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A critical examination of implementing the substitution, augmentation, modification, and redefinition model in elementary school instruction

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Abstract
Teachers in a rural southeastern state school district are not integrating technology in ways that provide students with engaging technology-based learning experiences. This study explored teachers' current technology-based instructional practices based on the substitution, augmentation, modification, and redefinition (SAMR) model. This research study was guided by three research questions focusing on how elementary teachers integrate technology in their instructional practices, the levels of SAMR being implemented by elementary teachers, and the SAMR levels of students' technology-related assignments. The study was conducted using an instrumental case study design, and data were collected through interviews, observations, and lesson plans for 12 elementary teachers. Data analysis was performed using a priori and inductive coding to generate themes. The findings revealed that though teachers are integrating technology, integration is typically more teacher-centered or at the substitution and augmentation levels when student-centered. Based on the results, a 3-day professional development workshop was created for teachers with a review of the SAMR model and methods to shift their instructional practices to higher levels of the SAMR model. This study promotes positive social change by providing technology-based professional development opportunities for teachers in the local district that encourage them to use technology resources to increase student engagement and transform student learning.

Keywords: technology education, technology instruction, professional development, technology integration, elementary education

1. Introduction

The problem is that there was a need to explore how teachers in a rural southeastern state school district use technology and how this use aligns to the four levels of a student-centered technology integration model. Even though the rural teachers had various classroom technologies and the district's technology department documented the use of technology devices during instruction through classroom observations, the results from a survey and interviews conducted by the district's technology department revealed that teachers were not engaging students in technology use. Moreover, the district research indicated that teachers primarily use technology, with students being secondary users.

This research study addressed an existing gap in practice at the study site; where it is unknown how teachers were using technology in their everyday instructional practices and unknown how their current instructional practices align with the district's implemented substitution, augmentation, modification, and redefinition (SAMR) model (Puentedura, 2014). Teachers use technology in the classroom for different reasons and to different degrees to engage with students (Sarkar *et al*., 2015) [14]. Teachers may use technology to assess student learning, deliver instruction, or foster peer collaboration. However, teachers may be the sole users of the technology devices in the classroom (Henrie *et al*., 2015) [4]. Shifting technology use to students is one way to provide students with opportunities for learning in and out of the school and transform their learning

(Yarbro *et al*., 2016) [17]. Effectively integrating technology as a learning tool rather than a delivery tool can enhance student Learning (Yarbro *et al*., 2016) [17]. However, many teachers are not utilizing technology to engage students in the learning process by having students use the technology (Herold, 2016).

Because the school district was concerned about the level at which teachers utilize technology and allow student use, in 2016, the district implemented the SAMR (Puentedura, 2014). This implementation of SAMR was to ensure that teachers are integrating technology in the classroom to transform student learning and to have 60% of teachers using technology to teach state standards. However, there has been no systematic investigation into how teachers use technology and how their uses align with the SAMR.

This study aimed to explore how teachers use technology in their everyday instructional practices and how their current instructional practices align with the district's implemented SAMR model (Puentedura, 2014). The SAMR model consists of four levels, which may be used to define the levels of classroom technology integration. Therefore, exploring how teachers use technology will provide invaluable information for the school district, such as data that could create a new professional development focusing on classroom technology integration. Furthermore, using the SAMR model to analyze how teachers use technology adds to the literature by supporting the use of SAMR as a data analysis tool for analyzing classroom instruction.

1.1 Research Questions

To guide this research study, two research questions (RQs) were used:

RQ1: How are elementary teachers integrating technology based on the SAMR model in Their instructional practices?

RQ2: Which levels of the SAMR are being implemented by elementary teachers?

1.2 Conceptual Framework

The SAMR model was established to assist teachers in developing more meaningful and purposeful student-centered uses for technology in their instruction. Integrating technology using the first two levels of the SAMR model, substitution and augmentation enhances student learning. Integrating technology using modification and redefinition transforms the learning experience of the students (Puentedura, 2014). The result of integrating technology at the redefinition level is student-centered learning with students as the technology users. Consequently, students are more engaged and motivated to learn (Harris & Al-Bataineh, 2015) [3].

The first level of the SAMR model is substitution. Teachers use technology to replace traditional tools (Puentedura, 2006). One example of technology use at the substitution level would be students using note-taking software to take class notes (Theisen, 2013) [15]. Next, the technology serves as a tool at the augmentation level, but there are functional changes. For example, after using a word processing program to write a story, the students use technology to improve by using spell check and changing the fonts of the text (Theisen, 2013) [15]. These two levels of technology integration enhance student learning, but the primary instructional activity remains unchanged from its non-technological antecedent.

The third level of the SAMR model is modification. At this level, the technology alters how tasks are completed; this level begins to transform the learning. An example of technology being used at the modification level would be students sharing a PowerPoint presentation and working collaboratively with peers to give and receive feedback (Puentedura, 2014). The final group of SAMR, redefinition, uses technology in a "previously inconceivable" (Puentedura, 2014, p. 13). For example, in developing a story, students might use a publicly accessible online site to work collaboratively with peers and individuals from other states or even countries to share work and add to the story's progress, including the various story elements (Puentedura, 2014). At the redefinition level, technology integration has resulted in a type of learning that looks different from its paper and ink predecessors and has shifted the locus of control from the teacher to the students.

As teachers develop lessons that require technology use, substitution and augmentation tend to be the levels at which they integrate technology; however, these levels affect little change in the student learning (Puentedura, 2014). When teachers begin to engage students with technology at the modification and redefinition levels, the technology transforms student learning (Theisen, 2013) [15]. While participating in the learning process, the students become responsible for their learning as independent thinkers and doers (Theisen, 2013) [15]. As teachers begin to understand better how to think about technology integration using SAMR, they can use technology more effectively as a tool in the learning process (Puentedura, 2014).

2. Literature Review

2.1. Technology, Student Engagement, and Student Achievement

The SAMR model focuses on transformed learning; therefore, it is essential to review the literature on technology and how its use can increase student engagement and student motivation. Technology can motivate student engagement and impact student achievement (Ciampa, 2014) [1]. Student motivation is necessary for learning because as students' motivation increases, their engagement and participation in classroom instruction increases (Ciampa, 2014) [1]. Student achievement is the success or outcome students encounter throughout their learning experiences. What and how effectively students learn or achieve may rely on their level of motivation (Ciampa, 2014) [1].

Technology has the potential to motivate students and increase their engagement and learning (Ciampa & Gallagher, 2013) [2]. However, technology alone does not bring about greater student engagement and achievement. When a teacher uses technology at the modification and redefinition levels, technology has more significant potential to transform student learning and impact student engagement and achievement. Technology has the potential to reverse the traditional teacher-student role by having students be the sole users of technology and technology devices (Ciampa & Gallagher, 2013) [2]. In this reversal, students use the technology devices to complete tasks designated by the teacher rather than passively receiving instruction delivered by the teacher using the technology (Ciampa & Gallagher, 2013) [2]. This moves education toward being more student-centered and with greater student engagement. Thus, students are engaged in completing tasks involving technology and taking ownership of the learning rather than the traditional teacher-centered environment (Ciampa, 2014) [1]. Therefore, the modification and redefinition levels of SAMR are

essential for using technology more student-centered. As teachers purposefully and intentionally integrate technology at higher levels of the SAMR model, they can impact student motivation, leading to greater student engagement. Using the SAMR model to investigate how teachers integrate technology may lead to understanding why some technology increases motivation and attention, and others do not.

2.2 Barriers to Technology Integration

Despite the many uses and benefits of technology, teachers often encounter barriers that influence how and why they integrate technology. Obstacles include the lack of professional development relating to technology, the lack of availability of technology, teachers' attitudes toward technology (Pittman & Gaines, 2015) [10], and teachers' self-efficacy (Motshegwe & Batane, 2015) [9]. Four similar barriers include student lack of technology skills, teacher lack of training in technology, teacher lack of time to integrate technology-infused lessons, and teachers' lack of technical support (Hsu, 2016).

2.3 SAMR Model and Students

As teachers use SAMR to guide their instructional decision-making to move from the substitution and augmentation levels to modification and redefinition, student learning begins to transform (Puentedura, 2014). When teachers know the SAMR model and integrate technology with that knowledge, they can help students develop 21st-century skills and build toward success (Hilton, 2016) [8]. The SAMR model enables teachers to reflect on integrating technology and how students can be involved in that integration process (Puentedura, 2014). As students become more involved in the learning process, how they learn changes.

SAMR can be implemented in every level of school (Hilton, 2016) [5]. It was found that as the teachers integrated technology, they typically stayed at the substitution and augmentation levels. When the teachers moved students toward the modification and redefinition levels, the use of technology continued to correlate with the intended goals of the learning experiences. The findings suggest that using the SAMR model for guiding technology integration decisions is useful (Hilton, 2016) [5]. When teachers view technology to engage students in their learning, it tends to be used for student-centered learning experiences (McKnight *et al*., 2016) [7, 17]. The researchers documented teachers' perceptions that incorporating technology in their practice increased technology access for students. Due to the possibly of not seeing the whole picture, conclusions about technology use may be limited.

Because the SAMR model leads teachers to consider how the technology meets their instructional purpose, understanding and using the SAMR model may help address barriers to technology use by assisting teachers in determining the type of technology to be used (Tsybulsky & Levin, 2014) [16]. As teachers plan and integrate technology as guided by the SAMR model, they can determine what devices will be used and what devices will be used. Tsybulsky and Levin (2014) [16] argued that considering o how devices are to be used and by whom can shift teachers to higher levels on the SAMR model. Furthermore, determining the purpose for the technology may help address teachers' attitudes about technology usefulness and student skills in technology use. As a result, teachers would have an environment supported by technology that engages and motivates students. As teachers have students use technology to effectively communicate with others, extend their learning audience, and create authentic student work, teachers begin to shift levels of the SAMR model (Tsybulsky & Levin (2014) [16].

3. Methodology

The research methodology for this study was a qualitative instrumental case study. In the study, the case was the process of using SAMR in one elementary school. By employing an instrumental case study design, an in-depth look into how teachers use the four levels of the district-mandated SAMR model to integrate technology into their classroom instruction and their intended goals for their technology choices was gained—in addition, employing an instrumental case study allowed for insight into the situation of technology integration on a broader scale, rather than just within one setting. Although this research can be used to identify how teachers are using SAMR to guide technology integration at the study site, the knowledge developed from the study can be used in understanding and adding to the literature of teacher technology integration in general.

Participants. The participants for the study were chosen using typical purposeful sampling. Specific, purposeful sampling occurs when participants selected are individuals who reflect the average person operating within the phenomenon being studied (Merriam, 2009). A set of criteria were established to structure the purposeful sampling. Participants must currently be intermediate classroom teachers (second through fifth grade). These grade levels are more content-focused, which means developing technology-driven, student-centered tasks is expected.

Moreover, teaching content at these levels allows teachers to use technology for more content learning. The participants must have been teaching five or more years in the district and have attended district-provided professional development on the SAMR model. These criteria ensured that participants had learned the foundation of the SAMR model. Furthermore, by having taught a minimum of 5 years, the participants have witnessed and contributed to the plan developed by the district's technology department.

Out of a total population of 20 teachers, 12 teachers were selected to participate in the study. In purposeful sampling, the goal is to reach data saturation (Merriam, 2009). By involving 12 participants, data saturation was achieved through in-depth observations, collection of lesson plans, and interviews, which provided insight into teacher integration of technology. All eligible teachers were invited to participate. The first 12 who responded positively were included in the study.

3.1 Analysis of the Data

Lesson Plan Analysis. During the analysis and coding process of participants' lesson plans, codes were drawn from the SAMR model. These codes included the substitution, augmentation, modification, and redefinition levels. Inductive principles were then applied to capture those aspects of the lesson plans that were not captured by a priori codes. Finally, the codes were tabulated to document occurrences of technology-driven practices and activities each Participant planned to carry out during their instruction.

Observation Analysis. Observations were coded using the a priori codes and inductive codes derived from the lesson plan analysis and the creation of new codes as needed. Codes were

also tabulated to document technology-driven events during each Participant's classroom instruction. The tabulated codes were based on the substitution, augmentation, modification, and redefinition levels of the SAMR model.

Interview Analysis. Transcripts of each interview were coded using a priori and inductive codes derived from the lesson plan and observation analysis and the creation of new codes as needed. The transcripts were created after transferring interviews from Otter to MS Word. Codes, both a priori and inductive codes, were then tabulated to capture the frequency of occurrence. After coding, each observation was compared to teacher interviews and lesson plans. After comparison, categories were created to inform each Participant's second round of observations. Next, the categories and the supporting evidence from the interviews were placed in a matrix. The matrix served as an organization method for the categories and the evidence from the data. Once the initial categories were developed, the second interviews were conducted, and the coding and analysis processes were repeated.

Reflective Journal and Memos Analysis. The reflective journal and memos were analyzed separately from the interview, observation, and lesson plan analyses. The analysis of the memos was an examination of comments made throughout the analysis of lesson plans. They analyzed the journal notes entailed reviewing quick notes written during interviews and observations.

3.2 Discussion of Themes

The reported and analyzed data came from interviews of participants, observations of technology integration, and lesson plan reviews. The data was present to help determine how elementary teachers integrate technology based on the SAMR model in their instructional practices. The data also showed the SAMR levels at which teachers integrate technology into their instructional practices.

Interviews were conducted as well as observations. Lesson plans were also reviewed. Seven themes were developed a priori using the SAMR integration model: (1) teachers are integrating technology at the substitution level, (2) teachers are integrating technology at the augmentation level, (3) teachers are integrating technology at the modification, (4) teachers are seldomly integrating technology at the redefinition level, (5) barriers of technology integration, (6) teacher-centered instruction is evident in technology-based instruction, and (7) student engagement and motivation are evident in technology-based instruction. Two additional themes were developed inductively: (8) benefits of technology integration, and (9) teachers must plan for technology integration.

3.3 Overview of Themes

Four themes were developed deductively based on the SAMR model. They were: (1) teachers are integrating technology at the substitution level, (2) teachers are integrating technology at the augmentation level, (3) teachers are integrating technology at the modification level, and (4) teachers are seldomly integrating technology at the redefinition level. In addition, different themes were taken from the SAMR. Also, they developed a priori: (5) barriers of technology integration, (6) teacher-centered instruction is evident in technology-based education, and (7) student engagement and motivation are explicit in technology-based instruction. During continued analysis, two additional themes formed using an inductive process: (8) benefits of technology integration, and (9) teachers must plan for technology integration.

Theme 1: Teachers are Integrating Technology at the Substitution Level

During analysis, it was found that teachers are integrating technology on the substitution level. Out of the 12 participants, 10 of the twelve participants discussed tasks at the substitution level. Two participants discussed having their students use technology to perform low-level research tasks, which coincides with the substitution level. Three participants discussed having students use web-based programs to complete online assignments. During the first observations, four participants engaged students in tasks on the substitution level. Participant A had students use technology at the substitution level when students were required to use Google Earth to identify their location. Participant B also integrated technology on the substitution level; students used computers to practice addition and subtraction facts. This was a "skill and drill" activity for students. Participant D's lesson involved students taking narrative writing and using a word processing program to publish their final drafts. The students in Participant I's class were responsible for reading a book and completing a quiz on Accelerated Reader. This was a substitute for traditional paper and pencil-based quizzes teachers traditionally give.

Tasks on the substitution level were evident in three of the 12 observations during the second round of data. Participant G also utilized technology at the substitution level when students were given the task of using a web-based program to create and classify triangles and quadrilaterals. Students in Participant F's class used technology at the substitution level as they used a web-based application to practice identifying fractions. Finally, during Participant I's second observation, students were engaged with technology at the substitution level while word processing a response to a text assignment.

Theme 2: Teachers are Integrating Technology at the Augmentation Level

Throughout the analysis of each data source, it was evident that teachers are implementing technology-based tasks at the augmentation level of SAMR. Five participants mentioned student tasks aligned to the augmentation level of the SAMR model. Two participants said using Kahoot and Mastery Connect to assess student learning and gauge their teaching. Participant E engaged students in a Kahoot assessment that focused on shapes. Upon completion, she began reteaching and differentiating instruction and utilizing the feedback from the assessment, aligned to the augmentation level. Students in Participant J's class were responsible for editing and revising, thus annotating on an existing typed paper. In Participant I's class, students were engaged in a story read online. Students then responded to a quiz using Mastery Connect, an online assessment application.

Students were engaged in a computerized reading assessment during Participant A's and B's second observations. Participant A's class students read in small groups but completed the assessment individually. In Participant B's class, students read as a whole class and took the online quiz for specific books as they completed their reading. In Participant L's class, students could come to the board, that

board being a team board, to solve problems she wrote on the board during her math lesson.

Theme 3: Teachers are Integrating Technology at the Modification Level

The data analysis noted that teachers have students use technology that shifts to the modification level. Seven participants mentioned tasks on the modification level. These tasks varied in grade level and content area. Some participants described assignments in which their students collaborated with peers and provided them with feedback. Participants also mentioned having students use technology to present their products to their peers. Participants engaged students in many collaborative (student-to-student) tasks in the observations conducted. Participant H, in particular, designed a study in which students had previously started working on presentations using technology. Students then used technology to present their information (animal habitats) to students; students used a program (i.e., Prezi, PowerPoint, and Google Slides) of their choosing to design and present their content. They were having students engage in this type of assignment aligned with the modification level of the SAMR model.

Participant C's students used Google Slides to provide visuals of their chosen historical figures. Students were tasked with embedding one video and web page link for their historical figures within their presentations. Participant J used feedback from a Kahoot game focusing on text structure to formulate her small groups for instruction. Participant E had students work with a partner to create a presentation explaining one of the state's land regions. Students would then take their product and post it on the class's Edmodo page. The subsequent lesson would allow students to view and comment on each group's presentation. Receiving and providing such feedback shifted the task to the modification level.

Theme 4: Teachers are Seldomly Integrating Technology at the Redefinition Level

During analysis, it was also evident that teachers integrate technology at the highest level of SAMR, redefinition. Only one out of twelve participants mentioned tasks on the redefinition level. However, this level was evident in two of the participants' observations. Two teachers integrated even more student-centered technology, reaching the highest level. During a science/social studies class period, Participant K had students complete a discussion using Flipgrid. Students were responding to peers after Participant K posed several questions. This student-to-student interaction allowed for academic discourse as students could explain their thinking using Flipgrid as the mode of technology. Participant C had her students work with partners using laptops to complete a peer assignment online using Google Classroom. Students used the internet, finding images to match similes of their choosing.

Theme 5: Barriers of Integrating Technology

In analyzing data collected, participants shared that while technology integration is essential and beneficial, it does not come without its difficulties. There are barriers that teachers face when integrating technology that may cause reluctance in moving to higher levels of the SAMR model. Ten out of twelve participants mentioned a form of barrier when integrating technology. One of Participant A's barriers was indicated as technology availability. She stated that "this year, there are only two desktop computers." She says that "the lack of having technology makes it harder to integrate technology." Another noted barrier was teacher self-efficacy which was evident in Participant I's interview. The Participant stated that she often struggles with "the technology part of my teaching career."

During four observations on four different occasions, the participants and students encountered technological issues. In Participant B's classroom, the display would not turn on at the start of class. Technology personnel was contacted, and the case was resolved. Internet connection, another barrier, was experienced during three other observations. The laptops would not connect during the planned time for one of the classes. However, students could go back and complete the task closer to the end.

Theme 6: Teacher-Centered Instruction is Evident in Technology-Based Instruction

Data collected from lesson plans, observations, and interviews helped solidify that there is still teacher-centered instruction even with the implementation and use of the SAMR model. All 12 participants indicated occurrences of teacher-centered education. For example, during one interview, Participant B stated that she uses her Promethean board to "model during direct instruction." Participant C said she begins her instruction by showing the day's agenda and modeling expectations for assignments. Participant C also stated that she uses the technology more teacher-centered for "direct instruction, the anticipatory set and to show short video clips."

In every observation, participants began with teacher-centered instruction. For example, during Participant A's statement, the Participant began her instruction by modeling how students would go about using Google Earth. Teacher-centered instruction was also evident in participant G's observation as she was the primary user of technology while teaching strategies for multiplying whole numbers.

Theme 7: Student Engagement and Motivation are Evident in Technology-Based Instruction

The data analysis confirmed that teachers see that technology integration impacts student engagement and motivation. The impact of technology integration on student engagement and motivation was discussed in every interview. Participants were asked to reflect on the effects of technology; all 12 mentioned student engagement and reason within their classrooms. During one interview, Participant J explained that her "students are more engaged when using technology because of student-centered technology integration." The same Participant stated that "they [students] are raising their hands to come to the board or read what is on the screen rather than what is on the page." In addition, participants reflected on student engagement and motivation when student-centered technology-based tasks were offered to students. Participant G said she sees "increased participation and student confidence." Moreover, the inclusion of technology engages students and motivates them.

Theme 8: Benefits of Integrating Technology

Through the analysis of interview transcripts, it was found that teachers believed there are many benefits of integrating technology. Eight of the twelve participants mentioned the possible benefits of integrating technology. Many of those

benefits include critical and creative thinking, collaboration, development of independence in students, and retaining new learning. Integrating technology can be beneficial to the learner completing the tasks. By integrating technology, many participants felt that critical thinking benefits integrating technology. Participant C said that when students use technology at higher levels of SAMR, they become engaged, independent, and critical thinkers. Some participants thought that having students use technology to complete various tasks contributed to their creative thinking. Most participants felt that having students use the available technology "increases their excitement and willingness to participate" Another participant, Participant A, stated that the "technology component allows all students to be confident in what they are doing."

Participants also mentioned that implementing technology using the SAMR model allows more student collaboration. For example, participant E commented that students are "willing to collaborate with and help their classmates by integrating technology." In addition, while designing student-centered technology-based instruction, participant H said that she considers ways in which students can collaborate.

Theme 9: Teachers Must Plan for Technology Integration

Data collected from lesson plans and interviews helped solidify that teachers use technology. A planning component is imperative to the efficient use of technology. Of the 12 participants, each Participant mentioned planning out the use of technology in their practice. For example, participant E stated that "designing a SAMR lesson takes planning during one interview." Participant H commented that "as I plan my lesson for my students, I try to give the kids more opportunities to explore and use technology throughout my lesson."

Furthermore, through planning, participants could integrate teacher-centered or student-centered technology. Participant A indicated that designing "student-centered and technology-based lessons takes much planning." The responses from interviews were consistent with the idea that when integrating technology, teachers plan effectively.

In evaluating the lesson plans, 10 out of the 12 participants planned SAMR lessons. The intended level of SAMR was indicated at the beginning of that specific day's lesson. Although the levels of the planned assignments varied among the participants, teachers wrote out a plan of how students would be engaged with technology. As students began to use technology during independent practice on most lesson plans, the SAMR model was more evident.

4. Conclusion

The main limitation of this research is that the professional development is designed specifically for the school district. Consequently, the professional development is not intended for an entire district audience but rather school-wide. If other districts wanted to consider the professional development, then the professional development would need to be revised to audiences beyond this study. Another limitation may be acceptance of the professional development given. Based on their self-efficacy, some teachers may feel apprehensive about shifting their instructional practices with technology integration.

Additionally, teachers' comfort level with technology may influence their integration of student-centered technology in their instructional practices. As for future research, one focus should be to conduct the study using a larger sample size. Increasing the population size would make the study more generalizable for similar districts. Another direction would be to duplicate this study on the middle and secondary levels. This would allow for a wide range of perspectives on technology integration, rather than just the elementary level.

Technology plays a vital role in the education of students; technology is present and is dormant in the instructional practices of all teachers in a classroom today. As educational researchers develop new strategies and best practices, technology is a factor in implementation. This research study sheds light on how technology can be used in today's classroom. This study showed that the purpose of different technology devices, Chromebooks, laptops, or iPads, can vary in every school. Furthermore, technology can be used differently and to varying degrees based on the SAMR model. However, the goal of any technology used within a lesson is to impact student learning. Moreover, teachers want to help transform students' learning experiences through technology-based student-centered tasks.

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