotsky's ZPD provides a logical platform for understanding adult-child and teacher-student interactions (Cazden, 1979).

Required Elements of Scaffolding

Since the induction of scaffolds, researchers have suggested important elements that are required for scaffolding to be successful; however, not all researchers agree on exactly the same elements, so some variation occurs in these elements.

In their research, Wood et al., (1976) developed six requirements for types of support that can be provided for the successful implementation of scaffolding: (a) Recruitment, (b) Reduction in degrees of freedom, (c) Direction Maintenance, (d) Marking critical features, (e) Frustration Control, and (f) Demonstration. Recruitment is the first and most crucial step according to Wood et al. (1976) for the reason that it is in this stage when you elicit the interest of the child. Reduction in degrees of freedom involves the expert tutor reducing the number of tasks that are required of the child so that he or she can focus on the important part of the task at hand. Direction maintenance is when the expert tutor is required to keep the child interested in the goal, as well as keeping the child motivated to complete the task. Marking Critical features is important to the process because it is when the expert tutor points out the parts or features of the task that are needed to properly complete the task. Frustration control is also crucial to the process because with the guidance of an expert, the task should be easier to complete than if there was no help at all. Finally, Demonstration must take place so that the child can see how the task should be completed and imitate it in order to achieve success (Wood et al., 1976). Stone (1998) suggests that the elements provided by Wood, et al. (1976) can be easily put into three categories: (a) a perceptual component (pointing out critical features), (b) a cognitive component (reducing degrees of freedom) and (c) an affective component (reducing frustration of the task).

Van de Pol et al., (2010) also provide three common characteristics that are necessary for strategies to be considered scaffolding: Contingency, Transfer of Responsibility, and Fading (discussed in later sections). Contingency refers to the adjustments that must be made while the student is being supported. In essence, the teacher must adjust the support being provided, depending on the students' current level of understanding, ensuring that the student remains within their ZPD (Lin et al., 2012). Transfer of Responsibility requires that, over time, the learner gradually assumes responsibility for the task, so that the responsibility of learning completely transfers from the expert to the student.

Stone (1998) argues that there are four key features necessary in order for scaffolding techniques to be successful. Fist, Stone necessitates the need for a task that is meaningful and culturally desirable to the student in order to ensure that the student will be interested in achieving the objectives. The second feature is that the adult needs to titrate their assistance. In other words, teachers must add or remove supports provided to the student as needed. Third, the adult needs to provide a wide range of supports that can include either nonverbal (e.g., pointing) or verbal supports (e.g., dialogue). Finally, the supports need to be assumed as temporary in order to provide for a transfer of responsibility. Stone also mentions another element that he does not include within his four features: activation of prior knowledge. Stone (1998) claims that before the child can move on to completing the new task, the child must be reminded of the previous knowledge that is required to complete this task, which also helps to maintain interest in the task.

Scaffolding Environments

Scaffolding was first presented by Wood et al., (1976) as a support that involved one-on-one interactions. Such interactions were conducted between a tutor and a tutee; or a parent and

child, but has since been modified to include interactions between student(s) and teacher(s) (Davis & Miyake, 2004). The majority of the research conducted between 1976 and 1990 involved one-on-one interactions between a parent and their child. Cazden (1979) asserted that there was room for scaffolding in more complex environments, such as the classroom, but it was not until the mid-1980's that researchers started to research scaffolding within these complex environments.

Complex learning environments. Complex scaffolding environments changed the notion of scaffolding from one-on-one interactions to interactions with groups of two or more students, including scaffolding inside the classrooms. Davis and Miyake (2004) note that complex learning environments do not consist of only an expert and a learner. Instead, they point out that teachers, peers, paper-based artifacts, classroom decorations, technology, and manipulatives can also be used to scaffold students' learning.

Rogoff (1990) claims that peers can also be as valuable scaffolding agents. Peers, she says, can provide motivation and encouragement, both of which are crucial in a classroom setting for the reason that peers often force each other to think. On the other hand, Rogoff points out the fact that peer scaffolding could also be detrimental, especially if the partner's level of competence is lower or higher than their peers. This is because the partner may not be able to help the learner reach their potential if too much or not enough support is provided.

Hogan and Pressley (1997) point out another important concern with the use of scaffolding in complex environments: when working with an entire classroom, it is almost impossible for a teacher to interact with every student in a one-on-one basis. Instead, the teacher must address the entire class at once, thus being confronted with multiple ZPD's and ultimately,

a variety of student needs at one time. As a result, Hogan and Pressley (1997) suggest that teachers place students within groups and scaffold each group according to their current needs.

Fading of Scaffolding

Scaffolding is the support provided to learners to enable them to complete a task that is initially too difficult for them to complete on their own. In the construction world, scaffolds are slowly removed as sections are no longer needed and fully removed when the building has been constructed. The same is expected to happen within the field of education, particularly in regards to student acquisition of knowledge. Sherin et al (2006), suggests that "It [is] assumed that the task is one that is characteristic of expert activity and that the novice will ultimately perform the task without assistance" (p. 395). In other words, as time progresses, scaffolding supports are gradually decreased and eventually completely removed, making the supports no longer accessible to the student (Lajoie, 2005). This process of slowly decreasing the amount of scaffolding provided is referred to as fading. The ultimate goal of scaffolding is to ensure that students are able to complete a task on their own without support (McNeill et al., 2006).

In this process of fading, the expert slowly transfers the responsibility of the task to the learner so that each time the task is completed, the learner completes more of the task on their own until eventually it can be completed without support (Lajoie, 2005). Vygotsky (1978) described this process as Internalization for the reason that once the student has internalized the scaffolding support, the support is then able to be removed. Van de Pol, et al. (2010) states that the rate at which fading occurs depends on the child's current level of development and competence with the task. Lajoie (2005) has noted that once a student has demonstrated competence in the task, the scaffolds should be faded gradually, ensuring that the student can independently show that they can complete the task before supports are fully removed.

Davis and Miyake (2004) report that even though the idea of fading scaffolding is considered a necessity for scaffolding to be effective, very little research has been conducted on the issue. They also claim that the cause is the complexity of the scaffolding process. They further assert that the interactions between adult and child are constantly changing, making it hard to know when it is appropriate to reduce the amount of support a learner requires. Hogan and Pressley (1997) also note that scant research has been done in regards to fading scaffolding in a complex environment because it is difficult to gauge where the ZPD of each student in the classroom. However, they point out that even though complex environments involve many ZPD's, scaffolding can still be effective if the environment is structured properly.

Conclusion

Scaffolding is crucial in any learning context because it allows students to learn a concept that may be too difficult for them on their own and allows them to complete a task on their own, assuming that the proper supports are provided. Scaffolds can be found in many forms: teachers, peers, technology, manipulatives, paper-based artifacts, and even classroom decorations (Davis & Miyake, 2004). While the notion of scaffolding first started with one-on-one interactions, over the years, scaffolding has evolved into a strategy that can be used in more complex environments, such as classrooms (Cazden, 1979). Although researchers are conflicted in the true meaning of the metaphor, most researchers will agree that there are three features of scaffolding that are required for scaffolding to be considered successful: Contingency, Fading, and Transfer of Responsibility (Davis & Miyake, 2004; Lajoie, 2005; McNeil et al., 2006; Sherin et al., 2006; Van de Pol et al., 2010). If the expert can provide adaptive support that is tailored to a students' current understanding of the task and slowly transfer the responsibility of the task to

the student, while reducing the amount of support provided, it can be considered successful (van der Pol et al., 2010).

Researchers also agree that fading of scaffolding is one of the most important factors in determining the success of scaffolding (Lajoie, 2005). For scaffolding to be successful, the student needs to be able to internalize the support that they have been provided with so that they may complete the task again in the future without any extra support needed (van de Pol et al., 2010).

While there has been a substantial amount of research conducted on scaffolding, very little research has been conducted on the concept and process fading of scaffolding. Since Wood et al. (1976) first mentioned scaffolding, many researchers have mentioned the idea of fading scaffolding, but no one has yet to describe the exact process of how one should implement fading within the classroom so that students can be more successful in completing tasks (Stone, 1998).

Implications for Research

While a substantial amount of research has been conducted in the area of scaffolding, little work has been completed on fading scaffolding within the classroom. Future research needs to focus on the process of fading scaffolding, including, but not limited to, a procedure for fading scaffolding in the classroom. Research should also be conducted in regards to working with multiple ZPD's and the best way to scaffold in those situations.

Summary

Chapter Two presented literature on the uses of scaffolding, its history, the different environments it can be found in and fading of scaffolding. Chapter Three consists of the setting and participants of the action research study. Additionally, Chapter Three discusses data collection procedures and the implementation of the scaffolding supports.

Chapter 3—Methodology

Introduction

In this chapter, I will describe the methods I will use to gather and analyze data to answer the following research questions:

1. Can scaffolding be faded so that students can perform a task expected of them when they are no longer provided with scaffold supports?
2. What factors contribute to a successful fading exercise?
3. What is the effect of fading, and eventual removal of scaffolding on the completion of the expected task?

Action Plan

Overall research design. Students were given a pretest to determine how well they could write a paragraph without any supports. Throughout the year, students were given additional paragraphs, with varying amounts of supports. At the end of the study, students wrote a three paragraphs to determine how well they have internalized the Introduction, Citation, Analysis, Tie-it-up (ICAT) template through the process. At the end of the study, I performed a comparison of the sample means and standard deviations to be used as an indicator of student performance in regards to paragraph writing skills.

Specific research plan. Specifically, I conducted a comparison of the means and standard deviations to gauge student performance throughout the study in order to determine if students improved in their ability to write paragraphs and in turn internalize the supports provided. There was no control group utilized during this study due to the fact that I wanted to ensure that all of my students had equal access to the scaffolding supports that would ultimately

help them improve their writing skills. Because of this, I was only able to compare the means and standard deviations as students wrote paragraphs that gradually faded scaffolding.

Setting

The setting of my research was Teal Meadow Middle School in Hillview, CA (pseudonyms). The following information was taken from the city and school websites.

Community. According to the U.S. Census (2010), the population of Hillview, CA was 150,498 and consisting of roughly 75% Hispanic, 16% White alone, 2% Black alone, 6% Asian alone; the remaining 1% consists of "Other" or "Mixed" races. Median age of the population is 28.6 years. The median household income is $50,587 (www.city-data.com).

School. The school where the research was conducted is one of five middle schools in the district, serving the largest student population in the district with approximately 1200 students from grades seven through eight.

Class. For the 2014-2015 school year, there were 144 students listed on my roster spread amongst five different sections of seventh grade Life Science. One section was composed only of English Learners, with most of their first and home languages being Spanish. The other four sections include a mix of Reclassified English Learners and English Only students. There were also five students classified as needing special education resources.

Participants

Students. Due to the fact that I am a teacher and only have access to the students who were placed on my roster, I used a convenience sample consisting of all my students spread across five different sections of seventh grade Life Science. Racial demographics of the 144 students were approximately: 88% Hispanic, 6% Asian, 4% White, 2% African American and less than 1% other. Approximately 59% of the students are female and 42% were male. Twenty-

seven percent of the students were classified as English Learners. Thirty percent were classified as socio-economically disadvantaged. These students varied in age, from 11 to 13 years old throughout the study, depending on when they were first enrolled in school.

Prior to the pre-test, I randomly selected half (72 student) of the 144 students on my roster to collect data from. This ensured that I had a large enough sample of data to analyze. Allowing for attrition and student absences on data collection days, the number of participants included in the study was reduced to 51 students.

Data Collection Procedures

Intervention. The intervention required students to write four-to-six sentence paragraphs regarding different science concepts. The students were provided with a template abbreviated ICAT. This template broke down the paragraph into four sections: (1) Introduction sentence (2) Citation (Students will cite a text that they read or a video they watched. (3) Analysis (Students will analyze the citation that the chose, stating why it is important, what it means, why it matters, or a combination of the three. (4) Tie it up/ conclusion sentence. In total, students wrote 10 paragraphs throughout the school year; five paragraphs used scaffolding and four paragraphs were written without scaffolding. During the study, students were required to write six paragraphs that included only one citation and analysis; and three paragraphs with two citations and analyses. As such, the names of the paragraphs were modified depending on the number of citation and analysis sentences students were required to write (e.g. if students wrote two citations and analyses it was called an ICACAT paragraph).

Implementation. At the beginning of the study, students wrote a baseline paragraph in which they were not provided with any supports for writing their paragraphs. This baseline paragraph was graded using a very basic 4-point rubric that gauged how well they are able to

write an ICAT paragraph from "0" (did not write the paragraph, off topic, etc.) to "3" (wrote a perfect ICAT and exceeds expectations).See Appendix A. After students wrote their baseline paragraph, they wrote another paragraph on the same topic, except this time, they were introduced to the ICAT template and other resources that they needed to write their paragraphs. The ICAT template provided students with sentence frames and sentence starters to help them write out their paragraphs. For all paragraphs written following the baseline paragraph, the students were graded on a 4-level, 4-point rubric (additional levels are added depending on the number of citation and analysis sentences required) that assessed each part of the ICAT paragraph as being on-topic and having complete sentences. See Appendix A.

As they wrote more paragraphs, the amount of sentence frames and sentence starters was reduced and the amount of the paragraph that students were to write on their own was increased over time. Eventually, students were no longer be provided with sentence frames, starters or even the ICAT template. It was the expectation that by the end of the study, students would have written enough paragraphs using the ICAT template that they would have internalized the ICAT template and were able to write a paragraph without the template or any sentence frames or starters, but still be able to write a paragraph using the ICAT structure.

Data Sources

Quantitative data. Student data was collected from the scores they received on the two grading rubrics.

Baseline rubric. Student scores were recorded as earning a number between "0" (did not write the paragraph, off topic, etc.) and "3" (wrote a perfect ICAT and exceeds expectations). See Appendix A.

Post-baseline rubric. After students wrote their baseline paragraph, all paragraphs that they

wrote were graded using a 4-level, 4-point rubric (16 points in total) that assessed each part of the ICAT paragraph. Paragraphs that use the ICACAT template (i.e., students need to write two citations and two analyses) used a 6-level, 4-point (24 points total) rubric. See Appendix A.

Data Analysis

To analyze the data, I collected the scores that the students received in a Google spreadsheet. For the baseline, I wrote the number of the score they received on the paragraph from zero to three. Following the baseline, I collected the students' total scores (out of 16 or 24) and divided those scores by the number of sentences in order to obtain a score out of four points. I then recorded this number to be used in the same spreadsheet as the baseline data. Finally, I analyzed the scores for all students and found the mean score and standard deviation for each paragraph to use for comparison.

Limitations

Although many efforts were put into place to help prevent threats to internal and external validity, there were threats that could limit the overall validity and usefulness of the findings.

- **Understanding of content.** Typically, when students write paragraph on a topic, it is not fully related to the content they are learning. For example, they may learn about unicellular versus multicellular organisms and then write a paragraph explaining their opinion of the brain-eating amoeba as a dangerous organism after reading an article and watching a video about the brain-eating amoeba (which was the prompt for the first and second paragraphs). Usually, the paragraphs are meant to extend their knowledge on the topic, so they may reference the content that they just recently learned (e.g., unicellular organisms), but the paragraphs are not directly reinforcing the content. As a result, a limitation of this would be that the students do not understand the content that the

paragraph is addressing, thus hindering their ability to write a successful paragraph utilizing the instructional supports (i.e. the ICAT template).

- **Understanding use of scaffolding support.** For some students, the ICAT template may be confusing or the type of support and hints provided may be difficult to for them to understand and not ask for help or clarification on how to use it. For example, students may not understand that they need to write the sentence starter (provided to them on the template) and then the end of the sentence that they initially wrote in order to form a complete sentence. If this, or another misunderstanding, is the case, students may not write successful paragraphs using this template. If this does occur, then the result may be that the student does not earn a very high score when graded using the scoring rubric.
- **Multiple zones of proximal development.** When working with more than one student at a time, there can be a risk of working with two or more different ZPD's, meaning that the students could be in different places as far as understanding how to use the scaffold support put in place. As such, when providing supports to an entire class of 20-plus students, there are a multitude of varying ZPD's, and a limitation could be created in the sense that everyone will be moving along at the same pace as far as the fading of scaffolding support. This poses an issue that not all students may be ready to have the scaffolding supports faded at the same time or rate and need more support than is being provided to them, ultimately resulting in a lower overall score on the scoring rubric.
- **Baseline data.** In multiple baseline studies, usually more than one baseline measure needs to be conducted in order to promote internal validity. Center and Leach (1984) state that "the minimum number of measures required for a baseline is three, since a trend in the data cannot be detected with any fewer," (p. 233). However, due to the limitations

in the length of the study, as well as the rigorous curriculum pacing guide provided by the school district, it will be difficult to collect more than one baseline measure before beginning the intervention. Students usually require two to three days to complete their paragraphs (including a rough and final draft); therefore, a total of 10 paragraphs would require 20-30 school days in order to collect all of the data. As a result, it is necessary to move on to providing scaffolding supports as soon as possible in order to gauge how well students can use the supports provided; this method allowed more time to students to learn how to use the supports and eventually learn how to write without the supports being provided. Additionally, if students wrote more than one baseline paragraph, they may have formed writing habits that could be detrimental to their success in using the scaffolds (i.e., they may have become so used to writing paragraphs that are not properly structured that they become unable to utilize the support to its fullest extent).

- **Difference in teacher implementation.** At the start of the school year, my school's administration decided to have everyone implement the ICAT format in all classes. As such, it could be possible that students will learn how to complete the ICAT paragraph in a different manner than I expect them too. If this is the case, I may not immediately recognize this and be able to make sure they know how to complete it correctly in my class. This could have a negative effect in terms of having to re-teach individual students independently how they should complete it in my class.

Summary

This chapter provided descriptions of the study that took place, including the description of participants, data collection procedures and the intervention implemented. The next chapter will present the results of the study.

Chapter 4—Results

Introduction

The purpose of this study was to answer the following questions: (a) Can scaffolding be faded so that students can perform a task expected of them when they are no longer provided with scaffold supports? (b) What factors contribute to a successful fading exercise? (c) What is the effect of fading, and eventual removal of scaffolding on the completion of the expected task? This chapter presents the data collected from the study. In addition, I will be providing a detailed explanation of the scaffolding providing to the students and how the supports were faded during the study.

Participants

Due to attrition and student absences, I allowed for students to have no more than one score missing for their scores to be included in the data. As a result, the participant number was reduced from 72 students to 51 students over the course of the study. The number of students that data was collected from in each of my five sections can be found in Table 1.

Table 1

Participants per Class Section

Period Number	Number of Students
Period 1	9 Students
Period 2	14 Students
Period 4	13 Students
Period 5	9 Students
Period 6	6 Students

Baseline Paragraph Procedures and Results

Procedure. Students wrote nine paragraphs using the ICAT structure (Introduction, Citation, Analysis, Tie it up) during the course of the study. Paragraph names and descriptions

are included in Table 2. Detailed descriptions of procedure and modifications provided to students are given below.

Table 2

Brief Paragraph Descriptions

Paragraph #	Paragraph Name	Prompt	ICAT or ICACAT	Support Provided
1	Brain Eating Amoeba-Baseline Assessment	Explain if you think the brain eating amoeba is dangerous. Support your opinion with evidence from both articles and the video.	N/A	NO
2	Brain Eating Amoeba- Scaffolded	Explain if you think the brain eating amoeba is dangerous. Support your opinion with evidence from both articles and the video.	ICACAT	YES
3	Photosynthesis/ Global Warming	How can we use the process of photosynthesis to solve global warming?	ICACAT	YES
4	The English Peppered Moth	What caused the peppered moths to change colors?	ICAT	YES
5	Polar Bears	Explain why polar bears are not well adapted to the dry land environment.	ICAT	YES
6	What Darwin Never Knew	What is Natural Selection?	ICAT	NO
7	Cactus Adaptations	What adaptations help make cacti successful in a hot and dry environment, like a desert?	ICACAT	YES
8	Spaceship Earth-The Universe	Write an ICAT paragraph (4-6 sentences) about what you learned in the video.	ICAT	NO
9	Bill Nye: Fossils	Explain what a fossil is. Be sure to cite your evidence from the video.	ICAT	NO
10	Cornell Notes: Sedimentary Rock an Superposition	Explain the importance of superposition.	ICAT	NO

Baseline paragraph assessment procedure. Students were provided with an article and guiding questions and watched a short video on the topic. After they read the article and answered the questions, they were instructed to write a minimum five-sentence paragraph. No

additional directions were provided to the students. Paragraphs were collected the next day and later scored. See Appendix B.

Baseline paragraph results. Of the 51 paragraphs scored: eight students earned a score of zero; 40 students earned a score of one; three students earned a score of two and; zero students earned a score of three. The mean score for all students (N=51) was 0.91 and the standard deviation was 0.46. See Table 3 and Figure 1.

Table 3

Comparison in Student Performances between Scaffolded and Unscaffolded Tasks

Paragraph #	Paragraph Name	Mean Score	Standard Deviation	Support Provided
1	Brain Eating Amoeba-Baseline Assessment	0.91	0.46	NO
2	Brain Eating Amoeba	3.60	0.88	YES
3	Photosynthesis/ Global Warming	3.74	0.74	YES
4	Peppered Moth	3.72	0.69	YES
5	Polar Bears	3.64	0.79	YES
6	Natural Selection	2.42	1.41	NO
7	Cactus Adaptations	3.73	0.55	YES
8	Spaceship Earth-The Universe	2.93	1.46	NO
9	Bill Nye: Fossils	3.47	0.9	NO
10	Cornell Notes: Sedimentary Rock and Superposition	3.62	0.97	NO

Note: See Appendix E for complete student data

Mean Scores and Standard Deviations

To analyze the data presented in Table 3, a comparison of the mean scores and standard deviations was used. The mean score is the average score that all students received on each paragraph. The baseline paragraph was graded on a 3-point rubric and the following nine paragraphs were graded using a 4-point rubric.

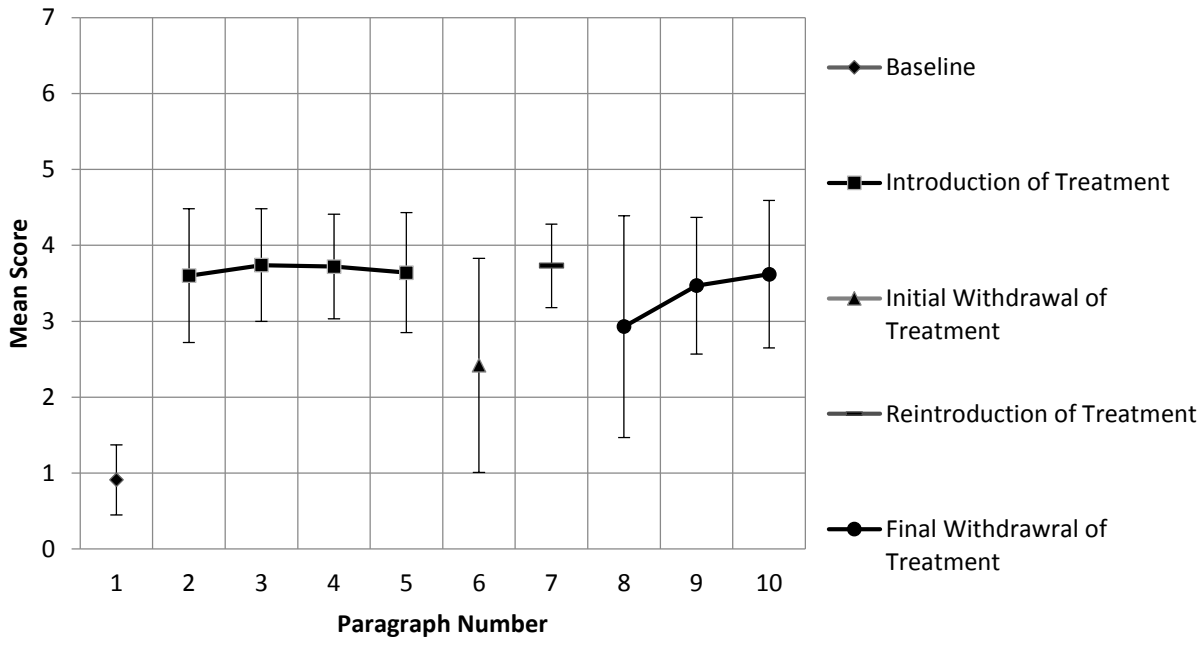

Figure 1. Mean Score of Paragraphs. Error bars represent standard deviations.

A comparison of the means will show student performance throughout the study. A high score (i.e., mean scores ranging from three to four points following the baseline paragraph) indicated that students understood the task expected of them and were able to properly use the scaffoldings support provided to them. Conversely, a low score (i.e., a mean score below three) indicated that students have not been able to learn how to use the scaffolding properly and that the amount of scaffolding provided needed to be increased rather than continuing to fade the supports provided.

The standard deviation is the indicator of variability from the mean score. A higher number indicates that there is a larger distribution of scores from the mean. A larger standard deviation indicated that that many students needed more support when writing paragraphs. A small standard deviation is indicates that the difference in means are less likely to be a result of chance, in other words, to be more statistically significant.

Introduction of Treatment Procedures

Procedure. Students were introduced to the Says-Means-Matters to ICACAT graphic organizer, ICAT Matrix, and Says-Means-Matters (See Appendix D). Students used three different colors to color-code each box in all three pages as a citation, analysis or introduction/conclusion sentence. Students had not used the Says-Means-Matters in my class before, but had seen it in other classes, so it was necessary to show them how there were using it in my class to write an ICACAT paragraph. The Says-Means-Matters template required students to state what a source said, then restate what the source said in their own words, and then finally indicate why that citation matters to help support their claim. Students then worked in groups to select a quote from each article, analyze it and complete the two Says-Means-Matters on their handouts.

Students were introduced to the planning template the next day. The planning template was broken down into three columns. The first column informed the students what type of sentence they were to write and hints to let them know what each sentence type required (i.e., "topic sentence", "Evidence from video", etc.). The second column provided sentences starters or frames to help guide the students in their thinking. The final column included space for students to finish writing their sentences. See Appendix B.

The planning template for this paragraph included a sentence starter for both the introductory sentence and conclusion sentence. The citation and analyses sentences provided very brief sentence starters to help ensure that students cited the author and explained what the quote said. Next, students used the planning template to write a final draft of the paragraph on a sheet of binder paper. When students finished writing, they used the same colors to color-code their sentences to show that they had all parts of the ICACAT format.

Finally, students were introduced to the ICACAT Rubric. After they were shown what they would need to do to earn full points, they scored themselves using the rubric. Next, they shared the paragraph with a peer who scored their papers and finally, they turned in their paragraphs to be scored. See Appendix C.

Paragraph #2 results. Student scores increased once the scaffolding structure was implemented. Zero students scored a zero; three students earned a score of one; one student earned a score of two; 12 students earned a score of three and; 20 students earned a score of four. Fifteen students do not have scores for this assignment due to absences or because they neglected to turn it in. The mean score for this assignment was (N=36) 3.60 and the standard deviation was 0.88. See Table 3.

Selected Paragraphs from Table 3

Paragraph #	Paragraph Name	Mean Score	Standard Deviation	Support Provided
2	Brain Eating Amoeba	3.6	0.88	YES
3	Photosynthesis/ Global Warming	3.74	0.74	YES

Faded Treatment Procedures

Paragraph #3 modifications. This paragraph was conducted in a test setting. The students read the article, watched the accompanying video and then answered the guiding questions at their own pace using their provided note-taking tool. Students then wrote a rough draft using the planning template. For this planning template, students were again provided with sentence starters very similar to those provided in Paragraph #2. See Appendix B.

Paragraph #3 results. Student scores continued to improve with this paragraph. One student earned a score of zero; one student earned a score of one, two students earned a score of

two; six students earned a score of three and; 42 students earned a score of four. The mean score was (N=51) 3.74 and the standard deviation was 0.74.

Paragraph #4 modifications. Students read the article and then answered the guiding questions. The guiding questions including two questions that were designed to help students create their citation and analysis sentences. Students then wrote a draft using the planning template, which only provided very brief sentence starters to guide students in what type of sentence they should be writing. In addition to the reduction in the support provided in the sentence frames, the first column was also modified on the planning template— Instead of providing a hint as to what students needed to be write, the column now only said what type of sentence needed to be written (i.e., Introduction, Citation, Analysis, Tie it up). See Appendix B.

Paragraph #4 results. Zero students earned a score of zero; two students earned a score of one; three students earned a score of two; four students earned a score of three and; 41 students earned a score of four. The mean score was (N=50) 3.72 and the standard deviation was 0.69.

Selected Paragraphs from Table 3

Paragraph #	Paragraph Name	Mean Score	Standard Deviation	Support Provided
4	The English Peppered Moth	3.72	0.69	YES

Paragraph #5 modifications. Students wrote this paragraph in a test setting. Students were given two days to read the article, and answer summary sentences. They were shown the accompanying video twice as a class. Students were given a planning template that provided no support aside from the graphic organizer with two columns, one column provided the type of sentence to be written with quick hints about what to write and the other to write their complete sentences. See Appendix B.

Paragraph #5 results. Student scores continued to remain consistent for this paragraph. One student earned a score of zero; zero students earned a score of one; three students earned a score of two; eight students earned a score of three and; 37 students earned a score of four. The mean score was (N=49) 3.64 and the standard deviation was 0.79.

Initial Withdrawal of Treatment Procedures

Procedure. For this paragraph, students were not provided any support for the first time. Students did not receive a planning template for this paragraph. Instead the received a handout that had lines for them to write out their paragraph. For this assignment, students watched a video and answered questions about the video while they watched. When the video finished, students were expected to summarize the video using the ICAT format. The only scaffolding students received was verbal instructions telling them what should be included in each paragraph. See Appendix C.

Paragraph #6 results. Student scores decreased when the scaffolding was completely removed for the first time. Five students received a score of zero; 12 students received a score of one; five students received a score of two; 13 students received a score of three and; 15 students received a score of four. The mean score was (N=50) 2.42 and the standard deviation was 1.41.

Selected Paragraphs from Table 3

Paragraph #	Paragraph Name	Mean Score	Standard Deviation	Support Provided
5	Polar Bears	3.64	0.79	YES
6	What Darwin Never Knew	2.42	1.41	NO

Reintroduction of Treatment Procedures

Procedure. Since the student scores decreased when the scaffolding was initially removed, the scaffolds were put back in place. For this paragraph, students read an article and

answered guiding questions while they read. The planning template was reintroduced and provided increased support from the last time the template was implemented during paragraph #5. Similar to paragraph #5, the template was only two columns, however, this time, hints were once again provided to help guide students in their writing. Additionally, the template provided directed questions for the citations to ensure the students gave citations regarding specific parts of the article. Sentence frames and starters were not provided to the students for this paragraph. Aside from the provided hints, students did not receive any other support in their writing. See Appendix B.

Paragraph #7 results. Student scores returned to the level they were before supports were removed in paragraph #6. Zero students received a zero; zero students received a one; five students received a two; eight students received a three and; 36 students received a four. The mean score for this paragraph was (N=50) 3.73 and the standard deviation was 0.55.

Selected Paragraphs from Table 3

Paragraph #	Paragraph Name	Mean Score	Standard Deviation	Support Provided
7	Cactus Adaptations	3.73	0.55	YES

Selecting Relevant Quotations Lesson

Procedure. It had become apparent with the first paragraph that provided no support that students were having difficulty selecting quotes that were relevant and helped answer the prompt. As such, students were given a supplementary lesson that provided recommendations for finding the most appropriate quote to use in their paragraphs. In addition, students were given support to help them provide reasoning for why they chose the citation that they did. The guidelines provided to the students are as follows:

- What is the question you are trying to answer?

- What are the keywords in the question?
- As you are reading, look for things that relate to those key words.
- Once you find the question, make sure it *directly* answers the question asked.

Students were provided with four excerpts of different news articles. I modeled how to use the guidelines with the first excerpt; the second excerpt the students completed as a class; the third one they worked in groups; they selected the most relevant quotation independently for the final excerpt. See Appendix D.

Results. The learning goal for this lesson was "I will be able to select a relevant quotation, given a scientific question and justify why this quotation provides evidence to answer the question." Data was collected based on student performance during the lesson. This lesson was part of a coaching cycle that I completed with the teachers that have the same subject and grade level. Data was only collected from the class that the other teachers observed. As such, the results for this assignment were not collected for all students in the sample. Instead, data was collected only from the students in my fourth period. Although it is not a complete data set, the results of my fourth period are included in Table 4 since these results were consistent across all classes.

Table 4

Lesson Objective Student Performance

Performance	Number of Students	Percentage of Students
Met learning objective	22	73.3%
Approaching learning objective	6	20%
Did not meet the learning objective	2	6.6%

Final Withdrawal of Treatment Procedures

Paragraph #8 modifications. Students were again given a paragraph that did not include any scaffolding supports. For this paragraph, students watched a video and answered questions

as they watched. After the video, students were given verbal instructions and were told to use one of the answers from their worksheet as the quotation. See Appendix C.

Paragraph #8 results. Student scores improved compared to the initial withdrawal of support. Seven students received a score of zero; three students received a score of one; four students received a score of two; 10 students received a score of three and; 27 students received a score of four. The mean score was (N=51) 2.93 and the standard deviation was 1.46.

Selected paragraphs from Table 3

Paragraph #	Paragraph Name	Mean Score	Standard Deviation	Support Provided
8	Spaceship Earth-The Universe	2.93	1.46	NO

Paragraph #9 modifications. I was sick the day this paragraph was given to the students. Instead instructions were left with a substitute teacher for students to complete with verbal directions to be read to the class. When I returned, due to the fact that almost one-third of the students received scores lower than three on paragraph 8, I gave a mini-lesson in order to remind students what was expected of them in an ICAT paragraph. I allowed students to revise paragraph #8 and also gave them an extra night to fix paragraph #9 as needed before turning it in. I also showed them a student sample from paragraph #8 that earned a score of four and suggested that they use self-monitoring techniques (e.g., making a checklist of each part of the paragraph and marking it off as they completed it, writing and circling the part of the ICAT structure that they needed prior to writing each sentence, etc.). This paragraph did not include any supports. Students were only provided with a handout that had lines for them to write the paragraph on. See Appendix C.

Paragraph #9 results. Student scores increased compared to paragraph #8. Zero students earned a score of zero; three students earned a score of one; four students earned a score of two; nine students earned a score of three and; 33 students earned a score of four. The mean score was (N=49) 3.47 and the standard deviation was 0.90.

Paragraph #10 modifications. To increase validity and reliability, a third and final paragraph was provided without supports; only a handout was provided that included lines for them to write their paragraph on. Prior to writing this final paragraph, students were given a lesson on a science topic. They completed a fill-in-the-blank notes handout during the lesson. When the lesson was completed, they were instructed to write a paragraph explaining the importance of the main topic of the lesson. Verbal instructions were provided that to let students know that they needed to use a specific part of the worksheet to use as a citation and that they needed to cite the notes as their source. No other supports were provided. See Appendix C.

Paragraph #10 results. For this paragraph, student scores continued to increase. Two students earned a score of zero; one student received a score of one; one student received a score of two; five students received a score of three and; 38 students received a score of four. The mean score was (N=47) 3.62 and the standard deviation was 0.97.

Selected paragraphs from Table 3

Paragraph #	Paragraph Name	Mean Score	Standard Deviation	Support Provided
9	Bill Nye: Fossils	3.47	0.9	NO
10	Cornell Notes: Sedimentary Rock and Superposition	3.62	0.97	NO

Comparison of Student Performance between Treatments

The grand mean score for the all paragraphs in the second through fifth paragraphs were calculated for each student and then compared to the score each student earned on the first

paragraph given without supports in place (paragraph #6). Two-thirds (66%) of the students (N=50) showed a decrease in scores when the support was removed, while only three-fourths (24%) of the students showed an increase in scores when the supports were removed. The remaining eight percent showed no change in performance when the supports were removed. See Table 5.

Table 5

Comparison of Student Performance between Introduction and Initial Withdrawal of Treatment

Change in Mean Score	Number of Students	Percent of sample
Increase	12	24%
Decrease	34	68%
No Change	4	8%

Note: N= 50.

Table 6

Comparison of Student Performance between Initial Withdrawal of Treatment and Final Withdrawal of Treatment

Change in Mean Score	Number of Students	Percent of sample
Increase	33	66%
Decrease	11	22%
No Change	7	14%

Note: N= 50.

The grand mean was also calculated to compare student performance between the initial withdrawal of treatment (paragraph #6) and the three paragraphs (#8-10) written without support. Two-thirds (66%) of the students showed an increase in performance from the initial withdrawal of treatment while less than one-quarter of students (22%) showed a decrease in performance between the two treatments. Seven students either increased or decreased in their performance between the two treatments. See Table 6.

Summary

This chapter reviewed the findings of the study. Students were assigned 10 paragraphs over the course of the study. Students wrote the first paragraph without any supports provided (M=.91, SD=.46). Then students were introduced and provided with the planning template which served as a scaffold to support students in writing their paragraphs.

Students wrote a total of four paragraphs with supports. For these four paragraphs, the grand mean was 3.675 and the standard deviation was 0.07). However, the amount of support provided in each paragraph decreased as the study progressed. Following these four paragraphs, students wrote a paragraph without supports, which resulted in a decrease of their scores (M=2.42, SD=1.41). As a result, students were then reintroduced to the supports previously provided. The results of this scaffolded paragraph indicate an increase in their mean score which was consistent with results when scaffolding was initially provided (M=3.73, SD=0.55).

Since the scores had returned to a consistent level, students then wrote a second paragraph without supports (M=2.93, SD=1.46) following a lesson on selecting quotes where 73% of the selected sample were able to meet the lesson objective. Due to the fact that the score increased from the previous attempt at completely fading the scaffolding, an additional paragraph was given that did not provide scaffolding to the students (M=3.47, SD=0.9). A final paragraph was then provided without support and the students showed an increase in scores again (M=3.62, SD=0.97).

Finally, mean scores were calculated for the paragraphs provided with treatment and paragraphs without treatment. These scores were then compared to the performance to the paragraph where supports were initially withdrawn from students use (Paragraph #6). Comparison of the scaffolded phase to the initial withdrawal showed a decrease in performance

for 68% of the students and an increase in performance for 24% of the students. Comparison of the initial withdrawal of treatment to the final withdrawal of treatment showed an increase in performance from 66% of the students and a decrease in performance from 22% of the students. The remaining percentage of students in both comparisons showed no change in scores.

Chapter 5—Discussion

Introduction

This chapter will discuss the results of the previous chapter and also present the major findings. Limitations of the study will also be considered and discussed. In addition to the implications of the research and recommendations for future research will be explained.

Major Findings

Student mean scores and standard deviations were analyzed. After analyzing the data, three themes were evident. These themes are:

- Students became dependent on the scaffolding support to the extent that when the support was removed for the first time, many students were unable to earn a high score on the paragraphs written without support provided.
- Once the support structure was fully removed for the second time, two-thirds of student scores increased over time, indicating that students had begun to internalize the scaffold.
- The students who did not improve over the course of the study indicated that they may need more support, that the task expectation was too complicated or that the supports provided may have been too far out of their Zone of Proximal Development (ZPD).

Relevance of Study

The primary goal of this study was to validate a process for fading or removing scaffolding for seventh grade students in a science classroom. A successfully faded scaffold would result in students having internalized the supports they were provided, leading to students being able to complete the expected task without the supports in place.

Although not the main purpose of this study, it should be mentioned that one of the major contributors to the context of this study was the use of scaffolding in my school district. My school district has introduced and required the implementation of various instructional methods across all subject areas; placing a major emphasis on student academic reading comprehension and writing at every grade-level. One of the programs that are heavily implemented is called Constructing Meaning (CM). All subject areas are trained and expected to use Constructing Meaning strategies such as graphic organizers, sentence frames and oral academic language supports, (e.g., conversation sentence starters). Constructing Meaning is a program that is designed to emphasize "...both academic English and critical literacy skills, thereby supporting English learners in acquiring the analytical language necessary to meet the demands of the Common Core," ("About CM", para. 2).

While these supports are helpful in providing students the structure to write and converse about the subject matter, there is little research that proves that the methodology provided by Constructing Meaning actually works and is beneficial to the students' academic language acquisition. However, based on the analysis of the results of the study, there may be reason to believe that students can become dependent on the scaffolding and when a teacher abruptly removes the scaffolds, the students may not be successful in completing the expected task. In essence, the student reliance on these scaffolds may actually hinder, rather than help these students improve in their skills, particularly in writing.

Student Dependency on Scaffolds

The data revealed that when students were initially withdrawn from the scaffolding, the overall mean score decreased for 68% of the students, while only 24% of the students showed an increase in performance. The fact that more than half of the students showed a decrease in scores

indicates that they may have become dependent on the scaffolding and were unable to write an ICAT paragraph because they had not been provided with enough time to internalize the scaffolds.

The baseline assessment results showed that the majority of the students in the sample were not able to write a paragraph using ICAT structure. When the scaffolds were first introduced, scores increased by over two points on average (M=3.60). Subsequent scaffolded paragraphs had mean scores of 3.50. Following the second paragraph, scaffolding was provided, but gradually faded. Prior to being fully withdrawn, paragraph #5 only provided students with a planning template that indicated which type of sentence needed to be written, as well as a brief hint that stated what each sentence should look like (i.e., the Citation sentence hint provided was "Evidence from the article"). See Appendix B. While very little scaffolding was provided to the students to assist them in their writing, student performance still resulted in a high mean score (M=3.64).

Due to consistent results, even with faded supports, I decided to fully remove the scaffolding from the students. This initial withdrawal of scaffolding resulted in a decrease in the mean score by over one point and a large standard deviation (M=2.42, SD=1.41). A low mean score indicated that many students were not ready to write ICAT paragraphs without support. A low score also indicated that they may have needed more time to practice with the ICAT structure before writing without support. Although students had been able to write an ICAT paragraph with minimal support, they still needed more time and support before they would be able to write a successful ICAT paragraph on their own.

A high standard deviation for this paragraph indicates a large amount of variation in the scores. Many students were able to earn a score of three or four suggesting that they may have

internalized the ICAT format and were not dependent on the supports in order to write an ICAT. However, many students earned a score of zero, one, or two suggesting that they needed more support and time to familiarize themselves with the ICAT structure before supports are removed.

Overall, these results suggest that time and repetitive practice is needed for students to be able to mentally process the structure before the supports can be fully removed. These findings also indicated that the students may not have had enough time to internalize the scaffolding supports between the time that the ICAT structure was introduced and subsequently faded. However, the large standard deviation also indicates that some of the students were starting to internalize the scaffolds and were able to write an ICAT paragraph without any supports.

Student Improvement after Final Withdrawal Treatment

Following the initial withdrawal of the scaffolding, the students were assigned a paragraph where they were reintroduced to the scaffolding supports. For this paragraph, students were once again provided with the planning template indicating which type of sentence was required as well as hints about what needed to be included in each sentence. The results provided a mean scores similar to the mean score for paragraphs with support (M=3.73).

After students' scores increased with the reintroduction of scaffolding supports, students then wrote an additional paragraph without support. Although the mean score was slightly higher than the initial removal of supports (M=2.93, SD=1.46) there was again an evident decrease in scores when the supports were fully removed as compared to the scaffolded paragraphs. Despite the fact that this score was low, this mean score was higher compared to the first paragraph without supports, this pattern suggests more students internalized the support. As a result, fewer students were dependent on the scaffolds.

Following paragraph #8, student scores continued to increase as they wrote more paragraphs without support. Paragraph #9 was written following the students being shown what an ICAT with a score of four looked like. Students were also advised to self-monitor their progress as they wrote to ensure they wrote all parts of the ICAT. There was a large increase in the mean score for this paragraph (M=3.47). Finally, an additional paragraph was administered to the students without supports provided and the mean score continued to increase (M=3.62).

If the scores of paragraphs nine and ten had remained consistent with the paragraph #8, it would suggest that students were not improving in their ability to write paragraphs. However, since the mean score increased by more than half a point from paragraphs eight to nine, this strongly points to the indication that students were starting to internalize the scaffold. This increase in scores following the initial withdrawal and reintroduction of treatment suggests that more students internalized the supports as they wrote more paragraphs. Additionally, when the scores of the initial withdrawal treatment were compared to the grand mean of the three paragraphs of the final withdrawal treatment, 66% of the students had scores that showed an increase in performance between the two treatments which reinforces the suggestion that more students were beginning to or had already internalized the scaffolding.

These results indicate that students may benefit from having multiple treatments in which the scaffolding is provided and then ultimately withdrawn. The withdrawal may apply pressure on the students to internalize the support. Removing and introducing the support multiple times provides the students the opportunity to refresh their minds and reinforces the requirements of an ICAT paragraph. Consequently, this process provides them time to mentally process and internalize the scaffold and practice applying the structure at their own pace.

Scaffolding and the Zone of Proximal Development

The paragraphs with the largest standard deviations were paragraphs six and eight. Both of these paragraphs resulted in a decrease in performance based on the mean score results. Paragraph #6's standard deviation was 1.41; and paragraph eight's standard deviation was 1.46. In comparison, the highest standard deviation in the other paragraphs (scaffolded and unscaffolded) was 0.97. As stated previously, a high standard deviation indicates a large variation in the scores that students received. The data (see Appendix E) shows a large distribution in scores. While more than half of the students earned scores of three or higher on both paragraphs, there were 22 students who received scores of two or lower for paragraph #6 and 14 students who earned scores of two or lower on paragraph #8. Of those scores, eight students received scores of two or lower on both paragraphs six and eight. The data from these eight students indicate that there may be some variance in the rate at which internalization occurs. Additionally, of those eight students, five of them received scores of three or higher on paragraphs nine and ten, indicating that by paragraph #9, they had been able to internalize the scaffold, while the other three students still needed additional practice and time before they would be able to internalize the scaffolds.

The Zone of Proximal Development is described as the gap between a child's ability to complete a task on their own and the potential that the same child has of completing that activity with the guidance of adults or peers (Vygotsky, 1978). Scaffolding is the method used to bridge the gap of a child's ability and their potential to complete the expected task that may be out of their capabilities were they to complete the task on their own. Although scaffolding can be used to help a child improve skills in a particular task, most research is conducted between a single student and a single expert. In a classroom, there are more than one student and usually no more

than one expert. As such, it is difficult to differentiate the scaffolds so that each student can work at their own level and own pace to learn the expected task. This could result in a variation in overall student performance, such as the variation seen in the results of this study.

Some students may have been able to perform at the expected level and internalize the scaffolds necessary to complete the task, while other students may need more practice and more time in order to internalize the scaffolds. This suggests that when working with a range of ZPD's, as one would in a classroom of 20 or more students, some students may require extra time and support as was evidenced by the eight students whose scores decreased when scaffolds were removed in paragraph #8 and the five students who improved their scores in paragraph nine and ten.

Student Trends throughout Study

Throughout the course of the study, the paragraphs written by the students were scored by me, using the grading rubrics (see Appendix A). As paragraphs were scored, I noticed that the student scores were being affected by (a) not following the ICAT structure and (b) when the supports were removed, during both the initial and final withdrawal phases, there was a tendency to revert back to summarizing sentences, rather than using the ICAT structure— being able to summarize is another scaffolded task they are expected to do in my class, hence it could explain the students' confusion.

One of the most common mistakes was students not following the ICAT structure by not including (or correctly writing) the citation or analysis sentences, or both. For instance, students would provide quotation or a paraphrase from a source, but would not indicate what or where they got their citation from. As a result of not citing the source, students' scores were affected because they lost one point automatically. Another common error with the citation sentence was

students selecting a quotation that was not relevant or supportive to the prompt. This is the reason why students received a lesson on how to select relevant quotations following Paragraph #7. The lesson provided them with guidelines for selecting the most relevant quotes to support their paragraphs. Following this lesson, students seemed to be more confident on being able to provide citations that helped to support their claim better than they had been able to previously (see Appendix D).

Students' scores were also affected by their performance on writing analysis sentences. The students that lost points lost them because they resorted to paraphrasing the citation or critical thinking was not evident through their analysis. Prior to writing the second paragraph, a scaffold was used. Students were introduced to the Says-Means-Matters template which required students to copy and write their citations in a specific way. The Says sentence required students to restate what the source stated. The Means and Matters sentences required the students to restate what the citation means in their own words and then indicate why that citation matters in order to support their citation (see Appendix D). If the students failed to state either what the citation meant or why it mattered, they automatically lost one point.

Another trend appeared only when students wrote paragraphs without scaffolding. Many of the students received low scores on the paragraphs without supports for one of two reasons. First, the students appeared to not understand the prompt or verbal directions, resulting in them writing a summary paragraph that simply explained four facts that they had learned from the source. Many times, students submitted paragraphs that met the required minimum length, but instead of each sentence following the ICAT structure, the sentences were statements of what they had understood or learned from the source (e.g., "I learned…"). The majority of the students who wrote paragraphs in this manner received a score of zero because their entire paragraph did

not follow the ICAT structure. Second, students did not self-monitor themselves as they wrote their paragraphs to ensure that they were including each part of the ICAT structure, resulting in many paragraphs that contained an introductory sentence followed by summary statements. This indicated that students were not keeping track of their writing and once they wrote the introductory sentence, they appeared to either forget the structure or stop paying attention to their writing and started to summarize the source instead. These students often earned a score of one because they may have been able to write an acceptable introduction sentence, but did not follow with the rest of the ICAT structure. It should also be noted that this tendency to write summaries instead of ICAT's, became a pattern for students who received low scores which could be the result of confusion about the task. While many students seemed to be able to internalize or remembered to follow the ICAT structure after initially receiving a low score, there were still a few students who continued to get low scores on the paragraphs as they continued to write summary paragraphs rather than follow the ICAT structure. See Appendix E.

Limitations

Although many efforts were put into place to help prevent threats to internal and external validity, there were still threats that could potentially limit the overall validity and usefulness of the findings:

- **Understanding use of scaffolding support.** For some students, the ICAT template was confusing, and the hints provided to the students did not provide any clarification. As such, I was asked a lot of clarifying questions by my students. Many times, the questions were related to what they needed to write in the Citation and Analysis Sentences. For example, students often asked me if they needed to write a "means" or "matters" for their analysis. While I was not particular in which type of

analysis they gave me, even after telling the same students they could do either (or even both), I would still be asked the same question the next time we wrote a paragraph.

- **Curriculum and time constraints.** Each year, before the school year has even begun, the school district prepares a curriculum pacing guide. This guide outlines any content that needs to be taught during the school year, as well as a timeline for how long each unit should last. The seventh grade science curriculum pacing guide is rigorous and leaves very little time for extra activities, including paragraphs. As such, having students write paragraphs requires taking time from another area of the content that does not need as much time as was outlined or may not be included on the district assessment. Due to changing standards, the district decided only to have two district assessments which allowed for my department to choose what content to focus on and how long we wanted to spend on them once both assessments were completed. Because of this time constraint, I was limited in how many paragraphs I could assign the students prior to the assessments. As a result, students only wrote five paragraphs from August to January with paragraph five being included as part of the second district assessment. The remaining paragraphs were written as time allowed in the remaining school year. Had there not been any constraints placed by the district for curriculum instruction, more paragraphs could have been assigned and this may have resulted in different data that could be more applicable to a larger realm of readers.
- **Data Collection.** During the beginning of the study, I neglected to record student scores for paragraphs two and four before the paragraphs were passed back to them. I

had recorded the scores that they earned in the grade book; however, these scores often included extra points for completing the assignments that were in addition to completing the paragraph. As such, these scores were padded with extra points making the grade book scores unusable for the purposes of this study. It was not until students had already written paragraph #6 that I realized this mistake. At the time that I realized it, four months had already passed. I collected as many paragraphs from the students that had held on to them; however, I was now limited by the number of students I could include in the data. Allowing for each student to have missing data for no more than one paragraph increased the number of students I could collect data for. However, because of this mistake, there is a smaller sample size than is ideal for this study. As such, the small sample size limits the power of the study and makes it difficult to demonstrate a significant difference in the scores of the sample.

Implications

There are many implications of this study. First, students are capable of being scaffolded onto a task that is slightly out of their reach and eventually have the ability to internalize the scaffolding supports provided to them, allowing them to complete the task on their own. At the beginning of this study, students were unable to write a paragraph using the ICAT format. Although some students were able to provide evidence to support their claim during the baseline assessment, there were no students in the sample set that were capable of analyzing a given source to further support their claim.

Through the scaffolds provided, students were able to complete a complex task that required them to critically evaluate a source in order to find evidence to support a claim and then further analyze the source to be able to correctly answer a prompted question. It is a part of the

seventh grade Language Arts curriculum to teach students how to extract quotes from a source, so at the onset of this study, students were barely starting to learn how to cite a source in their Language Arts classes, so being able to analyze the source and state why it is important is a task that is difficult for them and for most, impossible to complete without help. That being said, for this age group, the expectation of writing an ICAT paragraph is a task that necessitates scaffolding in order to bridge the gap of what types of paragraphs students can already write and what types of paragraphs students could write with extra support and instruction available to them. Ultimately, if students are provided with the right amount of scaffolding and the time to mentally process the scaffolding, they may be able to internalize the supports and eventually be capable of completing the task of writing a complex paragraph on their own.

A second implication from this study is that some students may require additional support before the scaffolds are able to be fully withdrawn from their use. As discussed previously, some students may need additional support before they can complete a task that they are incapable of completing unless additional guidance is provided. Scaffolding is usually thought to be a one-on-one process so when working with multiple students at a time, some students may not be ready to move on to more complex tasks when others are. As such, it is important to allow time for students to be able to familiarize themselves with the supports provided before they can be expected to internalize the supports and complete a task on their own individually. Additionally, it may be required for supports to be faded and then reintroduced multiple times before all students are able to internalize the scaffolds and be successful at an expected task.

A third implication from this study is that students may require more support in order to be able to complete an expected task than was originally expected. When I first introduced the scaffolds to the students, I assumed that they would not need any more support than I initially

provided to them for paragraph #2 (See Appendix D). However, throughout the study, I have to needed to provide additional supports as I realized areas where the needed extra support or could use more instruction. While some students were capable of extracting quotes from a source without help, the majority of the students needed extra support in order to be able to use a citation that helped support their claim. For this reason, it became necessary for me to deliver a lesson that provided strategies for selecting the most relevant quotation. Furthermore, I assumed that students would be able to self-monitor their writing and be able to make sure that they had included all parts of the ICAT structure in their paragraphs before turning it in. This was not the case however as many times, students lost points due to missing parts of the structure or repeating parts of the structure that they had already written.

A fourth implication from this study is that teachers need to be able to find ways to take away the scaffolding without assuming that students have internalized the scaffolding by that time. When I first removed the scaffolding entirely, I thought I that students would be able to complete the task on their own at that point and had come to find after looking at the results that this was not the case. As a result, it became necessary to reintroduce the scaffolds and then withdraw them later. Had I provided students with an intermediate paragraph in which students were provided with some support to bridge the gap created by removing the planning template, student scores may have not decreased as much. Ultimately, a teacher may look at the results of an assignment and assume that the students have learned it completely, when in fact; they may be completely or partially dependent on the supports provided in order to complete the task at that point. As such, it is necessary to be creative in fading the scaffolding so that students are supported throughout the entire process, ensuring that they are successful in completing the task when supports are eventually fully removed from their use.

A final implication of this research is to ensure that the scaffolds provided are eventually faded from the students use. As referenced earlier in this chapter, this study was conceived from the realization that students who were provided with unfaded scaffolds were unable to complete expected tasks when the scaffolds were subsequently removed. The fading of scaffolding allows students the opportunity to be able to mentally process the scaffold and with enough practice, be able to internalize the supports provided to them. If there is not any fading of the scaffolding, students may be left unsure of how to complete a task, resulting in confusion on the students' part and frustration on the teachers' part. Allowing students the opportunity to be able to learn how to use the scaffold while slowly removing the amount of scaffolding provided will benefit the student in eventually being able to internalize the supports and be able to complete a task they could not have done previously.

Recommendations for Future Research

This study has many implications that could be further researched and analyzed. However, I would like to suggest two recommendations for future research that would help to expand the current knowledge on fading scaffolding: (1) conduct a similar study that compares the results of the scaffolding provided to an experimental group, in addition to a control group, and (2) collect data from a larger sample of participants. Both of these modifications can only help to increase the validity of the results of this study.

The modification to this study that would have the greatest outcomes would be to repeat this study so that there was a control group as well as the experimental group. Due to the fact that I wanted all students to have equal access and opportunity in my classroom, I did not have any of my students act as a control sample. Had I developed a control group to compare to the results to, I may have been able to directly analyze the scaffolds' effectiveness in helping students improve

their paragraph writing abilities in order to determine which scaffolds were most beneficial in helping the students to be able to internalize the ICAT structure. Additionally, having a control group would add to the validity of the study and allow generalization of the results to other subject areas and environments, as well as other tasks.

Another recommendation would be to increase the sample size of the study. I was limited by the number of students on my roster for this study. An ideal way to modify this study would be to include more students in the study. One way to do this could be to enlist the help of another teacher that also uses the same scaffolding supports and utilize that teachers' data in the analysis to help increase the sample size and ultimately the significance of the data. Due to my small sample size, all statistical analysis conducted resulted in data that was statistically insignificant, meaning that I could not use my results to generalize to other populations of students. Ultimately, increasing the sample size may allow for a greater statistical significance as well as the capability of generalizing the results for use in the general population.

Action Plan

The results of this study indicate that the students at my school are able to be scaffolded onto more complex tasks than they can complete on their own. Scaffolds are used in all content areas and as such, the finding of this study could be useful to all teachers at my school. Most teachers are aware of scaffolding techniques and implement these strategies in their instruction, but very few are aware of the fact that the ultimate goal of providing scaffolds to students is to gradually fade the supports so that eventually, students internalize the supports and complete tasks on their own. This gap in the knowledge is particularly significant because many teachers are unaware they need to eventually fade scaffolding. Instead, teachers usually provide supports to their students and then abruptly remove the scaffolding expecting them to be able to complete

tasks when scaffolds are no longer in place. If these findings were to be disseminated to other teachers at my school, then the teachers might spend more time providing scaffolds to their students, while gradually fading the supports; as a result, students may become more successful at more complex tasks.

The findings of this study will be shared with the teachers at my school in two ways. First, I will be presenting these results to other teachers at my school, as well as school administrators during my New Teacher Induction Program Colloquium (a presentation where all beginner- teachers present the findings of projects they completed in the program). Second, I will share my finding with my principal and ask him to share the findings with the rest of the staff electronically. Through these two methods, I hope to open the lines of communication in regards to what scaffolding is and how it can be implemented so that students are more successful in their learning.

Conclusion

As a teacher, this study allowed me to see how the use of scaffolds could benefit my students in being able to complete a task that they may not have been capable of on their own. The implications of this research are tremendous. If a teacher can properly scaffold students onto a complex task, and gradually remove the supports from their use, over time, the students may be able to internalize those scaffolds and be able to use them without needing to have the teacher provide any additional support to them. I too often hear other teachers complaining about the fact that their students are not able to complete a task that they should already know how to do or should easily be able to complete on their own.

If teachers can find methods to be able to bring the complexity of the task down to the students' level and bridge the gap between what the student can do on their own and what they could do

with a little help, then any teacher should be able to help any student increase their performance in an area where they may not have been able to perform previously. However, teachers also need to know how to fade, or gradually remove students from any scaffolding provided so that they may be able to complete the task on their own if and when the scaffolding eventually is removed. If not, the student may develop a dependency on the scaffolding and as a result, need more help and support in order to be able to complete the task on their own. Ultimately, scaffolding can be of tremendous use to teachers if they learn the best ways to implement scaffolds and then gradually remove the scaffolds over time so that students have had enough time and practice with the supports to be able to internalize them and be able to complete the task on their own.

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Appendix A—Rubrics

Baseline ICAT Rubric

0	1- Approaching	2- Met	3-Exceeds

• Blank Paper
• Only Sentence Starter
• Name Only
• Off Topic
• No ICAT format
	• Includes some but not all of the 4 elements:
	  • Introduction
	  • Citation
	  • Analysis
	  • Tie it Up/ Transition
	• Elements may not be in order
		• Includes all 4 elements of the ICAT in the following order:
		  • Introduction
		  • Citation
		  • Analysis
		  • Tie it Up/ Transition
			• Includes all 4 elements of the ICAT
			• Shows insight and critical thinking in the analysis
			• May use unique, complex sentences with higher vocabulary
			• May use an extended ICAT form with more evidence

ICAT Rubric Used with All scaffolded and Unscaffolded Paragraphs

Component	**4 (Perfect)**	**3**	**2**	**1**	**0**	**Self-Score**	**Teacher Score**
Introduction	❑Makes Claim(s) ❑Claim addresses prompt ❑Leads to the evidence cited ❑Complete Sentence	Is missing **ONE** of the "perfect" elements.	Is missing **TWO** of the "perfect" elements.	Is missing **THREE** to **FOUR** of the "perfect" elements.	**The claim/ introductory sentence is missing.**		
Citation	❑Cites the source ❑Evidence supports claim ❑Evidence is relevant ❑Complete Sentence	Is missing **ONE** of the "perfect" elements.	Is missing **TWO** of the "perfect" elements.	Is missing **THREE** to **FOUR** of the "perfect" elements.	**The evidence/ citation sentence is missing.**		
Analysis	❑Explains the evidence ❑Explains *why* evidence supports the claim ❑Explanation is relevant to prompt ❑Complete Sentence	Is missing **ONE** of the "perfect" elements.	Is missing **TWO** of the "perfect" elements.	Is missing **THREE** to **FOUR** of the "perfect" elements.	**The reasoning/ analysis sentence is missing.**		
Citation	❑Cites the source ❑Evidence supports claim ❑Evidence is relevant ❑Complete Sentence	Is missing **ONE** of the "perfect" elements.	Is missing **TWO** of the "perfect" elements.	Is missing **THREE** to **FOUR** of the "perfect" elements.	**The evidence/ citation sentence is missing.**		
Analysis	❑Explains the evidence ❑Explains *why* evidence supports the claim ❑Explanation is relevant to prompt ❑Complete Sentence	Is missing **ONE** of the "perfect" elements.	Is missing **TWO** of the "perfect" elements.	Is missing **THREE** to **FOUR** of the "perfect" elements.	**The reasoning/ analysis sentence is missing.**		
Tie it Up/ Conclusion	❑Addresses Claim(s)/ prompt ❑Concludes paragraph **OR** leads to next paragraph ❑Complete Sentence	Is missing **ONE** of the "perfect" elements.	Is missing **TWO** of the "perfect" elements.	Is missing all **THREE of** the "perfect" elements.	**The tie it up/ transition sentence is missing**		
					TOTAL (24)		

Appendix B—Scaffolded Planning Templates

Planning Template used for Paragraph #2—Brain Eating Amoeba-Scaffolded.

Summary Template

	Sentence frames and starters:	Directions: Write a complete sentence in this column.
Topic sentence	A unicellular organism, such as an amoeba, (can/ cannot) be considered dangerous because…	_____ _____ _____ _____ _____
Evidence from article	The article titled _____ _____ _____ explains…	_____ _____ _____ _____ _____
Evidence from video	An important idea from the video titled _____ _____ _____ is…	_____ _____ _____ _____ _____
Your opinion	According to these sources, I think…	_____ _____ _____ _____ _____
Concluding statement	In conclusion, amoebas…	_____ _____ _____ _____ _____

Planning Template used for Paragraph #3—Global Warming.

Planning Template

Writing prompt: How can we use the process of photosynthesis to solve global warming?

ICACAT	Sentence frames and starters:	Directions: Write a complete sentence in this column. (It is not necessary to use the frames given.)
Introduction (Topic sentence)	Global warming can be solved by….	
Citation (Evidence from video)	The video titled _____ _____ explains…	
Analysis (Why is this evidence important?)	This means that…	
Citation (Evidence from article)	An important idea from the article titled _____ _____ is…	
Analysis (Why is this evidence important?)	The author is saying…	
Tie it up (Concluding statement)	In conclusion, photosynthesis…	

Planning Template used for Paragraph #4—The English Peppered Moth.

Guiding Question: What caused the peppered moths to change colors?

Planning Template

	Sentence frames and starters:	Directions: Write a complete sentence in this column.
	A peppered moth is…	
	The article titled _____ _____ _____explains …	
	This means that….	
	In conclusion….	

Planning Template Used in Paragraph #5—Polar Bears.

Planning Template

Writing prompt: Explain why polar bears are not well adapted to the dry land environment.

ICACAT	Directions: Write a complete sentence in this column. (It is not necessary to use the frames given.)
Introduction (Topic sentence)	_____ _____ _____ _____
Citation (Evidence from article)	_____ _____ _____ _____
Analysis (Why is this evidence important?)	_____ _____ _____ _____
Tie it up (Concluding statement)	_____ _____ _____ _____

Planning Template used for Paragraph #7—Cactus Adaptations

Summary Template

Prompt: What adaptations help make cacti successful in a hot and dry environment, like a desert?

Sentence frames and starters:	Directions: Write a complete sentence in this column.
Introduction (Topic sentence- What are you going to be talking about?)	
Citation (Do cacti have a lot of adaptations that help them survive in their environment?) (Remember to cite the article OR author)	
Analysis (Why is this citation important? What does it mean?)	
Citation (What is one adaptation that cacti have?) (Remember to cite the article OR author)	
Analysis (Why is this citation important? What does it mean?)	
Tie it up (Restate your introduction)	

Appendix C—Unscaffolded Planning Templates

Planning Template used in paragraph #6—What Darwin Never Knew.

Write a 4-6 sentence paragraph explaining, in your own words: *What is natural selection?* Use examples from the video as needed.

_____

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_____

Planning Template used in Paragraph #8—Spaceship Earth-The Universe.

Spaceship Earth- The Universe (Earth's History)

1. Bacteria helped produce _____ so we could breath.
2. ¾ of Earth is covered with _____.
3. Small asteroids that hit Earth left small craters. (*Circle one)* True / False
4. The great iron catastrophe occurred in our planet's first _____ million years.
5. About 50 million years ago, an object the size of _____ slammed into Earth.
6. Earth is _____ million miles from the sun.
7. Water came to Earth from one of 2 sources. They are _____ (on Earth), and _____ (from space).
8. The Asteroid Belt is located between _____ and _____.
9. In Earth's early atmosphere, was oxygen present? (*Circle one)* YES / NO
10. An Extremophyle is an organism that lives in _____ environments.
11. Cyanobacteria inject mass amounts of free _____ into ocean water.
12. After 2 billion years of evolution, _____ and _____ moved from water to land.
13. Today, the increase in CO_2 levels are (*Circle one)* More / Less than in the past.
14. The Earth's _____ and _____ poles are the Cryosphere.
15. Antarctica holds _____% of Earth's fresh water.
16. Humans could die off 500 million years from now, due to the brightening of the _____.
17. Write an ICAT paragraph 4-6 sentences about what you learned in the video. _____

_____

_____

_____

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_____

_____

_____

Planning Template used in Paragraph #9—Bill Nye: Fossils.

Write an ICAT (4-6 sentences) using the following prompt: Explain what a fossil is. Be sure to cite your evidence from the video.

_____

_____

_____

_____

_____

_____

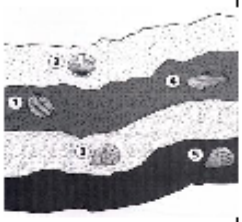
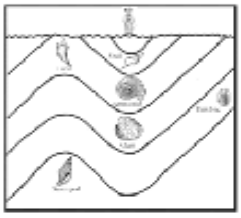
_____

_____

_____

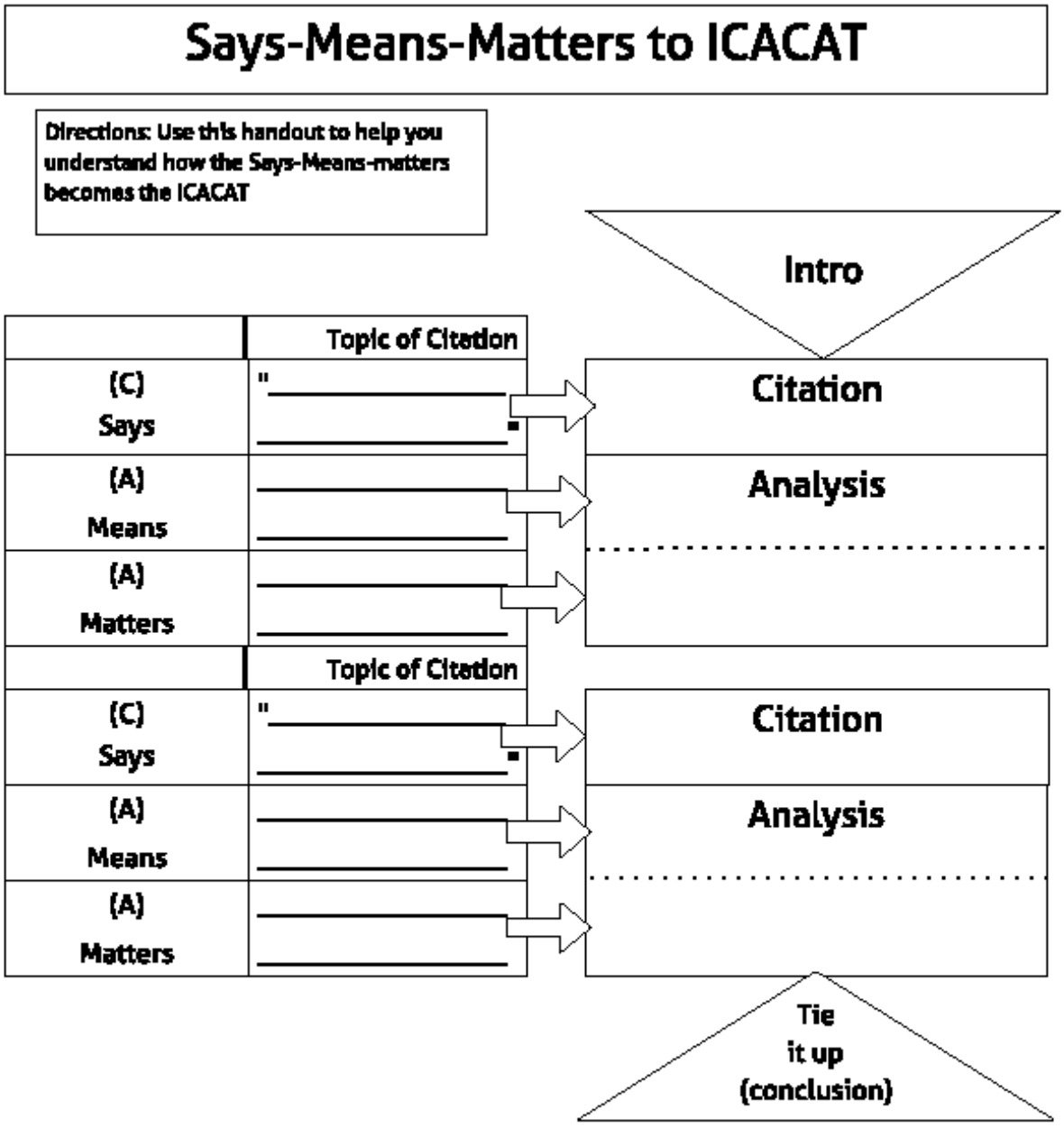
_____

Planning Template used in Paragraph #10—Cornell Notes: Sedimentary Rock and Superposition

	• Rock layers are deposited from the _____ up. • The deeper we _____, the farther back in _____ we see.
7) 	Fossil _____ is the youngest fossil. Fossil 3 is younger than fossil _____. Fossil 4 is approximately the same age as fossil _____. Fossil _____ is older than fossil 1.
8) 	The relative age of a fossil can be determined by_____ _____ _____ _____
Write an4-6 sentence ICAT(using your notes as you citation) to **explain the importance of superposition** _____ _____ _____ _____ _____ _____ _____	

Appendix D—Additional Resources

Says-Means-Matters to ICACAT Scaffold.



Brain Eating Amoeba: Says Means Matters.

Brain Eating Amoeba: Says (C) - Means (A) - Matters (A)
ICACAT

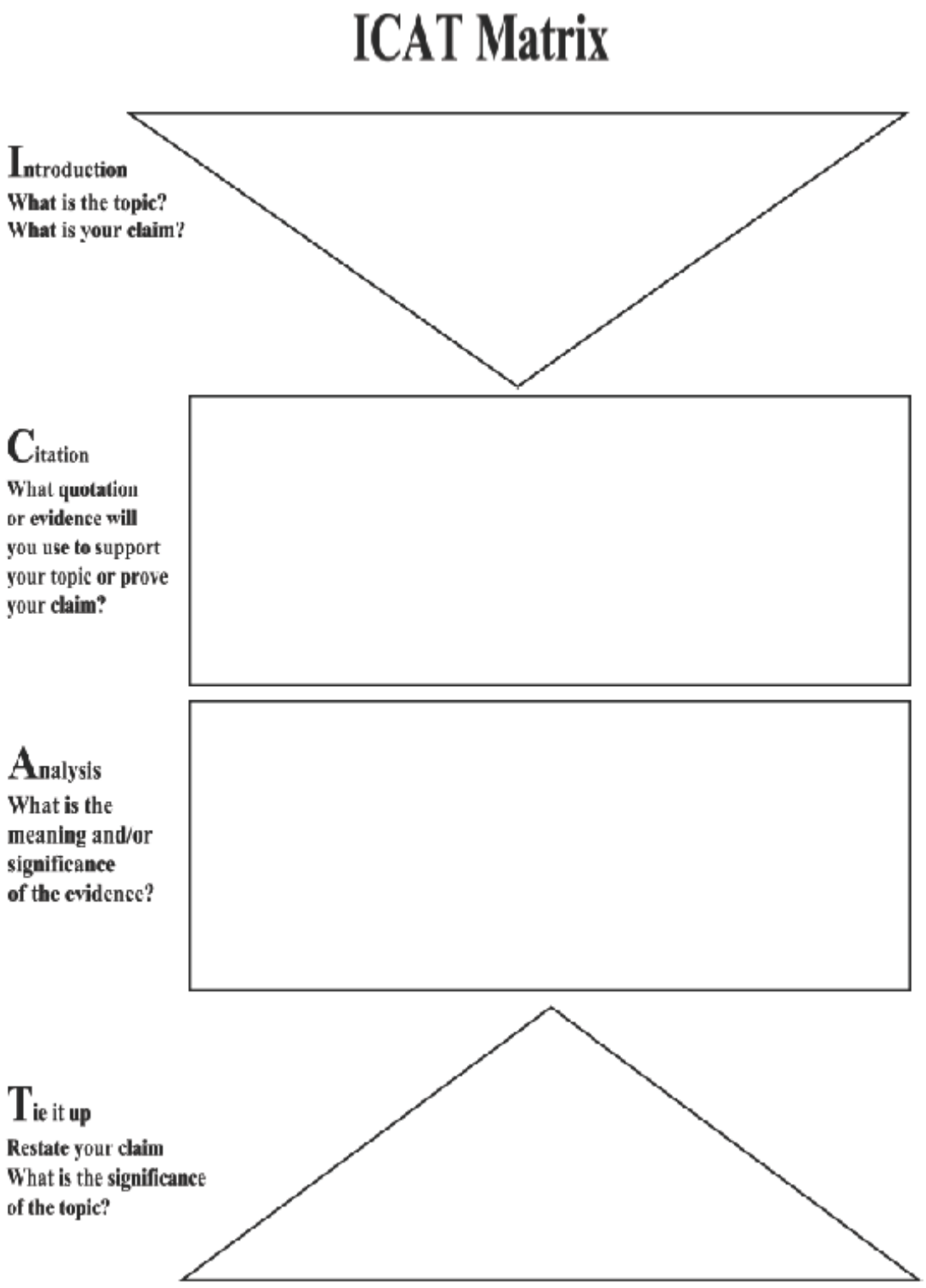
Title of Article #1: *Brain Eating Amoeba Kills Another*

Topic of Citation:	**How are people infected with a brain-eating amoeba?**
What does the article... Say? (Citation) Choose a direct quotation or paraphrase	**In the article titled** _____, **the author explains,** _____ _____ _____ _____
What does the author... Mean? (Analysis) Say it in your own words	**This qoute is saying that** _____ _____ _____ _____
Why does this... Matter? (Analysis) Who cares? So what?	**This is important because** _____ _____ _____ _____

Title of Article #2: *What is a Brain-Eating Amoeba?*

Topic of Citation:	**Why does the *N. fowleri* amoeba eat brains?**
What does the article... Say? (Citation) Choose a direct quotation or paraphrase	**In another article titled,** _____ **the author states,** _____ _____ _____ _____
What does the author... Mean? (Analysis) Say it in your own words	**The author is explaining that** _____ _____ _____ _____
Why does this... Matter? (Analysis) Who cares? So what?	**An examination of this quote reveals** _____ _____ _____ _____

ICAT Matrix.


ICAT Matrix
Introduction
What is the topic?
What is your claim?
Citation
What quotation or evidence will you use to support your topic or prove your claim?
Analysis
What is the meaning and/or significance of the evidence?
Tie it up
Restate your claim
What is the significance of the topic?

Appendix E—Complete Data

Complete Data from all participants (N=51). Students without data show as N/A.

Participant #	1. Baseline paragraph	2 Brain Eating Ameeba	3. Global Warming	4. Peppered Moth	5. Polar Bears	6. Natural Selction ICAT	7. Cactus Paragraph	8. Spaceship Earth	9. Bill Nye Fossils	10. Superposition ICAT
1	1	1	3.1	4	4	3	3	1	4	0
2	2	3.8	4	4	4	2	4	4	4	4
3	1	4	4	4	4	4	4	4	3	4
4	1	4	4	4	4	1	4	1	4	4
5	1	4	4	4	4	1	4	4	4	4
7	0	3.6	4	4	4	3	3.6	4	3	4
9	1	4	4	4	4	4	2.8	4	4	4
10	1	4	3.3	4	4	4	4	0	2	4
11	1	4	4	4	4	3	4	4	4	4
12	2	4	4	4	3	4	4	4	4	4
13	1	3.8	4	4	3	4	3.8	3	3	3
14	1	3.8	4	4	4	3	4	4	4	4
15	0	4	4	4	4	4	4	4	4	4
16	0	4	2	4	4	2	4	4	4	N/A
18	1	4	4	4	4	4	4	4	4	4
20	1	1	4	4	4	4	4	4	N/A	4
21	1	3.6	4	4	N/A	4	4	3	4	4
23	1	3.8	4	2	4	0	4	4	3	1
24	1	3.8	3.3	1.5	3	4	3.3	3	4	4
25	1	3.8	4	4	4	4	4	3	4	4
26	1	4	4	4	4	1	4	4	4	4
27	1	1	4	1.5	4	3	2	0	4	N/A
28	1	3	4	4	3	1	3.6	2	4	4
31	1	4	4	4	4	4	2.8	2	3	4
32	1	4	4	4	4	3	4	4	4	4
33	1	3.8	4	4	4	0	4	3	4	4
34	1	4	4	2	3	1	4	4	N/A	3
35	1	4	4	4	3	3	4	4	4	4
36	0	3.8	1.3	4	2	2	3	4	1	N/A
37	1	4	4	4	4	3	4	4	4	4
38	1	3.8	4	4	3	1	3.5	0	4	4
39	2	2	0.33	4	4	1	N/A	0	4	4
40	1	4	4	4	N/A	0	2.8	1	4	4
42	1	N/A	4	3	4	1	4	3	1	4
45	1	N/A	4	4	4	1	4	3	2	4
46	1	N/A	4	4	4	3	4	4	3	4
47	0	N/A	4	4	4	2	4	0	2	N/A
48	1	N/A	3.8	4	4	3	4	4	3	4
49	1	N/A	4	2.25	4	1	2.3	0	2	0
50	0	N/A	4	4	4	0	4	3	4	4
51	0	N/A	4	4	3	1	3.6	3	3	4
52	1	N/A	4	4	4	3	4	4	4	4
53	0	4	4	4	4	3	4	2	4	4
55	1	N/A	4	3	4	4	4	4	4	4
56	1	4	4	N/A	4	4	4	4	4	4
60	1	N/A	3.6	4	4	3	4	3	4	3
62	1	4	2	4	2	N/A	4	2	4	3
67	1	N/A	3.6	4	0	1	2	0	1	2
69	1	N/A	4	3	4	2	4	4	3	3
70	1	N/A	4	4	4	4	4	4	4	4
72	1	N/A	4	3.75	2	0	4	4	4	4
AVERAGE	0.91	3.6	3.74	3.72	3.64	2.42	3.73	2.93	3.47	3.62
STANDARD	0.46	0.88	0.74	0.69	0.79	1.41	0.55	1.46	0.9	0.97
N	51	36	51	50	49	50	51	51	49	47