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About the Journal

Founded in 2013, the Journal of Teacher Action Research (ISSN: 2332-2233) is a peer-reviewed online journal indexed with EBSCO that seeks practical research that can be implemented in Pre-Kindergarten through Post-Secondary classrooms. The primary function of this journal is to provide classroom teachers and researchers a means for sharing classroom practices.

The journal accepts articles for peer-review that describe classroom practice which positively impacts student learning. We define teacher action research as teachers (at all levels) studying their practice and/or their students' learning in a methodical way in order to inform classroom practice. Articles submitted to the journal should demonstrate an action research focus with intent to improve the author's practice.

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CHANGING TALK AND INTERACTION FOR DIALOGIC TEACHING IN AN EARLY YEARS’ LITERACY CLASSROOM

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Abstract
Dialogic teaching emphasizes changes to classroom interaction to promote student participation, yet there are still few studies which investigate how this might occur in early years’ literacy classrooms. This practitioner action research study focuses on one classroom teacher’s journey as she implemented a range of dialogic strategies to promote student talk, aiming to create a richer learning environment in a Kindergarten and Year One elementary classroom. Changes were made over a six-month period and these were documented using a reflective journal, video and audio recordings of classroom lessons and transcript analysis of those. Classroom talk was coded according to types of interactions, and the number of interactions produced by students and the teacher. Patterns in turn-taking and language use were identified and compared over time as various strategies were implemented. As a result of changes, a more dialogic classroom environment developed providing increased opportunities for students’ voices to be heard, particularly through promoting student-to-student interactions during class discussions.

Keywords: classroom interaction, dialogic teaching, literacy, teacher action research

Introduction

Researchers’ interest in classroom talk is not a new phenomenon. Studies focusing on talk have been conducted since the 1970s (e.g. Britton, 1970, 1988; Mehan, 1979; Sinclair & Coulthard, 1975; Wells, 1986). Despite this early substantive work, the importance of valuing and promoting student talk for learning has been slow to emerge (Edwards & Westgate, 1994, p. 12). The slow emergence of understandings of the importance of student talk in classrooms has contributed to the continued dominance of teacher talk and teacher-led discussion. Many teachers take classroom talk for granted, overlooking the ways “we construct our experience, build relationships and shape our sense of the world” (Jones, Simpson, & Thwaite, 2018, p. 2) through spoken language and interaction.
Significantly, many classrooms continue to be places whereby strong constraints are placed on opportunities for students to build understandings during talk with their teachers. The importance of young children’s interactions with others, in the home, has long been acknowledged (Filipi, 2009; Halliday, 1975; Wells, 1986). Influential researcher Britton (1988) stated that “it is in the course of conversational exchange that young children learn...both to listen and interpret what people say to them, and, to put into words their own messages” (p.1). This is particularly the case during early language socialization. However, classroom research documents the limits of classroom talk in the early years of schooling (Wells, 1986, 2009) when examined from the perspective of children’s contributions to whole-class talk in particular (van der Veen, van der Wilt, van Kruistum, van Oers, & Michaels, 2017). This contradiction suggests that although the early years at school should provide a fertile context for engaging students in conversational exchanges for learning, there are constraints on opportunities for students to engage dialogically with their teacher and their peers in the whole-class talk setting. The action research presented in this article sought to address this issue.

The purpose of the inquiry project reported here was to investigate how changing classroom interactions in systematic ways could open a dialogic space within one teacher’s Kindergarten/Year One classroom (or the first two years of formal schooling in the Australian state of New South Wales (NSW)) using open inquiry questioning about quality literature during whole-class talk. The project was conducted as part of a larger Critical Participatory Action Research study (Kemmis, McTaggart, & Nixon, 2014) addressing promotion of dialogic pedagogies in literacy lessons in primary, or elementary, school classrooms.

Literature Review

Classroom talk lies at the heart of learning, significantly influencing what and how students learn (Khong, Saito, & Gillies, 2017). Talk as it relates to pedagogical dialogues in classroom lessons has been encapsulated by key concepts or approaches such as dialogic teaching, dialogic instruction, dialogic pedagogy and dialogic inquiry. Wegerif (2019) refers to all of these as coming under the umbrella term ‘dialogic education’. Although the various concepts may be unfamiliar terms to many teachers, a growing body of research rests on the fundamental notion that talk constructs meanings collaboratively, encompassing individual contributions of participants (Jones, Simpson, & Thwaite, 2018, p. 9). By interacting with others, both in the world and inside the classroom, students construct knowledge in meaningful ways as a shared endeavor for learning (Vrikkii, Howe, Hennessy, & Mercer, 2019; Wegerif, 2019).

The concept of dialogic pedagogies is centered on the word dialogue, which is made up of two classical Greek words; ‘dia’ which means ‘through’ and ‘logos’ which means ‘word’ (Bohm, 1996). Together these words translate to ‘through word’. According to Alro and Skovsmose (2002), dialogue is a “learning oriented conversation” (p.113) where what matters is what is talked about and the relationship between participants in the dialogue (p. 115). The necessity of addressing the relationship between participants is essential since through dialogue people learn how to think, feel and act collectively (Isaacs, 1994, p. 358).
Emotions are important since interactions that are “truly dialogic are interactions that are exploratory, tentative and invitational” (Lindfors, 1999, p. 243). Although there are varying approaches characterizing dialogic pedagogies (Wegerif, 2019), Vrikki et al. (2019, p. 86) conclude that they share the following features: teacher invitations to talk that prompt thoughtful responses, extended contributions by participants in talk, critical engagement that builds on and challenges contributions of parties to classroom talk, and efforts to reach agreement to address inconsistencies or gaps in contributions.

Many researchers propose the value of dialogue and dialogic pedagogy in classroom interactions because these enable students to experience and participate in talk that is powerful because it promotes logical thinking, active meaning-making and knowledge construction in the pursuit of learning (Edwards-Groves, Anstey, & Bull, 2014, p. 83). Teachers have a crucial role to play in the promotion and guidance of talk that will enable learning (Jones, 2017; Jones, Simpson, & Thwaite, 2018, p. 4), in particular through student-student talk where students hold each other accountable for their contributions (Davidson & Edwards-Groves, 2018). Nonetheless, it remains apparent that classroom lessons around the world remain dominated by teacher-led talk (Alexander, 2008); indeed the substantial body of research that followed on from Britton’s influential work in the 1970s confirms this (Edwards-Groves & Davidson, 2017). It is troubling that this remains so, even in classrooms where teachers deliberately set out to address the predominance of their own talk but still severely constrain opportunities for students to have a stronger voice in the classroom and in their own learning (Alexander, 2008).

At its core, lesson talk is controlled and dominated by particular kinds of teacher turns. Sinclair and Coulthard (1975), linguists interested in human interactions, identified the Initiation-Response-Feedback (IRF) pattern in classroom talk. They found that interactions occurring in classroom talk were highly structured and generally unfolded (discursively) in a three-step sequence of turns:

- I - A teacher question to initiate exchange
- R - A response from a student
- F - Feedback from the teacher

This pattern of turns prioritizes a teacher’s contributions as it produces two turns by the teacher in the sequence for every one produced by individual students, thus leading to the “robust finding” (Michaels, O’Connor, Hall, & Resnick, 2010, p. 47) that teachers’ talk takes up two thirds of the interaction in whole-class lessons when compared to the amount of students’ talk. The IRF sequence, in particular, makes interaction in the classroom different from that of everyday conversation, particularly in terms of who gets to talk the most.

Teachers need support to alter their management of whole-class talk to produce dialogue with students that is more focused on students’ contributions and is more productive for their learning (Jones, 2017, p. 505). This challenge is fundamental to changing practices to actively promote classrooms where students have a voice and are able to talk their way to understandings and to learn from each other and from their teachers.

*Researching contexts for dialogic talk.* Much of the literature focusing on dialogic pedagogies in the classroom addresses middle and upper primary or secondary classrooms...
(Howe, 2014; Howe & Abedin, 2013). For example, Edwards-Groves (2003) investigated the changes to lesson talk that teachers in the middle primary years made after participating in a year-long action research study. Analysis of 48 transcribed literacy lessons from eight middle primary classrooms recorded across one year found distinctive shifts in teacher talk practices after they were supported to examine their own talk in lessons. Edwards-Groves concluded that teachers’ consciousness of their own talk practices became an impetus for adjusting their lesson talk in ways that more explicitly used talk as a pedagogical tool. Furthermore, focused critical teacher self-examination supported by collaborative analytic dialogues between professionals led to more sustainable changes to teachers’ talk practices (Edwards-Groves, 2000, 2008).

Snell and Lefstein (2018) examined how students, perceived by teachers to be of low ability, were managed interactionally during a dialogic intervention in Year Five and Six classrooms in one school. The study found a tension between enabling all students to participate in cognitively challenging ways, and a prevailing belief that children of low ability could not participate in classroom talk intended to be dialogic. The researchers concluded that perspectives on identity that were related to intelligence/class influenced the uptake of the intervention with consequences for school improvement. At the same time, they asserted the importance of dialogic pedagogies for supporting all students and for addressing limited expectations of those from low socio-economic backgrounds.

Van der Veen, de Mey, van Kruisten and van Oers (2017) highlight that there is still much to be understood about how dialogic classroom talk can contribute in the early years of schooling. In their intervention study, they examine the potential of a dialogic approach for developing young children’s spoken communicative competence. Children in the study were aged between 3.8 years and 6.5 years. The researchers found that teachers could learn to promote more productive talk in whole-class settings and that children’s oral competences benefited. The study highlighted the importance of teachers learning a specific set of talk moves that they could use.

Boyd (2014) focused on teacher researchers using empirical research and reflexive accounts of their own experiences of teaching students in early years classrooms. Analyzed video recordings found that it was not easy for teacher to engage in learning conversations that generate sustained shared thinking in formal school situations. This aligns with findings of much earlier studies (Siraj-Blatchford et al., 2003; Tizard & Hughes, 1984). Boyd’s study found that although teachers become aware of the challenges of developing dialogic instruction that encompasses shared thinking, workplace pressures constrain what is possible and restrict their interactions during lessons to a focus on curriculum and assessment (Boyd, 2014). This study highlighted the ways systemic accountabilities constrained teachers’ perceived capacity to find time to conduct one-on-one conversations with students.

A study by Edwards-Groves and Davidson (2017) found that teachers employing action research were able to develop classrooms that were more dialogic. They document, for example, a Year Two classroom where interactions between the teacher and her students enabled students to produce multi-unit or lengthier turns during whole class talk about a
fiction text. The teacher developed discussion around the book through the use of posing ‘big questions’ to students. There was evidence that students sometimes challenged the view of other students, producing interactions that showed more serious consideration of points being made (Edwards-Groves & Davidson, 2017). The information gained in the Year Two classroom establishes the need for students to competently interact with other students if talk and interaction is to shift away from the dominance of the IRF during whole-class discussion.

In the analysis that follows we seek to address the relative absence of studies that directly consider dialogic pedagogies during whole-class talk in the early years of schooling. We detail one teacher’s work to consider the challenges of implementing a dialogic approach and its potential for improving language and learning in the early years through productive classroom talk (Van der Veen et al., 2017).

Methodology

The practitioner action research project reported here was part of a larger Critical Participatory Action Research (CPAR) study conducted by Edwards-Groves and Davidson (2017, 2018). The study examined the development of dialogically-focused pedagogies in primary school literacy lessons. Stibbard (the lead author in this paper) was one of 12 practitioner researchers in the study. Her project examined changes to classroom interactions in her Kindergarten/Year One grade in a small rural primary school in the state of New South Wales (NSW), Australia. Kindergarten and Year One form the first two years of formal education in the NSW education system. The school had a population of 105 students and consisted of five composite classrooms. Stibbard was teaching in her composite Kindergarten /Year One classroom of 24 students throughout the project and had more than twenty-five years of teaching experience in a range of classroom settings.

During the overall CPAR study, teachers participated in three professional development days and follow-up researcher visits led by Edwards-Groves. These were used to initially learn more about a dialogic approach to teaching and to support the development and implementation of individual action research projects. Part of this support entailed each teacher developing a theory of action (Argyris, & Schön, 1978) followed by a research question that would guide the conduct of each teacher’s project. The theory of action developed by Stibbard was: If I focus on the explicit use of classroom talk as a pedagogical resource to build vocabulary then my students will have more opportunities to engage in dialogue with higher intellectual rigor. This led to the research question: How can I explicitly use pedagogical resources for classroom talk to improve and extend students’ vocabularies? As a result of this research question, the ensuing over-arching action was to use high quality picture books to develop active listening and dialogue within the classroom in order to provide a platform for developing a richer vocabulary (Edwards-Groves & Davidson, 2020).

Data Collection. Three types of data were collected by Stibbard during the project. The first was the collection of video and audio recordings of classroom interactions in her lessons. Recordings were transcribed to provide verbatim transcripts and analyzed in order to gain
insights into whole class discussions, teacher-student interactions, and student-student interactions. These transcripts provided the second set of data. The analyses of transcripts were necessary for gaining insight into the particular changes which occurred over time. The third source of data was a series of written journal reflections stemming from transcript analysis and a quantitative analysis of contributions recorded in lessons. The reflections focused on the teaching, learning, and interactions occurring during classroom discussions and documented future actions.

Data Analysis. Data were analyzed over the course of the project using thematic coding and graphing to determine patterns in interactions in class discussion. These were coded in a number of ways: utterances of Kindergarten students and Year One students, instances of teacher utterances and student utterances, and the number of teacher-student interactions and student-student interactions. Transcripts provided verbatim accounts of talk that occurred during selected sequences of interaction. Teacher observations from their close examination of these transcripts and the recordings of lessons were recorded in the reflective journal and considered to inform decisions about what actions would be taken as the project developed.

The next section documents actions taken over time by Stibbard and changes that were brought about during the course of the project. These are presented to relay the journey of Stibbard’s practitioner action research project and to document her learning about talk and interaction in her classroom.

Results

Change over Time and Supporting Evidence. The project began at the start of the school year with the intention of exploring quality literature through inquiry questions in the service of developing dialogic talk moves (Edwards-Groves 2014) and improving student vocabulary. In essence, changed talk moves were catalysts that led to a profound change in the dialogic nature of this classroom and a shift in the dialogic relationship between teacher and students, and between students in their student-to-student interactions.

An initial step was to make a recording of a classroom lesson (on the second day of the school year), and after a transcript was made, to make a numerical count of instances of teacher and student turns. Analysis of this data demonstrated the predominance of the three-part teacher-student-teacher interactions. These took the form of IRF sequences, established as the dominant pattern of exchange in whole-class discussion. Specifically, teacher turns were leading discussion throughout the lesson phase with the use of closed questioning that resulted in individual responses from students followed by a teacher feedback turn, often in the form of an evaluation of the previously offered student answer. The overall result was teacher-directed talk dominating the discussions which were not dialogic in nature. Figure 1 shows the graph that Stibbard developed and included in her reflective journal.
Teacher reflections on this pattern of exchange established the predominance of teacher-student interactions and the absence of student-student interactions or extended student turns. This awareness prompted the decision to introduce changes to some aspects of classroom interaction. Some of the new strategies implemented are presented next in Table 1.

Table 1: Strategies for Promoting Student Talk

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<tr>
<th>Strategy</th>
<th>Changes Made</th>
<th>Resulting Actions</th>
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<td>Classroom seating structure</td>
<td>Students would sit in a circle during group discussions rather than facing the teacher at the ‘front’ of the room. At times the teacher also moved to sit on the floor alongside the students</td>
<td>Active listening among students is encouraged. When students are engaging with each other they are able to look directly at the speaker rather than more typically at the teacher</td>
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<td>Opening the dialogic space</td>
<td>Elimination of the need for students to raise hands to enter the conversation</td>
<td>Students were able to choose (self-select) when they were able to contribute to a discussion rather than wait to be called upon or be nominated by the teacher</td>
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Piggybacking

Students were provided with a number of ‘stems’ to help them piggyback onto the ideas of others in order to build on their thinking and contribution. Led to an increase in student-to-student interactions during whole class discussions.

Questioning

Students were provided with a number of ‘stems’ to help them ask questions of their classmates during the discussions in order to find out more information or to clarify a point that had been made previously. Led to more considered (deeper) thinking by the students and demonstrated a genuine need for them to understand another person’s perspective.

Challenge

Students were provided with a number of ‘stems’ to help them respectfully challenge the ideas and opinions of others to support them realize that they can have a different opinion and to express these. Provided opportunities for some students to put alternative points of view forward. This strategy was only used occasionally during the period of the project.

As a result of implementing these new strategies over time, changes in the patterns of interaction began to occur (presented following). The impact of implementing these strategies was recorded in a journal entry made on the 14th March (after six weeks since the beginning of the school year) where reflections addressed what had occurred with the introduction of piggybacking.

• “At first the students just added in comments and there was no evidence of attempts to piggyback onto other people’s ideas. I then used the stem... I agree with Nixon about.... And a light seemed to go on in the eyes of a number of the children and I then had three or four children in a row piggyback on the last person’s idea. The act of me modeling what I expected or was teaching showed the students what I wanted and as a result they were able to put this new strategy into practice.”

• “Over the next couple of days, I am going to experiment with deepening the use of this strategy further with a range of texts and see if the students once they become more familiar start to build on without the need for direct modeling every time. I am still struggling with whether all these prompts are suitable for the students of this age or whether I should just reduce it to two simple prompts. I will continue to monitor this and make a decision.”

• “The benefit of this strategy is that the sentence stems provide a way/ a language for students to employ a higher level of dialogue in a simple and straightforward way which also promotes the concept of listening to others.”
This extract demonstrates the instructional struggles that occurred during the action research. In an effort to determine the most effective ways to implement dialogic strategies and to ensure that students were independently using these strategies during class discussions, the journal entry records both the plan, the process and the reasoning for this change. At this point in time, it was noticed (by the teacher) that the strategies were not embedded in the students’ talk repertoires and still required modeling in order to remind them of ways that they could use the strategy of piggybacking to enrich the discussion. Modeling was necessary to bring about more substantial changes to the ways that students participated in whole-class talk. This foregrounded the next cycle of action.

In the subsequent phase, as various strategies were implemented and more data gathered to examine the impact of these, it was possible to determine some specific interactional changes in patterns of talk overall. One was that students slowly began to take more turns following an initial teacher turn. The increased instances of student turns at talk, in the form of multiple student responses following a teacher initiating turn, can be clearly seen in the following extract from a lesson transcript. Such transcripts were developed systematically every two weeks. The talk occurred approximately half way through the discussion. After reading the picture book, “A Nice Walk in the Jungle”, students were asked to think about whether the children in the story had a nice walk in the jungle. The extract (Figure 2) shows the production of an initiating question followed by two student responses then a teacher turn, that recaps these statements, and another five student responses that followed. This demonstrates the emergence of a shift in teacher domination of talk – simply, students were taking more turns that the teacher.
**Teacher:** So why did the boa constrictor eat the children for dinner?

**Flint:** Cause he’s a wild animal and he wanted his dinner right now.

**Grayson:** Cause he’s hungry.

**Teacher:** So Flint said he’s a wild animal and Grayson said cause he’s hungry.

**Nixon:** When you’re in the jungle you have to eat anything what you can see cause sometimes there’s nothing to eat in the jungle.

**John:** I agree with Grayson um cause um he was hungry.

**Francesca:** I agree with John cause the snake ate the children.

**Nixon:** But the teacher didn’t have a good walk because the boa constrictor ruined it because by eating all the children.

**John:** The boa constrictor didn’t really have a nice walk or lunch because he got tied up.

---

**Figure 2.** Extract from transcript of classroom talk about the picture book, *A Nice Walk in the Jungle.*

Through developing this verbatim transcript, it was possible to notice that the students’ turns showed use of language of agreement following a specific pattern (“I agree with”) and also use of language to introduce a differing perspective (“But”). This appears to be directly linked to the strategies for questioning and challenging another person’s thinking that the teacher was modeling. Furthermore, and importantly, the teacher initial turn did not name any specific student. The absence of teacher nomination directly connected to the strategy for “opening up the dialogic space” that was the focus of teacher action at this time in the project. This absence left open a chance for any student to self-select, or to start to talk. So, the extract (and the transcript that it was taken from) documents language that students were using to take a turn, and without being nominated by a teacher turn as was the case in talk recorded early on in the project which produced a more restricted IRF sequence.

During the project, an important realization was made by the teacher - while student contributions had increased such that more students spoke after an initial teacher turn in the discussion, students were not actually directing their comments to the student whose talk they were building on in their turn. Instead, students were looking in the direction of the teacher as they built on the talk of another student. This was an important noticing because it showed that students still appeared to be orienting to teacher talk, rather than talk by their peers, and so the decision had been made to more evidently vacate the floor by not looking directly at students, in order to encourage them to converse with each other.
and not *through* the teacher. Table 2 encompasses the approach for vacating the floor through specific strategies (previously reported in Edwards-Groves & Davidson, 2017).

*Table 2: Strategies for Extending Student Talk*

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<th>Strategy</th>
<th>Changes made</th>
<th>Resulting Actions</th>
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<tr>
<td>Piggybacking sentence stems</td>
<td>I agree with... I also think... I think that too because...</td>
<td>As a result of using these stems, students were able to successfully enter the discussion and build on other students’ ideas. The use of the stem made it obvious what the students was trying to achieve—adding on to others’ ideas.</td>
</tr>
<tr>
<td>Question sentence stems</td>
<td>I wonder... Why? How?</td>
<td>As a result of teaching the sentence stems, students were able to ask questions of each other. It was interesting that the questions they asked were often spontaneous and did not require the use of the set stems.</td>
</tr>
<tr>
<td>Teacher vacating the floor</td>
<td>Once the discussion was initiated by the teacher, she would sit and look down rather than make eye contact with students.</td>
<td>This demonstrated to the students that the teacher was no longer in control or in charge of the conversation. This was initially followed by a period of silence but students soon became aware that this was a cue for them to take over the conversation themselves.</td>
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</table>
Conversation monitors were introduced about halfway through the project as the transcripts indicated that some students were dominating the conversation. The conversation monitors were used so students could monitor how many contributions they were making. A maximum of six contributions was the ideal.

The teacher and the students were able to monitor the number of contributions made by each student. Students were aware that the ultimate goal was for each student to be able to contribute and have their voice heard.

As Table 2 illustrates, teacher-designed strategies were selected that could be explained to young students in their first and second years of schooling. In the case of the conversation monitors, for example, students were provided with physical resources designed to enable them to visually indicate to others that they wanted to talk and needed an invitation from another student to speak.

The next transcript extract (Figure 3) demonstrates the ability of these young 5 and 6-year-old students to interact student-to-student during classroom discussions. The discussion was recorded after the students had watched a short Pixar film called ‘La Luna’. The initiating question provided in a teacher turn (not included in the extract) was ‘After watching that movie I want you to have a little think ...I wonder how the little boy was feeling throughout that movie?’
John: I agree with Angelina cause they were fighting over the hat what way it was going.

Valda: and the broom.

Grayson: I agree with Angelina cause um it was um hard to explain to the dad and the grandpa that the little kid he wanted it to go up like whatever way he wants it to go.

Marisey: I agree with Angelina because there um the boy was trying to give back the broom to both of them and say can I please have one from one of you and one of you keep on

Valda: I reckon he felt a little bit nervous because when he was going up the ladder he was probably thought he was going to get a little bit scared and fall off.

John: I think he was going to be happy when he just floated off the uh ladder.

Frank: I think he was a little bit frustrated because he didn’t know what to do and I also think he was surprised because he didn’t know if he was supposed to climb the ladder or not.

Flint: Um I agree with Grayson because you don’t have to put the hat anyway you can just put it the front way down.

Jaxson: I agree with Frank because I do think he felt a bit happy when he was just coming off the ladder and I think he was a little bit surprised.

---

**Figure 3. An excerpt from a discussion after watching La Luna.**

Over time (three months), significant changes were evident in the overall interactions evident in whole-class talk. These show the gradual emergence, and growing importance, of other interactional sequences.

**Figure 4. Change over time in types of classroom interactions.**
The graph demonstrates the changing nature of interactions from the beginning of the school year until the 2nd May. This graph provided the catalyst for the observations made in the reflective journal on 2nd May:

- “There has been a noticeable drop in teacher-student-teacher interactions from the initial recording back in February. There now appears to be more balance between teacher-student and teacher-student-student as well as teacher and then multiple students’ responses. This is exciting and is highlighting that by the teacher vacating the floor at points that the students can continue to generate conversation. Probably the most exciting thing that I am now observing is the student-student interaction. Which truly shows that the teacher has vacated the floor.”
- “Within these conversations, the use of the strategies of piggybacking, questioning and challenging are all evident. These strategies have provided these young students with handles to use in order to enter the conversation and to demonstrate their thoughts in conversation.”

In this reflection, important observations are made about the impact of the strategies being used to vacate the floor to create a more open dialogic space in the discussion. The journal entry notes the importance of these strategies for supporting young students to “enter the conversation and to demonstrate their thoughts in conversation”. The next transcript in Figure 6 demonstrates the evolving nature of talk within class discussions. In this extract there is evidence of limited teacher turns as well as multiple student-to-student responses.
Teacher: So why did they give him a hat?

Grayson: probably they wanted him to be a ...they wanted to be a ...probably they wanted to be another little master in the boat.

Valda: He probably ...they probably thought cause he...cause they had a hat on and he wants to be cool with them.

Frank: And why does he need ...why does he need to be cool with them? Why?

Marisey: Why...why does he need the hat?

Valda: It’s in the dark.

Teacher: Ummm. So it seems a bit strange.

Marisey: You don’t need a hat in the dark. You won’t get sunburnt.

Nixon: No, It’s because the sun because...

Winston: The moon

Nixon: The moon is all shining and it might sunburn his eyes.

Teacher: um. Good point Nixon.

Valda: Why do you think that Nixon?

Nixon: Cause sometimes when cause the moon is real shiny and sometimes when he’s moving stuff he has to look at the shine and then he might get blind because it it’s real hot.

Figure 5. Extract from discussion after watching La Luna

The most significant element of this transcript is the phenomenon of students starting to ask questions of each other and to try to answer each other’s questions. This is evident in the contributions of Frank, Marisey and Valda. For example, Valda directly asks Nixon for information about why he has made a particular comment. Furthermore, an element of challenge is added when Nixon disagrees with the other students about the need for the boy to wear a hat. He goes on to justify his assertion that the boy does require a hat even though it is night time.

Throughout her action research, Stibbard (teacher researcher) involved students actively in the change process. Specifically, she and her students spent a lot of time in lessons talking about talk and about what needed to change in classroom talk and why.
This small snippet of talk provides one example of talk that addressed some of the challenges of students actually getting to have a turn in whole-class talk. On this occasion numerous students were beginning to speak at once. This prompted a teacher turn, an instructional move, to remind them of ways to conduct a conversation in a lesson. The students in subsequent turns provided the rationale for the ‘one at a time’ speaker routine in their turns and the need for “being quiet and listening to their ideas so they can add on to”. In their responses, students also clearly articulated the importance of addressing the speaker by using their name and ways to build on to each other’s turns through agreeing and disagreeing. Conversations like this enabled the development of the young students’ understandings of what to do when trouble occurred in their classroom talk and these understandings were important for the students to be active participants in shaping up new courses of talk.

**Discussion**

Through this action research a number of significant findings emerged. One of the major findings was the ability of such young students to engage in student-to-student talk during
whole-class discussion. This concept of students talking to each other during whole-class talk challenges the view that teacher questions and evaluations are necessary to continue to drive talk over the course of literacy lessons (Freebody & Freiberg, 2001) or that teachers need to have every second turn in classroom discussions. These Kindergarten and Year One students demonstrated the capacity to engage in interactional exchanges which were supported by their teacher but did not necessarily rely on the teacher’s prompts or feedback. The students demonstrated they could provide feedback to other students as well as to extend their responses, providing strong evidence of active listening between students in their interactions (Edwards-Groves & Davidson, 2020). This shift away from the traditional IRF pattern of exchange (Sinclair & Coulthard, 1975) was achieved through experimentation and practice over time by the teacher and the students.

One of the essential components of developing a dialogic space was the recognition by both teacher and students of the need to change the existing classroom structure. Changing talk practices required changing the practice arrangements (Kemmis et al., 2014). For example, it involved changing the arrangements of students in the physical space during discussions by having them sit in a circle rather than as a group facing the teacher as a strategy to open up the dialogic space. This made possible a shift in the focus of the discussion from a teacher-led and dominated discussion to having the students facing one another to support the creation of a dialogic space for talking to one another; that is, it changed the social relational arrangements of the classroom. It provided an arrangement for interactive learning that at the same time emerged from the careful and scaffolded development of dialogic strategies. For example, this was done through modeling sentence stems which could assist students in entering the discussion to piggyback on the ideas of others, to ask a question or to challenge other students’ ideas. Another strategy which was employed was deliberate teacher feedback as soon as a student used one of the sentence stems to piggyback, question or challenge another student’s contribution. This provided all students with immediate input focusing on effective ways of entering, engaging in and evaluating the discussion.

This study encompassed whole-class talk about the need for change and showed that students’ perspectives were as integral as that of their teacher. As suggested by researchers such as Edwards-Groves (2014) and Jones (2017) among others, the power for change lies in the hands of the teacher. Therefore, it is necessary to provide support for teachers to change their practice in ways that shift away from the prevalence and over-reliance on dominant IRF exchanges towards more inclusive and participatory approaches to dialogue. This study demonstrates one way in which this shift can be achieved. Over a six-month period, through processes of participatory action research, this classroom transformed from a teacher-dominated and teacher-led environment to one in which the students’ not only had a voice but were active participants in the change process itself.

For the teacher, the benefits of this research were in the process of developing and implementing the research project. One of the most beneficial elements of this process was making regular video and audio recordings of the classroom discussions. Transcribing these recordings, as the teacher researcher, allowed for detailed analysis of the interactional exchanges occurring within the classroom. This was a critical step for providing evidence for ongoing focused reflection on the phenomenon, both on the changes which were evident...
and the ongoing instructional struggles experienced by the teacher-researcher. This data provided recorded evidence, and therefore the scope for making adjustments to practices in systematic ways by availing teacher researchers of material about their own practices upon which to they can make considered, deliberate and thoughtful responses to the problems experienced in their practices. There are too few accounts by teacher researchers of their detailed analysis of transcripts produced by them (Davidson & Edwards-Groves, 2020).

In any research study, there are limitations and challenges to be addressed. This research project was no different. The most significant limitation was the six-month implementation period as specified by the research deadlines of the overall CPAR study. Although the strategies employed within this classroom continued to develop, the project timeline ensured that the focus remained firmly on creating the dialogic space and monitoring its implementation along with the use of transcripts to focus reflection. Furthermore, the time limitations meant that it was not viable for the teacher researcher herself to continue to transcribe and reflect on classroom discussions on a regular systematic basis.

Conclusion

Findings show that changing talk and interaction practices in classroom discussions requires making systematic changes over time with an intentional focus on the established interaction practices teachers and students routinely engage in. These changes must be based on evidence and directly respond an analysis of the turn taking patterns identified in each teacher’s own practices. Importantly, the challenges to making sustained changed to the dialogic practices presented by this project includes the continual need for refining interaction strategies to meet the needs of the particular class group and their conversational needs. These were noticed and monitored by examining the turn-taking using graphs to show who was talking and the number of different types of talk which were used. Importantly, teacher-made transcripts were critical for revealing the use of language, for highlighting the language required in next step instructional actions, for determining the interaction strategies being used by the students and for examining the impact of introduced strategies on how classroom discussions support student’s participation.

In conclusion, the implementation of a range of dialogic strategies employed in a Kindergarten and Year One classroom demonstrated that it was possible to shift classroom interactions away from the rigidity of the IRF structure to more substantial sequences of interaction. The study shows the potential for young students to engage in extended and robust discussion when the existing structure of talk within the classroom is carefully altered over time to provide a space which promotes dialogue in the pursuit of students’ voices being heard and their knowledge and ideas appreciated and given merit.

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References


CANDIDATE TEACHERS EXPLORING ETHNOMATHEMATICS IN THEIR SOCIO-CULTURAL CONTEXTS

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Abstract This action research attempted to raise candidate teachers’ (CTs) awareness about the links between mathematics, history, society and culture in Bahrain. It also tried to improve the quality of the researcher’s teaching practices through drawing on ideas from the sociocultural and ethnomathematics theoretical frameworks, and the ‘authentic ways of learning’ teaching approach. This action research aimed to finding ways to integrate these theoretical ideas into actual practices through the development of a specific course curriculum design, and introducing new teaching techniques. The research was guided by the following question: How can the researcher improves the content and pedagogy of the “Modern History of Bahrain” course in order to enhance the learning experiences of the mathematics CTs? The research followed a qualitative methodology and used personal observations and classroom activities as the data sources. The findings indicated that by the end of the research cycles, the CTs seemed to know more about the connection between mathematics and history and some other social and cultural activities. The quality of teaching has improved because of the changes that were implemented systematically and because the CTs and the researcher worked collaboratively to achieve these changes. The CTs developed a sense of ownership of their learning because they were encouraged to discuss the project’s activities, negotiate their suggestions and give feedback during each step, and also locate connections between mathematics and their social and cultural contexts.

Keywords: teacher action research, mathematics education, elementary, pre-service teachers

Introduction

Many educational systems around the world are working to find ways for improving effective mathematics education through different reforms and initiatives (e.g. National Council of Teachers of Mathematics (NCTM) in the United States and Canada; National Centre for Excellence in the Teaching of Mathematics (NCETM) in the United Kingdom; and Enhancing Training of Mathematics and Science Teachers (ETMST) in Australia). These initiatives emphasise the need for making mathematics education more collaborative, connected to the real-world, contextualized, and related to the culture and ethnicity of the learners (Verner, Massarwe & Bshouty, 2019).
In addition, many researchers have recognized the importance of using action research in teachers’ training and professional development. For instance, Mertler and Hartley (2017) noted that action research has been viewed as a good alternative to typical in-service teacher training (e.g. lectures or workshops) as it can help them to investigate their own practices in systematic ways, to reflect on their work, and find out more about their weaknesses and strengths. It also adds to their professional growth as it allows them to focus on specific aspects of their teaching practices and decide on ways for further improvement.

In this paper, I present an action research that focuses on finding ways to improve the quality of my teaching practices – as a university instructor - by introducing ideas from the sociocultural and ethnomathematics theoretical frameworks and drawing on concepts from the ‘authentic learning’ approach. This research aimed to integrate these theoretical ideas into actual practice in one classroom and to reflect on Bahraini mathematics candidate teachers’ (CTs) views on using this new approach of learning. This action research also investigated how engaging the CTs in exploring their social and cultural contexts might improve the quality of teaching. The following section will provide a brief overview of the ethnomathematics framework and the sociocultural theory, followed by the research aims, questions, methodology and ethical issues. Then the research cycles will be explained and followed by the findings and conclusion.

**Ethnomathematics and the Sociocultural Theory.** Ethnomathematics is a pedagogical trend in education that emphasizes the centrality of culture and context in mathematics learning. This approach focuses on studying mathematical ideas of traditional people. These mathematical ideas involve number, logic, spatial configuration and ways of organizing these concepts into coherent structures (Ascher, 2017). The scholars of the ethnomathematics approach (e.g. Bishop, 1988; D’Ambrosio; 1997, Gavarrete, 2015, Gerdes, 1986) argued that mathematical knowledge is a cultural knowledge, which has been developed in all human cultures. Mathematics in this approach is conceived as a cultural product developed in particular ways under certain historical, social and cultural conditions in different cultures. This view challenges the traditional view of mathematics education as based on impersonal learning, technique-oriented curricula and Eurocentric knowledge. The traditional view can distance certain disadvantaged groups’ learning through denying their personal cultural experiences, which can conflict with formal mathematics education in schools. Education according to the ethnomathematics approach should seek to develop mathematics as a cultural resource related to learners’ experiences. Rosa & Gavarrete (2017) argued that the core of ethnomathematics research is to explore how mathematics is made in many historically rich, diverse and distinct traditions, and also on how mathematical thinking can be influenced by diverse types of human environments, which include language, religion, morals, economics, social and political activities.

Ethnomathematics can help students see the links between social and cultural contexts with the content and pedagogy of school mathematics, and to understand it in the context of ideas, procedures and practices used in everyday life activities. In addition, Palhares (2012) suggested that in order to improve mathematics education it is important to design
mathematical activities that are culturally contextualized and are grounded on the cultures, as this will help the students to associate meaning and ownership of the school curriculum. Another useful theoretical framework that supports ethnomathematics is the sociocultural theory (Vygotsky, 1978). According to this theory, learning cannot be separated from its social context; learning is not just a process that occurs internally in the individual learner, it rather occurs through the active participation of the individual in wider social practices mediated by social interactions and cultural tools. In other words, learning according to this theory is not just a mental process separated from its social context. Learners according to this view learn through interacting with others, they communicate using language, signs and symbols. They also use different tools to organise and control their behaviours, all in which are tools created and developed in specific contexts of cultures and societies. Certain types of higher thinking abilities such as deliberative attention, verbal and conceptual thinking cannot develop without the constructive assistance of such social and cultural mediation (Ivic, 2000). Accordingly, by emphasizing the interrelations and strong dependence in learning and development, this theory supports the idea that learners’ home environments are important in promoting learning; and other ‘expert’ people – such as parents, peers and teachers - can contribute greatly to the development of the ‘novice’ learning abilities (Tekin, 2011). Knowledge according to the sociocultural theory is shared and created among experts as they all engage in inquiry-based activities that serve to solve authentic and meaningful problems. Knowledge is also seen as a human creation process rather than a given fact and it is located in the cultural and social contexts of learning and not just in the mind of the learner (Eun, 2010).

In line with Vygotsky’s ideas (e.g. zone of proximal development and the role of mediation in learning), Moll and his colleagues (Gonzalez, Moll & Amanti, 2005) regarded every household as an educational setting with important educational potential. The term ‘funds of knowledge’ was used to describe forms of knowledge and skills, which can be found in local households and “these historically accumulated and culturally developed bodies of knowledge and skills essential for households or individual functioning and wellbeing” (Moll et al., 1992: 133). All knowledge and skills attained are connected with authentic activities such as farming, construction, trade and business located in the learners’ environments.

Looking at the Islamic, Arabic, and Bahraini history in context, we can see that ethnomathematics can have an interesting implications and applications for our classrooms. In the 13th and 14th centuries, Arab and Muslim scholars made seminal contributions to many scientific fields, especially mathematics. The development of mathematical ideas was often associated with social, cultural and economic needs such as solving problems related to navigation, astronomy and architecture. Islamic religious activities also involved mathematical aspects (e.g. calculating the time of praying, the direction of Mecca, the law of inheritance and the geometrical and engineering designs). Bahrain shares this Islamic history and culture. In the past, Bahraini people used different types of mathematics in their daily life activities; for example, in trading, traditional crafts, measuring the sizes of pearls, gold-smithing and jewellery design, ship building, games and architecture. Traditional crafts such as basket weaving, textile making and ornamenting are still practised in some villages in Bahrain and they include interesting mathematical concepts. An example of the use of mathematics in ancient Bahrain was highlighted by Serjeant (1968) who illustrated a star-
calendar system used by Bahraini fishermen. This ethnomathematics is embedded in real contexts and was developed for meaningful purposes. I think that this rich mathematical heritage and interesting ideas are still untapped in the Bahraini mathematics classroom. Recognizing and utilizing such ideas in the classroom can possibly help the CTs to see the social and cultural dimension of mathematics and to make them more aware that mathematics can be useful, interesting and essential not just for mathematicians, but also for common folk as well. Another study was conducted by Amit and Abu Qouder (2017), which attempted to address young Bedouin students' persistent difficulties with mathematics by integrating ethnomathematics into a standard curriculum. The researchers interviewed 35 Bedouin elders to identify mathematical aspects in their daily lives such as using traditional units of length and weight. Then the researchers combined these ideas with the standard school curriculum to design an integrated curriculum unit. Comparisons between the experimental group (75) and the control group (70) revealed that studying the integrated curriculum improved the students' self-perceptions and motivation but had no effect on achievement in school testing results that were conducted after the experiment. In addition, Gavarrete (2015) carried out a research project that was designed to train indigenous teachers in Costa Rica on incorporating cultural aspects of mathematics and to conduct action research projects as part of their professional development program. The finding of the research indicated that these projects helped the teachers to become more reflective about the connections between mathematics, culture, education and society. These experiences also helped the teachers to appreciate the valuable cultural and social resources that are connected with their students' indigenous identities. Through searching research databases, I found that there is a lack of studies related to ethnomathematics in the Arab world and especially in the Arabian Gulf states. Hopefully, this study will highlight the usefulness of employing ethnomathematics and the social and cultural contexts in classroom preparations conducted by the teachers themselves.

**Context.** The research was conducted in a relatively new teachers’ college. The college offers different teacher preparation and professional development programmes. The strategic plan of the college emphasizes the importance of conducting research that would contribute to the educational reform agenda for teachers’ professional development that includes: encouraging teachers and school leaders to conduct action research and to be open to the international educational developments.

In a previous year, I was assigned to teach a course called: The Modern History of Bahrain—a compulsory course that all university students have to take. My class consisted of a group of 18 CTs (12 males and 6 females) in their third year of the Bachelor Program in Primary Education—Mathematics specialization. Through my initial interaction with the CTs, two issues had emerged: The first issue being the CTs showed lack of interest and low motivation towards the course. Some of them said that they studied the same subject when they were in secondary school and they already have a good knowledge base about its content. Others said they preferred to study courses that are more relevant to their specialization and that they are more in need of scientific or mathematical content and skills. These views stimulated a discussion between us about two main topics: the importance of studying history in general, and the national history in particular, and the relationship between mathematics and history. In general, most of the CTs acknowledged
the importance of studying history, but at the same time they seemed unsure about the connection between mathematics and history. These two subjects seemed to them as quite distant from each other. The CTs generally thought that learning history is about knowing and memorizing facts that happened in the past. History can be interesting because it is full of stories. While learning mathematics requires different knowledge (e.g. symbols, numbers and equations); and it needs high thinking skills (e.g. understanding abstract ideas, analysis, reasoning and mental calculation).

The second issue was related to me as the course instructor. What follows are points explained with quotes from my course reflective notes. At the beginning of the project I sensed that I lacked experience and skills in teaching this course: “although I had general knowledge about the history of Bahrain, I didn’t have any previous experience in teaching this course – neither at school nor university levels – I felt that teaching this course would be different from the other educational courses that I used to teach and felt more comfortable with (e.g. educational foundations, citizenship education, study skills and professional development courses)”. I also had a sense of anxiety related to the best pedagogy which can be used to achieve my course objective: “I was anxious that I would need to read and plan more and to be more innovative in order to make learning history more meaningful and enjoyable for my mathematics CTs”. I had two options for planning the course materials and teaching methods: “the first option is to use a traditional teacher-centered approach where I will be delivering the course content through lecturing while the CTs will be listening most of the time in the class and then memorizing the historical facts at home for the exam. This seemed to be an easy option as it doesn’t require me a lot of planning, saves my time and energy and it is always easier to manage a ‘quite’ classroom”. I always asked myself while planning the project about how the CTs will react to the new pedagogy: “The CTs may feel bored but probably most of them would be happy as long as they ‘follow the book’ and don’t have to worry about writing reflective assignment or feel burdened with confusing tasks”. Although it was tempting to choose the first option, I decided to explore an alternative approach which aimed to raise CTs awareness that there is a strong link between mathematics and history and it’s important to work together to achieve a better understanding of mathematics, not as an abstract, pure, universal knowledge, but also as an everyday knowledge that is essential in every culture and every society: in the past, present and in the future.

It is generally accepted among educators that learning by doing is an effective way to learning as it can increase students’ motivation through engaging them in real world problem solving, experimentation and action (Gavarrete, 2015; Lombardi, 2007; Mims 2003). It is also important to make learning more meaningful for the students by promoting the connections between what they learn and what they actually do in reality. One of the strategies that can be useful to achieve this type of learning is the authentic learning which “focuses on real-world, complex problems and their solutions, using role-playing exercises, problem-based activities, case studies, and participation in virtual communities of practice” (Lombardi, 2007, p. 2). Authentic learning activities aim to move students’ learning beyond content and to give them challenges that cannot be solved easily with open and multiple interpretations. These problems are complex and need to be investigated by students over a sustained period of time and require a variety of resources and perspectives. The authentic
learning tasks also require collaboration, reflection, and they allow for diverse interpretations and competing resources (Lombardi, 2007). Mims (2003) argued that authentic learning is different from traditional methods of teaching because learning is centred on authentic tasks that are of interest to the learners; students are engaged in exploration and inquiry; learning is interdisciplinary; learning is connected to the world beyond the walls of the classroom; students produce a product that can be shared with an audience outside the classroom; and students have opportunities for social discourse.

I found that the idea of authentic learning useful as it can be used as a teaching method, which will frame this action research especially that it is well aligned with the previously mentioned theoretical call for more recognition of the social and cultural resources in teaching and learning mathematics. In other words, I am personally interested in using these ideas because I think it is important for me as a university instructor to show my CTs – who will be primary mathematic teachers in the future – how important it is to move from the teacher-centered way of teaching, especially when teaching important subject such as mathematics, to a more learner-centered approach, which allows the CTs to investigate, talk, reflect, solve problems, share ideas and see how mathematics is relevant to the social and cultural context, instead of, excessive reliance on memorization, drill and rote practice. I also hope that their engagement in the action research would open new doors for them to see the connection between mathematics and other subjects, history especially.

Research Aims. Although many educational researchers considered acknowledging the social and cultural dimensions of mathematics as potentially key in mathematics education, as mentioned earlier, it seems that this issue is overlooked in classroom practices in the educational system in Bahrain and also in the current teacher training courses provided to the mathematics specialization in the college. Therefore, I believe it is important to introduce these theoretical ideas to the CTs and try to integrate it in the history course and see whether it would have an impact on CTs’ understanding of mathematics as an abstract knowledge subject and also related to our everyday life activities and deep-rooted in our culture and history.

The overall aim of this action research (Coghlan & Brydon-Miller, 2014; Reason & Bradbury, 2001) is to improve the quality of my teaching practices through drawing on ideas from the sociocultural and ethnomathematics theoretical frameworks, and the authentic learning approach and finding ways to integrate these theoretical ideas into actual practices, mainly by the development of the history course curriculum design, and introducing new teaching techniques.

Research Questions. This action research tries to answer the following general question: How can I improve the content and pedagogy of the “Modern History of Bahrain” course in order to enrich the learning experiences of the CTs?

Improving the content of this course was intended through introducing new insights that aim to enrich CTs’ understanding about the social approaches in mathematics education and to see how this would reflect on their work in the class and in performing the required tasks. Improving the pedagogy is attained through utilizing the authentic learning approach as a
new teaching strategy that fits with the theoretical framework proposed earlier. By this approach I tried to move away from a traditional teacher-centered approach toward a more open and learner-centered approach.

**Methodology**

*Data Collection.* This research was based on a qualitative design. Two data collection methods were used in this action research: First, a reflective diary that contained my observations and comments about the research steps and cycles. These comments included information about how the research idea was developed, how well the action plan went, what kind of difficulties I encountered, what sort of unexpected issues emerged, how the CTs reacted to this new approach of teaching and how can I develop these ideas in future. The second source of data was the CTs’ course work related to the following tasks:

- **Task (1)** – finding authentic problems: this task was implemented in the first cycle of the action research (which will be explained more in a following section). The CTs were asked to work individually or in small groups to find, analyse, discuss and present an authentic cultural or social activity related to an aspect of the history of Bahrain. This activity must demonstrate advanced mathematical concepts and practices. The CTs were required to submit a final written report of around 1500 words and should have illustrations and pictures if possible.

- **Task (2)** – mathematical problems development: this task was implemented in the second cycle. The CTs were required to develop mathematical problems related to the topic chosen by them in the first task. These mathematical problems should have two levels: one that is suitable for the primary school students, and one that is suitable for the secondary or university level. For example, if the CT chose to investigate mathematical aspects in traditional sailing vessels building in the first task, better known as ‘dhow’s’ and were used in the past in wars, trading, fishing and pearl diving in Bahrain, then next, the CT should work on developing mathematical questions or problems related to the idea of vessel-building. Some of these questions should fit with one of the national primary ‘basic’ mathematics curriculum lessons and the others should be suitable for ‘high’ mathematics in secondary school or university levels.

The aim of these two tasks is to encourage the CTs to design mathematical problems that are connected to the cultural, historical or social contexts related to Bahrain. These problems can be used to support the formal curriculum which they study in the college or in the primary curriculum they will teach in schools. I hoped that the CTs would see the link between mathematics and history through their investigation, dialogue and reflection while working on the two tasks.

- **Task (3)** - CTs’ presentation: after finishing the previous tasks, the CTs presented their work to their classmates at the end of each cycle. In these presentations they had the opportunity to engage in mathematical dialogue with each other where they presented their work and explained the link between mathematics and history with reference to certain historical events that were discussed in the course textbook.

The data analysis process was structured on three interconnected stages (Miles, Huberman & Saldana, 2014): (a) Data reduction: cutting down the data and condense it in a meaningful
way, (b) data display: summarizing, coding, organizing the data, and (c) drawing conclusions: reaching possible findings and conclusions. During the different stages of the data collection and data analysis I went back and forth and reviewed the different sets of data (e.g. the reflective diary and the CTs activities and tasks) to look for overarching themes that help in answering the research questions. The finding section is organized around the following dimensions that are related to the research question: CTs’ views about their exploration of ethnomathematics, changes in the content element of the course, and changes associated with the pedagogical element of the course.

**Ethical Issues.** Participation in the research was voluntary and based on freely given consent. I gave the CTs sufficient information about the research, the data collection procedures, and how the data is going to be used. All of the CTs were happy to work with me on this action research and they even contributed with interesting ideas at the initial stages of the research design. However, once they accepted to take part, it was difficult to withdraw because the mathematical tasks, mentioned earlier, were part of their course assessment.

**The Research Cycles.** The first research cycle started in the first month of the academic year and it consisted of six teaching sessions. I mentioned earlier in a previous section how I began this research journey with the CTs and how they lacked interest and had low motivation towards the course, how they seemed uncertain about the connection between mathematics and history, and my lack of experience in teaching this course created mixed feelings. At this stage I planned to improve the quality of my teaching practice through drawing on ideas from the sociocultural and ethnomathematics theoretical frameworks and the ‘authentic learning’ approach in order to enhance the learning experiences of my CTs. I worked on planning my lessons for the following three weeks. In each week there were two sessions, each session was divided into two parts. The first part focused on teaching the normal history content of the textbook while the second part focused on the action research materials, which were as follows:

In the first week I focused on giving introductory information in regards to the course, encouraged the CTs to talk about their views and how we can work together on improving them, investigated CTs’ previous experiences in studying history and their current experiences in studying mathematics subjects. We also discussed the research idea, their role and my role, the process of getting CTs’ agreement about their participation in the research, exploring their perceptions about participating in the research and connecting this with the previous research skills course which they took a year before.

In the second week I tried to help the CTs to achieve better understanding about the idea of ethnomathematics. We talked about using mathematics in the Islamic religion (e.g. calculating the time or praying, the law of inheritance and the architecture designs). We also talked about the Islamic arts and some examples of traditional crafts, which, demonstrate interesting mathematical ideas. In another session we discussed the idea of authentic learning and the sociocultural approach to learning. The CTs were encouraged to work in groups to discuss their own examples of mathematics related to the cultural and social practices in Bahrain. They were asked to write a short summary of what they intended to do
in the first task (i.e. to find, analyse, discuss and present an authentic cultural or social activity related to an aspect of the history of Bahrain).

During the third week the CTs worked in groups under my supervision in discussing their first task and to explain how it is related to the historical content of the course. These discussions were interesting because it allowed the CTs to reflect on their understanding of ethnomathematical examples related to the social and cultural context in Bahrain. It also showed me how they demonstrated their understanding of the theoretical ideas through tangible examples. In another session they worked on presenting the final report of the first task. The final presentation encouraged a dialogue among the groups of CTs about why they chose this particular topic, what are the mathematical dimensions they found, how people in the past managed to achieve this level of complexity in mathematical thinking while they were illiterate or had lower levels of education, were there any links between mathematics and other subjects other than history in these topics, and most importantly, what they learned while carrying out this task.

The CTs were rewarded after finishing the first cycle with an invitation to visit a traditional cultural center where they saw traditional crafts such as textile weaving, pottery, basket weaving, traditional carpentry and artwork.

The second research cycle started in the second month of the academic year and consisted of around three weeks (six teaching sessions). In the first two weeks of the second cycle the CTs were required to reflect on what they learned and did in the last three weeks. They were encouraged to give their opinions about the first task and whether they found it useful or not and how we can continue our work in the same approach. Most of the CTs liked the first task, for instance, one of them said: “doing this report was a wonderful experience to learn about a new science – the ethnomathematics – which showed us the relationship between mathematics and culture and heritage ... a relationship which I didn’t know it’s that strong ... it showed us how important mathematics is in our life, I also learned about our grandfathers’ way of living and reminded me of the past”. It is important to say that some CTs showed good efforts in finding interesting ideas and worked hard on the tasks while others didn’t understand the actual point of doing this task and used ‘ready-made’ ideas from the Internet. So, I decided to change my approach at that point and concentrated more on how the CTs can produce their own new mathematical problems that reflect their understanding of the relationship between culture, history and mathematics. These mathematical problems were supposed to have a rich mathematical content, and also related to meaningful social, cultural practices or everyday life experiences.

So afterward, the CTs brought their mathematics textbooks and worked together on developing new ethnomathematical problems. These mathematical problems had two levels: one that is suitable for the primary school students and the other for secondary school or university levels.

In the third week the CTs presented their mathematical problems and discussed their answers. At the same time, they were working on presentation sessions that were more related to the historical content of the course. Again, some of the CTs worked hard and
demonstrated an excellent understanding and provided interesting problems while others still preferred to give ordinary and simple problems – not really convinced about the link between mathematics and culture.

Findings

Looking back at the research question which guided this study: How can I improve the content and the pedagogy of the ‘Modern History of Bahrain’ course in order to enhance the learning experiences of the CTs? I am still not sure if the action research was successful in answering this question in full because one semester wouldn’t be enough to cover the ethnomathematics ideas in depth. However, I will focus on three aspects that are relevant to the question, the first aspect is about CTs’ views about their exploration of ethnomathematics, the second aspect is associated with changes in the content element of the course, and the third is changes associated with the pedagogical element of the course.

CTs’ views about their exploration of ethnomathematics. At the beginning of the project, the CTs talked about their past experiences as school students and how this reflected on their current position as mathematics CTs. For example, one the CTs said: “When we were students in school, they only taught us how to calculate, we didn’t learn how to use mathematics in real life. I like mathematics, but other students say what is the benefit of learning mathematics? Where can we use it in our life?” Another CT said “Mathematics is about three things: memorization, understanding and application. But in our schools application doesn’t get much attention”. Another CT said: “There are some exercises in the textbooks that require students to link their theoretical learning with everyday activities, but some teachers skip those exercises especially word problems which require problem solving skills, because they take long time and requires lots of feedback.” Some CTs emphasized teaching the basic mathematics skills and expect it to be transferred directly into real life contexts e.g. “I think if the students learned well how to calculate and do school maths, then they can use it when shopping or when facing any everyday problems, the problem is that students already lack basic skills and that prevented them from solving problems.”

I noticed that the CTs tended to link their previous experiences as mathematics learners with their current practices as mathematics teachers. It seemed that these previous experiences guided them when they face difficulties in teaching mathematics in their classrooms. For example, they may focus more on memorizing mathematical calculations instead of understating and applying the basic underlying concepts. They may also overlook the importance of connecting school mathematics with everyday real mathematical problems or addressing how it is related to the social and cultural contexts of the learners. Therefore, it is important for the teachers to emphasize the connection between in school and out-of-school mathematics learning taking into consideration that it is not an easy straight, forward process. Creating these meaningful links require lots of efforts in planning, preparation and implementation. It also requires the teachers to move from a traditional teaching style to a one that appreciate the richness of their students’ social and cultural contexts.
In the second phase of the project the CTs discussed their mathematical problems and worked on finding connection between ethnomathematical ideas and the school curricula. One of the CTs said: “Mathematics seem to be everywhere, in games, in cars, in food, in time, etc. But this mathematics seems to be simple and common sense. Mathematics in school books needs the ability from the student to think logically, use symbols, use mental strategies ... School mathematics and ethnomathematics, both are different and also similar”. Another CT said: “The ethnomathematics seems to be good to support the existing curriculum with ideas relevant to the students in school; parents can also know through these activities how to link school work with what they do at home and to engage their children with more hands-on mathematical tasks”. Another CT said: “If you look at the cultural heritage you will see that mathematics was used in such innovative ways, even in agriculture, fishing and sailing, but as a mathematics teacher I never thought I would use these examples in the classroom because children nowadays are digital citizens, they are more concerned with technology than what their grandparents do!”

Although the CTs worked in groups on task 1, they submitted individual reports that each focused on a specific topic. Some examples of the CTs’ work include:

- Mathematics in building traditional vessels: different types of vessels, the scientific concept of floating and mathematical concepts of volume, capacity, and dimensions.
- The traditional tools used in the past for measurement, and the different processes of calculating. For example, how traders measure the diameter of pearls and estimate their prices according to different characteristics.
- Mathematics in the ‘Henna’ design (dyeing hand skin): the geometrical shapes used in the henna design and the different prices for designs.
- Traditional games and their rules, which are based on some mathematical concepts related to numbers, counting and round taking (e.g. dominos, carom, cards, chess and marbles). These games also include mathematical probability and statistics.
- Mathematics in traditional textile weaving, palm tree leaves weaving and the traditional geometrical shapes, dimensions in handmade artefacts. These traditional crafts include various mathematical ideas such as measurement, patterns, and ratios.
- Mathematics in fishing: the different types and sizes of fishing tools and how they are used for catching different types of fish in different seasons. Traditional fishing traps that are made of weaved wired in a specific geometrical design and also include various mathematical ideas such as measurement, patterns, and ratios.
- There were other interesting examples relate to mathematics in Arabic calligraphy, faming, and carpentry, pearl diving and tassel.

In the second stage of the action research the CTs seemed to change their views gradually about linking mathematics to their students’ social and cultural contexts. However, some of them still preferred to stick to the mathematics taught in their schools’ curriculum firstly because it is clearly defined, sequenced, organized and can be assessed formally through standardized tests. Secondly, some of the CTs focused on an important point related to the nature of today’s students who may not give much attention to the past and the history since they are more attracted to the present (e.g. using ICT in learning, video games, and
smart phone applications). Some of the CTs thought that their students can learn a lot through these attractive modern activities and they might feel uninterested in mathematical examples related to traditional crafts they might rarely see in their homes.

Changes in the content element of the course. The main change in the course content was enriching it with the ethnomathematical content and supporting it with a sociocultural framework in order to raise the cultural awareness among the CTs about the influence of history, social and cultural dimensions on mathematics learning. The two tasks that had been used in this research tried to follow what Bishop (1997) suggested helping CTs to develop more understanding about how and when to use mathematical ideas and techniques, why they work and how they are developed and to see mathematics as a reflective subject not just a set of mechanical procedures. For example, one of the CTs said: “I think after learning about ethnomathematics and problem solving it is important for me as a training teacher to expand my students’ understanding of mathematics. To let them see it in everything they do. Not just as word problems that are a bit detached from their childhood reality. They play games why not focus on mathematics in these games?” I tried my best to provide good learning settings that encourage the CTs to develop their own personal meanings and to exchange ideas and opinions and have more opportunity to talk with each other about their understanding about mathematics and how they teach it. By the end of the action research the CTs seemed to know more about the connection between mathematics and other subjects, especially with history and science and the richness of mathematical ideas in cultural and social activities. For example, one of the CTs said: “You can’t teach mathematics in isolation. It is connected to science; in experiments they have to do the right calculations and check their results. Mathematics is also related to religion for example to know the direction of Mecca and the times of praying – sunset and sunrise times. I also think our students need to learn about money, who knows they might become entrepreneurs in the future? They also should be proud of their civilization and history. A Muslim scientist called Al Khwarizmi developed algebra. I hope my students will learn from that history”. The CTs gained more knowledge about the national history of Bahrain and about the interesting crafts and artefacts with meaningful mathematical ideas found in different communities. The CTs learned more about these aspects and the uses of mathematics as a useful cultural tool to solve real problems, not just as an abstract knowledge that is moved away from reality. For example, one of the CTs said: “Our students should visit the museum one day and see how mathematics was part of our grandfathers’ daily life. They needed mathematics to solve real problems not to just answer exam tests. Maybe they were illiterate but they know how to use mathematics in a smart way. Not all of them of course. But they learn mathematics according to their needs”.

At the same I cannot claim that this short action research was completely successful in raising CTs’ awareness or it truly convinced all of them about the importance of the cultural and social aspects in mathematics learning. Some CTs were implicitly not happy with the new approach that I have used, maybe because these tasks were not really clear to them, they also needed a lot of reflection, discussion, accepting criticism from others, working with others in group, and refining the ideas again and again. This can be difficult for some students who got used to test-based learning. However, they did not object to work even to their minimum effort. I can generally say that the action research was successful in
challenging some of the dominant views of the CTs about learning mathematics in particular – e.g. mathematics as only pure and abstract knowledge – and I tried to attract the CTs’ attention to a different perspective of learning and mathematics education which is more ‘fallible’.

Changes associated with the pedagogical element of the course. The CTs feedback related to the ethnomathematics activities and the classroom discussions supported my feeling that I have gained better understanding about the ethnomathematics and sociocultural fields and gained more authentic pedagogical experience through teaching this course. This has influenced my performance positively in other courses especially in teaching research skills course. I used some examples of this research to show my CTs and other in-service teachers the usefulness of the action research approach. I also became more confident that CTs can change their views and beliefs if I acted as a role model for them and showed them how to connect theories into practice. In many occasions, educators teach their students important theories, but fail to provide practical hands-on examples and this might inhibit their students to implement these theories in their classrooms. In that case, the CTs will not see the benefits of using innovative ways of teaching when they go to the classroom and probably will duplicate their professor’s teacher-centered methods.

Through conducting this research, I also began to test my understanding of the sociocultural theory through using it in the real settings of the classroom especially interaction and tools mediation. Some theories seem convincing in the textbooks but they are difficult to implement in reality. I found the sociocultural theory helpful in tapping a new source of understanding of how the CTs learn through exploring their social and cultural contexts. They were encouraged to build upon their previous experiences and exchange ideas with each other through collaboration and dialogue, and they utilized the cultural and social tools and ideas to mediate both their learning and their teaching with each other.

I felt that the quality of my performance has improved through doing this action research. First, because I implemented change in a systematic way, and I worked with others in achieving these changes. I encouraged the CTs to speak about their suggestions and gave them consistent feedback about what we were doing at that stage and what we would be doing in the next stages. As a result, the CTs developed a sense of ownership of their learning because they felt the importance of their contributions and ideas to the research. Secondly, I felt throughout this process that I myself was a learner more than a teacher. I didn’t always have ready answers to my CTs’ questions, so I needed to reflect on my own understanding about ethnomathematics and authentic learning and to be always well prepared before each session. Finally, I hope this action research would be useful for other college instructors who are interested in using this approach to learn more about the valuable knowledge and skills that exists in the social and cultural contexts of their students. I also hope that mathematics school teachers would think about other action research ideas and implement them in their classrooms as this would help them develop their professional skills, and would also help their students to be active learners. The findings of this small-scale action research are aligned with Abu Qouder and Amit (2017) research recommendations that highlighted the importance of integrating cultural dimensions in mathematics teaching and in teaching materials; and to train teachers to enhance their
cultural knowledge as this would help them to support and enrich their students' learning. More so, I hope that this research would raise awareness in regards to acknowledging the social and cultural dimensions of mathematics in Bahraini mathematics education, and in teacher preparation and professional development courses provided to mathematics teachers.

About the Author

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References


THE IMPACT OF PEER LEARNING APPROACH OF TEACHING IN A PHOTOSYNTHESIS CLASS

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Abstract  Teachers are confronted with many challenges in the science classroom. One of these challenges is finding a reliable learning approach to improve students’ performance. This study used peer learning approach of teaching to help students learn and understand concepts in a photosynthesis class. The participants of the study were 40 science students at Shama Senior High School in the Western Region of Ghana. These students were put into mixed ability groups and taught for 10 consecutive weeks. Pre-intervention test, post-intervention test, and questionnaire were the main instruments used to collect data from the students. Descriptive statistics of the data collected shows an immense improvement in students’ performance after the implementation of the intervention. The strategy used improved students’ learning of photosynthesis in the classroom as well as their performance in the post-intervention test. Based on the findings of this study, it can be said that peer learning approach of teaching has a positive impact on the performance of students in the classroom.

Keywords: teacher action research, peer learning, photosynthesis, intervention, performance

Introduction

The importance of the concept of photosynthesis cannot be overlooked because of its direct link to life. This understanding is fundamental to student’s understanding of how energy is transferred from the sun to living organisms in the world. According to Griffith (1997), some
common misconceptions that manifest in the classroom are that photosynthesis is a reverse of respiration, and photosynthesis only occurs in plants. For learning to be meaningful, misconceptions should be corrected by modifying students’ previous knowledge in an approach known as the conceptual changes process (Smith, Blakeslee & Anderson, 1993). Panijpan, Ruenwongsa, and Sriwattanarothai (2008) investigated learners’ basic understanding of simple light-dependent and light-independent processes in photosynthesis in Thailand. Findings from their study reveal that students understanding of the main concepts was poor and so could not apply basic knowledge to answer simple questions about photosynthesis even after several introductions to the topics. They attributed these weaknesses to rote learning and master-disciple relationship which is predominantly practiced in Thailand. They propose an emphasis to be placed on self-learning, collaborative learning, self-reflection, and integration of knowledge by self.

**Literature Review**

A classroom environment that elicits thinking must be one in which students feel safe enough to share their formative thoughts (McKeown & Beck, 1999). Peer group learning sometimes called cooperative learning has been found to have a number of beneficial effects on students and should be encouraged (Brown & Palinscar, 1989 cited in Govender, 2007). Erinosho (2008) explain collaborative learning as a practice that allows students to benefit from one another’s abilities and knowledge as they interact in a small group within a non-imposing, non-threatening and non-competitive environment. Educators nowadays are more interested about the usage of collaborative problem-solving approach in improving students learning (Dillenbourg & Traum, 2006; Liu & Kao, 2007). Educators habitually do not plan well for peer interactions (Kutnick, Blatchford & Baines, 2002). The proper use of cooperative learning improved academic achievement increased, self-confidence, motivation and increased liking of school and classmates (Balckon, 1992). Peer dialogue enables students to restructure and elaborate their thoughts (Bereiter, 2002) and is very useful tool in the process of knowledge construction in classroom learning (Mercer, 1996). Studies has shown the importance of peer interaction in science classroom (Howe, Rogers & Tolmie, 1990; Howe, Tolmie, Greer & Mackenzie, 1995). The emphasis is on getting students to work together on a problem or task in small heterogeneous groups in order to achieve a common goal and support one another. Johnson, Johnson and Holubee (1993) listed five essential elements of cooperative learning processes. These elements were positive independence, face to face interaction, individual accountability, social skills and group processing. Grouping processing enables group to focus on good working relationship, facilitate the learning of cooperative skills and ensures that members receive feedback (Effandi, 2006). Groupings that consist of above average, average and below average students in groups had been reported to be most effective (Webb, 1989). American Association for the Advancement of Science (1989) re-echoed the importance of group activities. They strongly believe that the collaboration nature of scientific and technological work must be strengthened by regular group activity in the classroom.

Peer learning as a strategy of improving students’ achievement in the classroom has been demonstrated in studies (Slavin, 1987; Lou, Abrami, Spence, Poulsen, Chambers & D’Apolonia, 1996; Topping, 2002). Gillies (2004) studied the effects of structured and
unstructured cooperating groups on students’ behaviors, discourse and learning in Junior High School. He reported that the students in structured cooperating groups showed more cooperative behavior and demonstrated more complex and problem-solving skills than their peers in the unstructured groups. Lewis (2011) evaluated the effectiveness of Peer-Led Team Learning (PLTL) reform model in first semester general chemistry lectures. The PLTL was used in place of one-third of time allocated for lecture and maintaining the same amount of structured class time. The result shows that classes implementing the PLTL reform at the setting showed a statistically significant improvement of 15% in the pass rate compared to lecture-only classes at the same setting. The objective of this study is to improve on students’ understanding of photosynthesis in plants. Therefore, the study employed peer learning as a cooperative learning strategy to help students learn and understand the processes involved in photosynthesis.

Methodology

This study is action research, which seeks to find solution to students’ inability to form the right concept in photosynthesis (Griffard, 1999). The total sample size was forty science students at the Shama Senior High School in Ghana. A class of 3rd year science students were chosen as the sample of the study. This class of students was chosen because it is the only final year class pursuing general science program and they have been taught photosynthesis in the previous term. These students were taught for ten consecutive weeks. Pre-intervention test and post-intervention test (see Appendix A) were the methods used for the collection of data. A pre-intervention test on photosynthesis was given to the target group to find out their strength and weaknesses. The pre-intervention test was made up of ten (10) items. The first seven items were based on simple basic facts in photosynthesis. For the last three items on the pre-intervention test, the researcher asked the students to solve practical questions. The duration of the pre-intervention test was thirty (30) minutes. Answers of the students to the pre-intervention test items were marked using a marking scheme. After the intervention, a post-intervention test was conducted to find out how far the intervention activities helped the students to improve their understanding of photosynthesis. The post-intervention test was not exactly the same as the pre-intervention test, with the reason that if the intervention has been effective then the students should be able to answer simple questions on photosynthesis. The post-intervention test consisted of five (5) items and the duration of the test was thirty (30) minutes. A three-item questionnaire was also administered to students in order to gather further information about perceptions of their situations after the implementation of the intervention. Data on the tests were analyzed using descriptive statistics.

Intervention. To help students learn and understand the concept photosynthesis and stages involved in photosynthesis, students were put into ten groups of four. This group was formed based on students’ performance in the pre-intervention test. The average score of the test was 2.4. Students who scored below 3, were classified as below average students. Students who scored 3 and those who scored above 3 were classified as average and above average students respectively. Each group consisted of one above average student, one average student and two below average students. Students were made aware that the
groups were formed for them to work together, share ideas and present one solution on assignments and activities giving during lessons. Students working together would maximize their own and each other’s learning. Weekly lesson scheme as shown in Table 1 was developed and used for ten consecutive weeks. The lesson scheme consisted of basic topics and activities under photosynthesis in the syllabus developed by Ministry of Education, Ghana.

**Table 1: Scheme of Work**

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic/Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Autotrophs and heterotrophs</td>
</tr>
<tr>
<td>2</td>
<td>Photosynthesis in green plants</td>
</tr>
<tr>
<td>3</td>
<td>Structural adaptation of leaf for photosynthesis</td>
</tr>
<tr>
<td>4</td>
<td>The stages of photosynthesis (light dependent and light dependent stages)</td>
</tr>
<tr>
<td>5</td>
<td>Experiment to demonstrate the presence of starch in green leaf</td>
</tr>
<tr>
<td>6</td>
<td>Experiment to show that chlorophyll is necessary for photosynthesis</td>
</tr>
<tr>
<td>7</td>
<td>Experiment to show that water is necessary for photosynthesis</td>
</tr>
<tr>
<td>8</td>
<td>An experiment to show that carbon dioxide is necessary for photosynthesis</td>
</tr>
<tr>
<td>9</td>
<td>Experiment to show that oxygen is given off during photosynthesis</td>
</tr>
<tr>
<td>10</td>
<td>Evidence to show that there is production of starch during photosynthesis</td>
</tr>
</tbody>
</table>

A work plan was developed to aid the students in their lessons. This work plan as shown in figure 1, consist of five steps:

- **Reading**: students are expected to read extensively about the problem or situation they would be working on. Students are encouraged to read relevant literature on the materials provided, this will help them perform the activity successfully.

- **Discussion**: students are expected to deliberate on how to carry out the activity or solved the problem. They share ideas on the topic and discuss the guidelines for carrying out the activity

- **Activity**: Based on the instructions given, Students collaborate with each other to manipulate, demonstrate and examine the materials in a bid to come out with their findings

- **Findings**: This stage students come out with agreed solutions with inputs from each member of the group.
• **Resolution**: The findings from each group are discussed by the class. Representative from each group present their findings to the class. The findings presented are compared with the expected answer provided by the teacher.

The steps were discussed with the students and were told to use the plan whenever work or assignment is given to them.

![Figure 1. Students’ work plan](image)

Students were taken through weekly activities that were developed based on the scheme of work (Table 1). Details of these activities carried out are as follows:

**Week One.** The first lesson was on autotrophs and heterotrophs. Students were supposed to distinguish between autotrophs and heterotrophs and give at least five examples each. Students following the work plan discussed the two concepts and went out of the classroom to pick samples of autotrophic and heterotrophic organisms. Students presented guinea grass, bougainvillea, rose plant, hibiscus plant, cocoa seedlings, and plantain sucker as examples of autotrophs. They classified them as autotrophs because these organisms manufacture their own food. They presented houseflies, grasshoppers, bees, butterflies, moths, lizards as examples of heterotrophs. They classified these organisms as heterotrophs because they do not produce their own food but depends on autotrophs for their food.

**Week Two.** The second lesson was on photosynthesis in green plant. Students were expected to explain the concepts of photosynthesis, identify plants that can photosynthesize and those that cannot. Students discussed the concepts in groups and were asked to go out of the classroom to bring samples of plants that can photosynthesize and those that cannot. They brought in green grass, hibiscus and other examples of green plant as plants that photosynthesize. Unfortunately, they could not find plants that do not photosynthesize so they mention examples they have read in books (snow plants and Indian pipe).

**Week Three.** The third lesson was on the structural adaptation of leaf for photosynthesis. Students were given transverse section and cross section of a leaf to examine under a light
compound microscope and described what they see. Students described and explain what they saw under the microscope. The anatomical features important to the study of photosynthesis: stoma, guard cell, mesophyll cells, vein and chlorophyll were discussed. Most of the explanations that students gave during the discussion showed that students prepared well before coming to class.

**Week Four.** The concepts of light dependent and light independent processes in photosynthesis were introduced and students were given 20 minutes to discuss the concepts among themselves in each group and present their explanations to the class. Most of the explanation students gave relate with the concepts. They went on to described the Calvin cycle.

**Week Five.** The fifth lesson was an experiment to show the presence of starch in leaves. Each group was given the needed materials to carry out the activity. Before the commencement of the activity, students were engaged in a short discussion on how to write their reports.

**Apparatus and reagents:** beaker, tripod, Bunsen burner, test tube, tongs, porcelain plate, bottle containing iodine, a dropper and ethanol

The students:

- Plucked off a green leaf from a plant.
- Placed it in a beaker containing water and boiled it for about 5 minutes
- Removed the leave and placed it in a beaker/test tube containing a boiling solution of ethanol
- Rinsed ethanol from leaf by washing it with hot water
- Placed the leaf in a white porcelain plate and put few drops of iodine solution on it.

**Week Six.** The sixth lesson was a practical work and the objective was to find out whether chlorophyll is necessary for photosynthesis. Before the experiment was carried out, the students were given a tutorial and the needed materials were given to them.

**Apparatus and reagents:** iodine solution and dropper

The students:

- Took a variegated leaf (croton) with green and white patches
- Placed it in a beaker containing water and boiled it for about 5 minutes
- Removed the leaf and placed it in a beaker/test tube containing a boiling solution of ethanol
- Rinsed of ethanol from leaf by washing it with hot water
• Placed the leaf in a white porcelain plate and put a few drops of iodine solution on it.

**Week Seven.** The seventh lesson was a discussion on whether water is necessary for photosynthesis. During the discussion it was disclosed that, there is no simple experiment that can be carried out to show that water is necessary for photosynthesis. This is because we cannot deny the plant of water. This plant will not survive without water. However, the role of water in starch production has been investigated using water containing oxygen -18.

**Week Eight.** The eighth lesson was an experiment to show that carbon dioxide is necessary for photosynthesis.

**Apparatus and reagents:** two potted plants, polythene bags, elastic bands, damp soda lime and sodium hydrogen carbonate

**Students:**

• Took two potted plants (balsam)
• Kept them in the dark for 3 days.
• Covered each plant with a plain polythene bag.
• Within the enclosed environment of plant A, placed damp soda lime.
• Within the enclosed environment of plant B, placed sodium hydrogen carbonate
• Placed both plants side by side in a well-lit place for 3 days.
• After the 3 days tested the leaf of each plant for starch

**Week Nine.** The ninth lesson was an experiment to show that oxygen is given off during photosynthesis.

**Apparatus and reagents:** water, beaker, funnel and testing tube

**Students:**

• Took a beaker of water and placed in it some pond weed.
• Covered the weed with an inverted funnel making sure the mouth of the funnel is about 2-3cm below the level or surface of the water in the beaker.
• Filled a test tube with water and place their thumb over the open end.

With the thumb covering the end of the test tube, they inverted it and placed it inside the water over the neck or stem of the inverted funnel and left it to rest

Placed some small amount of sodium hydrogen carbonate in the water contained in the beaker to ensure that carbon dioxide is released to enable the pond weed photosynthesis.

Placed the set up in an area/place where there is enough light and left it for 3 days.

Lifted the test tube from the funnel and placed their thumb over the open end.

Allowed the water to run out but did not allow the gas to escape.
Tested the gas for oxygen by using a splint of wood

**Week Ten.** The tenth lesson was a practical lesson and the objective was to find whether starch is produced during photosynthesis.  
*Apparatus and reagents:* beaker, testing tube, dropper, petri dish, ethanol and iodine solution

**Students:**
- Used two similar potted plants of balsam to show the process.
- Kept both plant in the dark for 4 days
- Took one of the potted plants and placed in the light whilst the other was left in the dark.
- Took a leaf from each plant 3 days later and tested for starch.
- A dark blue color was formed with iodine for the leaf that was kept in the light while the leaf in the dark turned pale brown with iodine.

**Results**

The pre-intervention test aimed at finding the knowledge level of the students on the concept photosynthesis. Data collected from the pre-intervention test served as guide in developing suitable activities to help reduce the students’ difficulties in understanding the concept photosynthesis. The post-intervention test was conducted to see how the intervention activities helped to improve the students’ understanding in the concept photosynthesis. Students’ performance in the pre-intervention test and post intervention test are presented in Figure 2.
From Figure 2, more than half of the students (36) scored below 5 in the pre-intervention test. Six students scored 0 with the highest number (10) of students scoring 2. This result indicates that most of the students were not familiar with the questions. For example, students were asked to write a balanced chemical equation for the overall reaction of photosynthesis. Most of them could not write the equation, others could not write the chemical formula of the compounds in the reaction. Only few students wrote the balanced equation for the reaction. Students’ performance improved immensely in the post-intervention test as shown in Figure 2. Most of the students scored 5 and above in the test. It can also be seen from the graph that no student scored 0 or 1, only few students (6) scored below 5. The result shows remarkable improvement in the performance of the students.

Table 2 shows the descriptive statistics of pre and post-intervention test results. From the table it can be seen that the mode, median and mean values in the pre intervention test statistics were significantly lower than in the post intervention test analysis. The mode, median and mean values of 2, 2 and 2.425 respectively in the pre intervention test shows that the general performance of the students in the test was not satisfactory. Most of the students scored below half of the total marks allocated for the test. A mean value of 6.575 in the post intervention test statistics compared to 2.425 in the pre intervention test clearly indicate significant improvement in the performance of the students. The mode and the median values of the post intervention test statistics are 7, and 7 respectively.

Table 2. Descriptive Statistics of Students’ Performance before and after the Intervention

Figure 2. Performance of Students’ in Pre-Intervention and Post-Intervention Tests
These statistics show that more than half of the students scored above half of the total marks allocated for the test. This change in performance can be credited to the strategy and the numerous activities that the students were exposed to. Few students who scored below 5 found it difficult to understand, interpret and apply the knowledge gained. These students were slow learners and needed lot of time in order to comprehend the concept.

A short questionnaire was administered to students after the post intervention test in an attempt to determine the effects of the intervention on their learning. Each question is listed below with sample responses:

1. Did you feel more or less comfortable in this class setting and why?
   All of the students reported that they were very comfortable. They were relaxed and cooperated with each other. The activities aroused their interest and made the lessons very interesting to them.

   - Yes. The discussions and activities were very interesting
   - Yes. The lessons are enjoyable
   - Yes. Because I get opportunity to handle some of the apparatus
   - Yes. I felt free and relaxed
   - Yes. I am able to interact
2. What effect has this new class setting on your learning?
From their responses the strategy affected their learning positively. All the students said they were motivated by their colleagues in the group. The quality of discussions that ensued between them helped them gained vital information from each other

- I remember most of the things we discussed
- I learnt new things from my classmates because I get opportunity to discuss and compare my ideas with others
- My group members helped me when am wrong, they gave me different explanation of the problem
- I always read my note book before coming to class
- Learning has become easier for me because we do a lot of activities

3. How do you rate your understanding of photosynthesis?
Students were supposed to respond to the above question by choosing either very good, good, satisfactory, or unsatisfactory. Thirteen students (32.5%) reported very good understanding of the concept, twenty-one students (52.5%) reported good understanding of the concept. Six students (15%) said their understanding of the concept is satisfactory but no student reported unsatisfactory understanding.

Discussion

Before the introduction of the intervention, the general performance of the students on photosynthesis concept was very poor. Students could not distinguish between autotroph and heterotroph, and could not write the balanced chemical equation for photosynthesis. Most of the students could not state the conditions necessary for photosynthesis. The performance of students in the pre-intervention test as shown in Figure 2 was very poor. The students could not analyze simple scientific concepts and facts. This poor performance can be attributed to how the students were taught. In a typical classroom lesson in the school, teachers frequently employ lecture method of teaching which leaves the students with little or no interactions with peers and materials. When the intervention was introduced, students’ performance started improving and this was seen in the quality of responses during discussions. The relative success of the strategy reflected much of what is suggested by the literature (Slavin, 1987; Lou, Abraimi, Spence, Poulsen, Chambers & D’Apolonia, 1996; Topping, 2002). Students could explain the adaptation of the leaf to carry out photosynthesis and distinguish between light dependent and light independent processes. They were able to describe the experiment that demonstrate the presence of starch during photosynthesis. From Figure 2, it can be seen that students’ performance in the post-intervention test was good. Most of the students scored above the pass mark (5). Students performed much better in the post-intervention test than in the pre-intervention test (Table 2). This also sought to suggest that, the students have improved upon their level of understanding of photosynthesis. This improvement in performance by the students was not due to chance, but rather, it was because of the well-planned intervention strategy that was employed in class.
The results of this study support the findings of Lewis (2011) and Gillies (2004). Peer learning approach of teaching enables the students to participate actively in the lessons and also promoted cooperative learning among the students. Each student of a group was responsible not only for learning what was taught but also helped group mates learn, this created an atmosphere of achievement. It was confirmed by the students that, they were inspired and motivated by the way they were taught, which in turn helped improved their level of understanding of photosynthesis concept. The result of this study shows a positive effect of peer learning approach of teaching on students’ performance.

Conclusion

The peer learning approach of teaching was the major intervention for this study. Students were put into mixed ability groups and taught for ten consecutive weeks. Based on the findings of the study, it appears obvious that the use of this approach of teaching promotes active participation of students in class. The peer learning approach of teaching promoted and sustained students’ interest in the concept throughout the study period. This resulted in the improvement in the performance of students. For students to develop good attitude towards science, teachers must create a conducive and enabling cooperative learning atmosphere for them.
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References


Appendix A: Pre-Intervention and Post Intervention Test

Pre-Intervention Test

1. The major source of energy in the ecosystem is the.................

2. In an ecosystem, which group of organisms are classified as the most important?

3. The photosynthetic process removes ..........gas from the environment

4. What gas is released during photosynthesis?

5. Write a balanced equation for the overall reaction of photosynthesis

6. Which organelle contains the green pigment which is required for photosynthesis?

7. What is the purpose of each of the following steps or processes (7-10) when testing for starch in a leaf?

8. Boiling of the leaf

9. Placing the leaf in an ethanol solution

10. Washing the leaf with water after placing it in ethanol

11. Adding few drops of iodine to the leaf

Post-Intervention Test

1. State the products of light dependent reaction of photosynthesis

2. Distinguish between light dependent stage and light independent stage

3. Briefly explain the major limiting factors of photosynthesis

4. Describe an experiment that shows the need of carbon dioxide in photosynthesis

5. How is the leaf adapted for photosynthesis?
DEVELOPING 7TH GRADE STUDENTS’ MATHEMATICAL CONFIDENCE THROUGH THE PROCESS OF SELF-REFLECTION

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Abstract Much of the current research focuses primarily on ways in which reflections and self-efficacy individually lead to improvement in grades. However, research literature addressing the connections between reflections and academic confidence, particularly, mathematical confidence is largely missing. The aim of this action research study was to examine how students’ awareness of their strengths and areas of growth regarding geometry standards in 7th grade impacted their mathematical confidence. Researchers found that while students’ participation in self-reflections resulted in an increase in students’ mathematical confidence for the 3-dimensional geometry unit, such activities need to become commonplace in mathematics classrooms to impact students’ overall mathematical confidence.

Keywords: teacher action research, student reflections, mathematical confidence, middle school geometry

Introduction

As students entered class on the day of the test, several exclaimed “I am going to fail this test!”. They hadn’t even seen the test yet, and this was the first test of the year. These students were in a 7th grade advanced class, the majority of them had done all their homework and were active participants in class. As such, it was rather surprising that many of these students exclaimed such strong sentiments. During instruction and class activities, it seemed like they were understanding the material, so it was concerning that they did not feel confident for the test.

When asked how or what they studied, the most common responses included “I did not know what to study”, “I did not know how to study” or “I gave up”. It became apparent that they did not know what to study so they either focused on studying the wrong material or were very overwhelmed and gave up on studying. Through their demonstrated work ethic during class, the evidence suggested that the majority of these students are motivated to do well, so it was concerning that they felt so unprepared for the assessment.
The scenario described sets the stage for the action research study described in this article, in which the course instructor examined whether engaging in self-reflection following learning of material of three geometry content standards had an impact on student’s mathematical confidence. The following question guided the research: In what ways does student awareness of their strengths and areas of growth regarding geometry standards in 7th grade impact their mathematical confidence?

Research has shown that it is important that students develop self-reflection skills as it relates to an improvement in their understanding of the content (Schunk, 1996; Zimmerman, Moylan, Hudesman, White, and Flugman, 2011). Much of the current research focuses primarily on ways in which reflections and self-efficacy individually lead to improvement in grades. However, there are gaps in the research literature addressing the connections between reflections and academic confidence, particularly, mathematical confidence. Belief in self is measured by two interrelated constructs: academic self-confidence, and self-efficacy (Vogt, n.d). Vogt’s research has shown that “people with positive self-views are more likely to strive overcome obstacles to achieve success than people with lower levels of confidence” (p. 1). While much of the existing research focuses on ways in which self-reflection can improve students’ performance, the focus of this study was to help students become familiar with the process of self-reflection to increase their mathematical confidence. Previous research acknowledges that an increase in confidence leads to an increase in performance, however the first step is generally to help students feel more confident. If students are able to determine their strengths and areas of growth before they take an assessment, it may help them better focus on specific topics while they are studying. As 7th grade students begin to advance in their studies, the instructor felt it was important for them to gain academic confidence, especially in regards to mathematics.

This study was developed to examine how engaging students in opportunities to self-reflect to become more aware of their strengths and areas of growth regarding geometry standards in 7th grade potentially impacts their mathematical confidence. Once students finished learning a standard in the 3-Dimensional Geometry Unit, they filled out a pre-reflection form to describe how confident they felt about that particular standard. They also made a checklist for themselves in which they described up to three steps that they would take to ensure they felt prepared for the assessment. A post-reflection was administered at the end of the unit following the unit test.

**Literature Review**

Through reading and examining the available literature, it is perceived that continuous practice of self-reflections, and setting and working towards achievable goals will result in an increase in of students’ mathematical confidence (Schunk, 1996; May and Etkina, 2002; Zimmerman et al., 2011). When students are taught the process of self-reflection, they are able to determine for themselves their areas of strength and growth. “Students are often given various study skills advice but very few actually follow the advice given to them” (Gibbs & Northedge, 1979). The authors further claim that pieces of advice given to students do not seem to involve excitement, personal exploration, and unpredictability, all of which tend to result in making studying seem like a chore. This article, provides a new student-
centered alternative – where instead of requiring passive acceptance of given advice, students become active participants in this aspect of their learning. This requires more time as students need to experiment with various frameworks, and often one way may not always produce desired results. These types of interventions tend not to consistently bring about immediate changes. It is important to note that learning to learn is a continuous life process. Through this study, informed and adapted by the work of Frondeville, students will become familiar with one framework of doing reflections.

There is a need for additional research related to mathematical confidence, therefore the bulk of the literature review relates to the reflection process, self-efficacy, and performance in mathematics; connections are made to how these relate to mathematical confidence. As many different types of studies have been done on these topics, the following literature review is organized by the major subjects, namely learning to self-reflect, connections between self-efficacy and performance; and lastly connections between academic confidence, self-reflections and performance.

**Learning to Self-Reflect.** As teachers we often assume that reflection is occurring and overlook the importance of it in an educational setting. After attending a conference with the theme “Reflection: A Neglected Area in Learning”, Boud, Keogh, & Walker (1985) became convinced that reflections are a vital element in any form of learning, and teachers need to consider how to incorporate them in their classrooms. In their book *Reflection: Turning Experience into Learning*, the authors point out three points about the reflective process to keep in mind: only learners themselves can learn and only they can reflect on their own experiences; reflection should be pursued with intent; and the reflective process is a complex one in which both feelings and cognition as closely interrelated and interactive. The authors share their findings on the importance of reflections as a learning tool in professional education and that the skills required for reflection need to be developed in professional courses. They further suggest that through engaging in this reflection cycle, we start seeing the intended outcomes.

Much research has shown that it is important that students develop self-reflection skills as it relates to an improvement in their understanding of the content (Boud et al., 1985; May & Etkina, 2002). In a study by May and Etkina (2002), the researchers explored how students’ self-reflections on how they learned content in an introductory physics class impacted the epistemological beliefs they exhibited. While the previous piece of literature described the process of reflection, this was a study involved college physics majors to see whether engaging in the reflection process resulted in an improved understanding of the content. The students were asked to reflect on four open ended questions: “What did you learn in lab this week? How did you learn it?, What did you learn in lecture and recitation this week? How did you learn it?, What questions remained unclear?, and If you were the professor, what questions would you ask to determine if your students understood the material?” (May & Etkina, 2002).

The authors found that these reflections helped the professor in guiding their lessons, and as a result some conceptual gains were measured. This study supports much of the other research literature in education that suggests that students’ self-reflection on their own learning, and then acting upon those reflections contributes to higher performance.
Connections Between Self-Efficacy and Performance. There are several variables that play an important role in students’ academic achievement, namely, academic motivation (especially self-efficacy beliefs). “High self-efficacy helps to create feelings of serenity in approaching difficult tasks and activities. As a result of these influences, self-efficacy beliefs are strong determinants and predictors of the level of accomplishment that individuals finally attain” (Pajares, 1996, p. 545). The author refers to two areas of self-efficacy and academic performance and found a link between efficacy beliefs and college major/ career choices; relationships among efficacy beliefs, related psychological constructs, and academic motivation and achievement. In this literature syntheses, the author refers to many other major studies done one similar topic including Bourffard-Bouchard, Parent, Larivee (1991) who shared that students with high self-efficacy engaged in more effective self-regulatory strategies. Pajares further shares a table of items used to measure various self-efficacy constructs as shared by various researchers. In relation to my study, Bandura’s (1993) work on collective efficacy helps in measuring students’ confidence levels.

Bandura (1997), shares his theory stating that those with higher self-efficacy expectancies—the belief that one can achieve what one sets out to do—are healthier, more effective, and generally more successful than those with low self-efficacy expectancies. “Perceived self-efficacy is defined as people’s beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives. Self-efficacy beliefs determine how people feel, think, motivate themselves and behave” (Bandura, 1997). A strong sense of efficacy has been found to result in higher performance. People with high assurance are not afraid to approach and fail at difficult situations.

Self-efficacy is developed over a lifetime and occurs in developmental stages: Personal → Familial → Peer influence → School → Transitional experiences of adolescence → Concerns of adulthood → Advancing age. Focusing on school as it relates to this study, the “cooperative learning structures, in which students work together and help one another also tend to promote more positive self-evaluations of capability and higher academic attainments than do individualistic or competitive ones” (Bandura, 1997).

Connections Between Academic Confidence, Self-Reflections and Performance. According to recent reports, full time students in K-12 virtual schools have shown lower performance in mathematics than their counterparts in traditional schools. The purpose of Choi, Walters, & Hoge (2017) study included analyzing assessment data from virtual schools to explore the association between self-reflection and mathematics performance; comparing the patterns found in student self-reflection across elementary, middle, and high school levels; and examining whether providing opportunities for self-reflection had positive impact on mathematics performance in an online learning environment. The researchers found that participation in self-reflection varied by grade, unit test performance level, and course/topic difficulty; more frequent participation in self-reflection and higher self-confidence level were associated with higher final course performance; and self-reflection, as was implemented here, showed limited impact for more difficult topics, higher grade courses, and higher performing students.
Schunk (1996) conducted two studies in which students worked under the condition involving either a goal of learning how to solve problems (learning goal), or a goal of merely solving them. Students who pursue a learning goal experienced a sense of self-efficacy for attaining it and were motivated to engage in task-appropriate activities. Children given the performance goal and high ability feedback persisted at the task but avoided challenging tasks that they may have made errors in. Children given the performance who received low-ability feedback selected easier tasks, did not persist to overcome mistakes, and displayed negative affect. Through the study he found that emphasizing to students that their goal is to learn to solve problems can raise their self-efficacy for learning and motivate them to regulate their task performance and work diligently.

Schunk’s finding are similar to that of Zimmerman et al. (2011) who conducted a classroom-based intervention study to help struggling learners respond to their academic grades in mathematics as sources of self-regulated learning (SRL) rather than as indices of personal limitation. The study was done at a technical college in developmental (remedial) mathematics or introductory college-level mathematics courses. SRL instruction was hypothesized to improve students’ mathematics achievement by showing them how to self-reflect more effectively. Mathematics exam self-efficacy, and self-evaluation scales were used to measure how confident students felt about a specific question on the exam, and how confident they felt about the accuracy of their solution. The researchers found that students in this group out performed their peers on the exams. The self-reflections resulted in higher self-efficacy beliefs when solving problems. Participation in the study also helped students view academic grades as learning opportunities to further learning, rather than as an end-point to learning.

Methodology

Participants and Setting. The research took place at a middle school located in the southeastern region of United States. The majority of the students came from families classified as middle-class/upper middle class in terms of socioeconomic levels. The study took place in one 7th grade advanced mathematics class for which the researcher is the instructor. While the class in which the study occurred has 30 students, four of the students’ (N=26) scores were not analyzed due to missing/partial data. This study took place for the duration of the geometry unit (approximately 1 month). The students are already enrolled in the researchers’ class, and all activities in this study will be a part of their regular coursework.

From prior experience with teaching this same course last year, the instructor has witnessed students feeling nervous and anxious before exams as they do not know what they should spend their time focusing on. As a result, they often focus their time studying what they are already comfortable with, leaving behind the content they actually need to focus their time on. Especially with the geometry unit, since it covers several dense topics such as: deriving surface area and volume formulas, and understanding the relationship between volume of prisms and pyramids, the instructor felt it would be beneficial for them to be aware of their own strengths and areas of growth regarding the content in the standards. One limitation
that impacted this study included the fact that this was the students’ first time learning this reflection process. For this reason, some students had trouble reflecting about themselves.

**Research Design.** Current literature focuses on how self-reflection leads to higher performance, this study specifically focused on whether this reflection process lead to higher mathematical confidence. As suggested by Atkins and Murphy (1993) there are three stages of in this reflective process: (a) becoming aware of perplexing feelings and thoughts, (b) analyzing and examining the situation, feelings, and knowledge, and (c) developing a new perspective on the situation. This study further developed this research on various self-reflection processes. While performance is an important measure, in order for us to develop life-long learners, it is important that our students develop a growth mindset. In this study, immediately after learning and practicing a specific mathematics standard in the 7th Grade geometry unit, students reflected on their confidence level and then thought about steps they could take to work on the aspects of the standard which they listed as their areas of growth (see Appendix A). Through the remainder of the unit, students acted upon these steps, and then re-reflected after their unit test (see Appendix C). The idea of self-reflection and confidence is directly tied with self-efficacy. As supported by cognitive learning theory, much research has shown that that self-efficacy is correlated to students’ learning (Gibson & Dembo, 1984; Woolfolk & Hoy, 1990). As described by Bandura (1997), “Confidence is a nondescript term that refers to strength of belief but does not necessarily specify what the certainty is about... Perceived self-efficacy refers to belief in one’s agentive capabilities, that one can produce given levels of attainment” (p. 382). While self-efficacy and self-confidence are related, there is a distinction, and this study solely focused on students’ mathematical confidence. As this was the student’s first time formally experiencing this process, it becomes important to note that increasing mathematical confidence can be a long process, and drastic results were not expected in the duration of such a short study.

**Data Analysis Methods.** Both quantitative and qualitative measures were used to see whether there was any change in students’ confidence. Quantitative analysis was based on the data received from the pre-reflection (Appendix A) and post-reflection (Appendix C), and was analyzed using the scale shown in Table 1. To determine whether there was a significant change in the confidence level for individual students, a paired two tailed t-test was performed at $\alpha = 0.05$

$H_0$: There is no significant difference in student’s mathematical confidence after participating in self-reflections.

$H_a$: Participating in self-reflections impacts students’ mathematical confidence.

**Table 1: Pre-Reflection Data Scoring**

<table>
<thead>
<tr>
<th>Confidence Level</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Confident</td>
<td>1</td>
</tr>
</tbody>
</table>
Somewhat Confident 2

Confident 3

*Note: A score of 1.5 or 2.5 was given if the chosen selection was in the area of intersection of the two confidence levels.*

Qualitative analysis was based on the data received from the open-ended questions in both the pre- and post-reflections. Researcher looked for prominent strategies and themes from the collected data. The reason for combining both quantitative and qualitative data was to better understand the research problem by converging both quantitative (broad numeric trends) and qualitative (detailed views) data.

**Results and Discussion**

Students’ results were analyzed using both quantitative and qualitative methods and supported that engaging in this reflective process led to an increase in students’ mathematical confidence. Students responses to the Venn-diagrams were examined using quantitative methods while their responses to the open-ended prompts were examined qualitatively (see Appendix A and C).

**Quantitative Analysis.** Students were given a Pre-Reflection (see Appendix A) right after they finished learning the content for a particular standard. Similar Venn-diagrams (see Appendix C) were given to students after they had completed the Unit Exam- students assessed how confident they were about the content in each standard. The table below describes the mean mathematical confidence score for each standard.

<table>
<thead>
<tr>
<th>Standard and Description</th>
<th>Pre-Reflection Score</th>
<th>Post-Reflection Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.G.1.3: Describe the two-dimensional figures that result from slicing three-dimensional figures, as in plane sections of right rectangular prisms and right rectangular pyramids.</td>
<td>2.12</td>
<td>2.52</td>
</tr>
<tr>
<td>7.G.2.6: Solve real-world and mathematical problems involving area, volume and surface area of two- and three- dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.</td>
<td>2.17</td>
<td>2.42</td>
</tr>
</tbody>
</table>
8.G.3.9: Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.

As seen by a relatively high mean score, students were pretty confident with the 8.G.3.9 standard. Throughout the unit they engaged in various activities such as exploring how the volume of cylinders is similar to the volume of prisms, and volume of cones is similar to volume of pyramid, as well as exploring how the volumes of both solids are related to each other. Part of the high confidence for this standard can also be attributed to students understanding of the previous relationships established in 7.G.2.6.

For 7.G.1.3, students’ average confidence level shows that were the least confident with 7.G.1.3. While students did a hands-on activity where they made parallel and perpendicular slices to determine the cross sections of various solids, it was difficult for them to visualize the cross sections determined by other types of slices. More about this is described in the qualitative analysis section.

For the majority of the standards, students said they felt more confident about the content during the unit test. For 7.G.1.3 there was a 19% increase in the confidence level, whereas for 7.G.2.6 there was a 12% increase. The exception to this was for standard 8.G.3.9 for which there was has a slight decrease (1%) in the average confidence level. The results of the paired two-tailed t-test show a p-value of 0.03 meaning the null hypothesis was rejected and the data produced significant difference showing that self-reflections increased students’ confidence.

Qualitative Analysis. Also included on each of the reflections sheet were open-ended questions. While we discussed what each of the numerical confidence levels meant, for many students it was still hard to numerically describe how confident they felt. The open-ended responses on the pre-reflection served as a tool to gain insights on the specific skills students learned, and skills they found to be a challenge. The third question helped students set up a specific and feasible to-do list for themselves. This self-reflection helped in engaging learners with various types of learning styles, as each student was able to come up with their own list that matched their individual requirements.

To analyze such questions, responses were categorized using two different methods. In the first method, the responses to questions 1 and 2 were analyzed using students prior and new knowledge. For the second method, student responses were sorted by whether their checklist was school or home based.

Method 1 - Standard 7.G.1.3. The majority of students had not heard about cross-sections prior to this lesson. Their responses to what they learned varied from learning about what cross sections were to naming the cross sections given a specific 3D solid. “A new concept I learned is the concept of slicing” was a common student response. Students engaged in
hands-on Play-Doh activity for which they built a given 3D solid and made various slices to determine the 2D cross sections. Students were also shown online videos to help them in visualizing the non-parallel and perpendicular cross sections which can be a little difficult to visualize. One student stated that he learned “that slicing a figure a certain way can create a different shape”.

While many students were able to understand how to make perpendicular and parallel cross sections, at the end of learning this standard, they were still challenged by how to visualize the various 2D cross sections. Students responses such as “how to draw the slicing to make the shape” and “finding the correct angle to make the slice” were frequently seen.

Method 1 - Standard 7.G.2.6. For this standard, students came in with a little more prior knowledge than they did with the previous standard. Students had previously been exposed to surface area and volume in different contexts such as when buying wall paint or in other content areas such as science. For this standard, the student responses were more focused on how to find these two, and in understanding the formulas. “I already knew what volume was from an experiment in science class. In this class I learned how to find it given any shape [3D solid]”.

While students understood that finding the surface area meant finding the sum of the areas of each side, they often had trouble visualizing the hidden sides, and/or forgot to include that side in their calculations. One of the other concepts many students found challenging was remembering the formulas for 2D shapes. For this they said, “I just need to practice and remember the formulas, like the triangle one has 1/2”. Students also had a lot of trouble finding surface area and volume of composite figures. The other area of challenge was given surface area or volume, finding the side length. For these later two concepts, it is essential for students to have a good grasp of the basic concepts which as many students shared, they needed more practice with.

Method 1 - Standard 8.G.3.9. This standard was the one that students had the most prior knowledge with. They had just learned volume of prisms and pyramids so once we explored how the volume of cylinder was similar to a prism, and volume of cone is similar to pyramid, they had a much easier time understanding and remembering it. While not frequently mentioned, a few students stated that finding the area of the base was easier this time because it was always a circle. The volume for a sphere was a little more abstract. While students were shown how the formula was derived and how it related to the other formulas, they still found that this one was different from the others.

The challenges with this standard were similar to that in the previous one. Students stated that finding volume of composite figures challenging with this one as well.

While students were able to determine what they individually learned and areas of challenge for them, an important part of the reflective process is then working on those areas of growth. For this reason, students were asked for three steps they planned on taking to prepare for the assessment.
Post-Reflection Score. While some students still found some of what was mentioned in the individual section to be a challenge, they listed many more areas of strengths compared to areas of growth. For the areas of strengths, students shared that completing items on their checklists such as reviewing notes regularly and coming in for extra help increased their confidence. For the areas of growth, the majority of students shared they needed more practice with some specific types of questions. One particular question that many students referred to asked students to find the surface area of a side of a cube given volume of the cube. While students understood the individual concepts, they had little practice with a multi-layer problem just like this one.

Method 2 - Pre-Reflection Score. For the third question, students were grouped by whether the steps they were planning on taking before the assessment were going to primarily be in class or at home. The responses to this question were pretty similar for all three standards. The majority of students said they were going to do things both at home and school. In general, students’ responses were along the lines of:

At Home:
- Complete all homework assignments
- Use Khan Academy to practice concepts they were still struggling with.
- Review notes regularly using various methods including flashcards, and making a “cheat sheet”
- Work on practice problems from notes, textbook, etc.
- Using models to simulate the problems (primarily for the cross-section standard)
- Get help from tutor or family member
- Practice/ review formulas (primarily for the surface area and volume standards)
- At school:
  - Pay attention in class
  - Participate in group/class discussions
  - Ask more questions during class
  - Come for extra help

Method 2 - Post-Reflection Score. The majority of students completed about 90% of the checklist they had made for themselves. While the accountability for all the at home portion of student to-do list cannot be reliably measured (with the exception of homework), it was noticed that the majority of students who put doing homework on their checklist were ones who generally tended to complete it, so there was not a significant change. However, some changes could be noticed in students’ behavior in class. Many more students were focused on taking the notes and participating in class. At times I did have to remind students of what they had put on their checklist, and this often helped some students in refocusing themselves.

From an overall analysis of both the quantitative and qualitative data, it can be concluded that engaging in this reflective process led to an increase in students’ mathematical confidence. The t-test for the quantitative data shows that there is a significant difference,
and from the qualitative data, from a qualitative analysis, it can be assumed that students’ mathematical confidence increased after engaging in this self-reflection process.

Conclusion

As mentioned previously, there is a dearth of research on the connections between self-reflection and self-efficacy. While there is a distinction between the two, they are closely related in that both measure student’s perception of themselves. As found by many of the research studies described in this literature review, there seems to be a positive relationship between students’ engaging in the reflection process and their self-efficacy level and performance, and this is similar to what was found in this study. In this particular study, the process of engaging in self-reflections, did in fact result in an increase in students’ mathematical confidence.

Not all students have previously engaged in this process, so as mentioned by Schunk (1996), Boud et al. (1985), for them to conduct a true and meaningful self-evaluation, it was important to first teach them the importance and the process. As mentioned by Bandura (1997), and Boud et al. (1985), reflections are a developmental and cyclical process, this is not something that can be taught or perfected overnight. Yet, as Zimmerman et al. (2011) found, which was also found in this study, this process is important in getting our students to become self-regulated learners. It is the instructors hope that through consistently engaging in reflective practices in this course, students are able to determine a reflection framework that works for themselves and they will continue to engage in that process for this course and beyond.

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References


Appendix A: Pre-Reflection Instrument

Below is a version of the researcher created pre-reflection instrument used for this study. Students were given three of these forms (one for each standard). As indicated in the findings and analysis section, the Venn-diagram was used for quantitative analysis, and questions 1 and 2 below were used for Method 1 for qualitative data analysis, and question 3 was used for Method 2 for qualitative data analysis.

Reflection

Standard:

Brief description of standard:

Place an x on the line in the venn diagram below to describe how confident you feel about the content learned in this standard. Then answer the questions below.

1. Describe one new concept or strategy you learned.

2. Explain what challenged you.

3. Describe up to 3 steps you plan to take to make sure you feel prepared to be assessed on this standard.
Appendix B: Unit Test

Below is a version of the researcher created unit test. As indicated in the findings and analysis section, the test was grouped by standards. Students’ post-reflection (Appendix C) was based on their confidence on the items assessed on this test.

Name ___________________________ Date ___________________ Period ______

**UNIT 3 TEST: Three-Dimensional Geometry (Day 1)**

7.G.1.3: Describe the two-dimensional figures that result from slicing three-dimensional figures, as in plane sections of right rectangular prisms and right rectangular pyramids. (Questions 1-3)

1. Which of the listed cross sections can be formed by the intersection of a plane and the shape below?
   - □ Square
   - □ Trapezoid
   - □ Circle
   - □ Triangle
   - □ Rhombus
   - □ Rectangle

2. For the solid below, sketch two cross sections. One cross section should be parallel to the base, and the other perpendicular to the base. Identify each of the cross sections and describe how the dimensions of the cross sections are related to the dimensions of the solid.

   Original Solid | Parallel Cross Section | Perpendicular Cross Section

3. Describe a solid that has both of the following cross sections.

   Parallel to the base: | Perpendicular to the base: | Original Solid
7.G.2.6: Solve real-world and mathematical problems involving area, volume and surface area of two and three dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms. (Questions 4-8)

4. What is the surface area of a rectangular box that is 12 inches × 8 inches × 10 inches?
   a. 960 in$^2$
   b. 592 in$^2$
   c. 296 in$^2$
   d. 200 in$^2$

5. Find the surface area for the figure below.

[Diagram of a prism with dimensions: 7 in, 2 in, 4 in, 10 in, 5 in, 3 in, 8 in, 4 in]

6. You have a cube that is 64 cubic feet in volume. What is the surface area of one of its faces?
   a. 6 square feet
   b. 64 square feet
   c. 16 square feet
   d. 36 square feet
UNIT 3 TEST: Three-Dimensional Geometry (Day 2)

7. Find the volume of the pyramid shown below.

![Pyramid Diagram]

8. Find the surface area of the square pyramid shown below.

![Square Pyramid Diagram]

8.G.3.9: Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems. (Questions 9-12)

9. Mrs. Hartka is packaging soup in cylindrical cans. She calculated the volume of soup to be 325 cubic centimeters per can. The area of the base of each can is 25 square centimeters. What is the height to which Mrs. Hartka fills each can with soup?

a. 13 centimeters  
b. 25 centimeters  
c. 300 centimeters  
d. 8,125 centimeters
10. A box contains 9 identical glass spheres that are used to make snow globes. The spheres are tightly packed, as shown below.

What is the total volume, in cubic inches, of all 9 spheres? Round your answer to the nearest tenth.

Volume of a sphere = \( \frac{4}{3} \pi r^3 \)

11. The volume of a cone is 15 \( \pi \) cubic meters. What is the volume of a cylinder with the same base and height? Explain your reasoning.

12. Find the volume of the composite solid below. Round your answer to the nearest tenth.

a. 1,733.3 m\(^3\)

b. 2,486.9 m\(^3\)

c. 1,733.3 m\(^3\)

d. 2,486.9 m\(^2\)
Appendix C: Post-Reflection Instrument

Below is a version of the researcher created post-reflection instrument used for this study. As indicated in the findings and analysis section, the Venn diagram was used for quantitative analysis, and questions 1 and 2 below were used for Method 1 for qualitative data analysis, and question 3 was used for Method 2 for qualitative data analysis.

Name: __________________________ Per: _____

Test Reflection

Place an x on the line in the venn diagram below to describe how confident you feel about the questions relating to the content learned in the following standards.

7.G.1.3: Questions 1-3

[Diagram]

7.G.2.6: Questions 4-8

[Diagram]

8.G.3.9: Questions 9-12

[Diagram]
**Overall Reflection:** Answer the following questions about all three standards assessed on this test.

1. Looking at your responses to all three venn-diagrams, list the standard(s) you feel the most confident about?

2. Looking at your responses to the venn-diagrams, list the standard(s) that are still challenging for you?

3. Thinking back to the steps you had decided to take, describe the steps you took to make sure you felt prepared to be assessed on the standard(s) listed in question 1? What additional steps will you take to understand the standard(s) you listed in question 2?
ELEMENTARY TEACHERS AS ACTION RESEARCHERS

Justine Bruyère
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Abstract  This research describes the design and findings of a qualitative case study involving four teacher researchers from one private elementary school. The teachers embarked on a yearlong project to illustrate how the cyclical process of action research (planning, acting, doing, reflecting) might improve pedagogies, aid teacher planning time, help students, and enhance programming. The theoretical framework of the study elaborates on the concept of praxis (a marriage between theory and action) and communities of practice (Freire, 1970; Lave & Wenger, 1991). In education, a common understanding exists that fruitful learning takes place when the everyday ‘doing’ is informed by current research; it’s a mindset of tomorrow rather than the mentality of yesterday. The research, herein, details a process where teachers see action research as a way to expand their own thinking. It sought to explore whether looking deeply at questions about daily practice could impact teaching. Researcher observations, team meetings, and participant comments were used to analyze and decipher the events that took place in each of the three classroom settings during the fall of 2017 and the spring of 2018.

Keywords: teacher action research, reflection, praxis, teacher education.

Introduction

Our first meeting was held on a warm autumn Thursday. The three teachers, all of whom I had worked with for two school years, sat in my second-grade classroom as we discussed their research interests. In this role, I was not acting as their teaching colleague. Instead, I acted as a sort of action research mentor- the official title was Action Research Lead. For the next 10 months I would not only conduct my own action research, but I would also mentor these three teachers through the process of wondering, questioning, gathering, and researching. The first meeting then, was a chance for us all to share hopes of what was to come and what this research might look like in less than a year’s time. All three teachers, Jaclyn, Jerry, and Sarah, shared aspirations for their eventual action research projects. That day, and for the following seven weeks, we endeavored to not only understand what action research was and how we could use action research in our classrooms, but we also began to think deeply and critically about how action research could inform the practice of other teachers like us.

My interest in action research stemmed from personal experiences engaging in action research as an elementary school teacher and graduate student. This involvement with action research was supported by my professors and it was through their mentorship that I was able to better understand both my teaching and my students. The goal in the research described here was not to provide a one-size fits all approach to utilizing action research at
the elementary school level. Instead, this work aims to provide a sample action research road map and narrative.

Therefore, in this action research practitioner inquiry, I investigated how action research could aid teacher practice, specifically for a kindergarten, music, and a learning specialist teacher. While teaching at a private K-6 school, many of my interactions with teachers had been informed by both research and best practice. However, none of the conversations revolved around teacher-led research. Therefore, in the fall of 2017, I set out to gather and analyze data with a team of teachers as my subjects. Together, we each looked at teaching through a slightly different lens. My hope during the inquiry was to gain an understanding of how helpful a research culture, like the one we began, would be for teachers in their day-to-day practicing.

**Literature Review**

Research is a high-hat word that scares a lot of people. It needn’t. It’s rather simple. Essentially research is nothing but a state of mind...a friendly and welcoming attitude toward change. It’s going out to look for change, instead of waiting for change to come. Action research is an effort to do things better and not to be caught asleep at the switch. It is the problem-solving mind as contrasted with the let-well-enough-alone mind (Kettering as cited in Hubbard and Power, 1993, p. 1).

Teacher self-reflection and practice-based reflection have recently come into view as a beneficial tool for educators (Shakman, Bailey, & Breslow, 2017). Educational institutions, pre-service teacher programs, and teachers themselves recognize that “teachers must be more than mere technicians who carry out a cookbook approach of past instructional strategies and who, in turn, are evaluated by a checklist according to their competency in doing so” (Hoover, 1994, p. 83). One approach for reflection that is currently receiving widespread interest is that of action research. It is common for teachers who are obtaining a Master of Education degree to engage in action research as part of the fulfillment of their degree; however, this type of research is not common place following graduation (Pecaski McLennan, 2013).

Action research is a process of determining important questions, collecting data, and analyzing the data to answer the questions (Carr & Kemmis, 1986). A closer look at teaching, learning, schools, and curriculum can lead to genuine and purposeful changes that better serve students and the community. Questions for improvement and understanding, in relation to teaching, are natural. Inquiry is an important part of teaching and learning. Theoretically speaking, the foundations “...of action research in education are grounded in the importance that John Dewey gave to human experience and active learning in the generation of knowledge” (Herr & Anderson, 2005, p. 673). Dewey saw the teacher as a facilitator of knowledge, not the generator of it. This view shifts teachers from the role of instructor to the role of a professional reflective learner. A contemplative role, researchers agreed, was more likely to create a community of trust and respect where teachers were committed to best practices, human relations and partnerships in education (Corey, 1949; Herr & Anderson, 2005). Teacher inquiry is a medium for professional growth and
understanding. The inquiry process develops from wonderings and power changes in teacher practice (Dana, Gimbert & Silva, 2001). Within the bounds of action research, teaching and learning grow into a fusion between action and theory. Through this merging, teacher researchers are granted “...an opportunity to learn from unfolding experience” (Kemmis & McTaggart, 2005, p. 581). Today, teacher researchers see action research as a way to expand their own understandings of teaching practice (Herr & Anderson, 2005; Shakman et al., 2017). The hope is to enhance teachers’ intellectual activity, not to fill “teachers’ heads with new and innovative ideas that may come and go” (Nieto, 2003, p.18). Teachers who conduct and participate in action research frequently grow more skilled in assessing student learning and making use of data to modify and enhance their teaching strategies and lesson delivery (Stagg-Peterson, 2012). In traditional research, researchers are on the outside looking in. In action research, the researchers are embedded in the research and see themselves as part of the research.

The inquiry looked at how a group of research-minded colleagues worked together to define an area of teaching that both interested and perplexed them. Working together in this manner, we hoped, would improve and empower our practice helping the teachers to “...see themselves as transformers of education... directly benefiting students, their families, and other educational stakeholders” (Pecaski McLennan, 2013, p.2). Researching and writing about experiences and trials in the classroom, as noted by Pecaski McLennan, can operate as the beginning of a transformational experience. The teacher researchers each formulated a research problem and questions, collected and analyzed data, and eventually discussed the data and outcomes (Bambino, 2002; Curry, 2008; Taylor, 2017).

Methodology

This case study, action research project has been theoretically informed by concepts of praxis (Freire, 1970) and the theory of communities of practice, devised by Lave and Wenger (1991), whose notions conceptualize learning as both a situated and social interaction. Praxis is defined as "...reflection and action directed at the structures to be transformed" (Lave & Wenger, 1991, p.126). Through praxis, teachers are able to approach their craft with a critical awareness of self and an openness to possibility (Freire, 1970).

In case study research, investigators “...emphasize, describe, judge, compare, portray, evoke images, and create, for the reader or listener, the sense of having been there” (as cited in Merriam, 1998, p. 338). As a research strategy, case study has a long history of contributing to the field of education (Gibson, 1988; Lightfoot, 1983; Wolcott, 1973). The use of case study enables bounded system research through a comprehensive, in-depth data collection process in which interviews, observations, and documentation are used to explore the topic at hand (Creswell, 2007; Smith, 1978).

Action researchers who approach their work qualitatively, provide “a distinctive way of knowing and theorizing about educational and social practices and structures, and thus can make distinctive contributions to education knowledge and debate” (Freebody, 2003, p. ix). In qualitative research, validity is achieved when continuous and meticulous verification strategies are carried out (Creswell, 1998). These careful steps allow the reader to authenticate the methods used in the research (Rolfe, 2004). Two of the main validity
concerns applicable to this research are researcher bias and generalizability of the findings. I have attempted to address validity concerns through triangulation (Creswell & Miller, 2000, p. 124).

Triangulation. The purpose of triangulation is to gather validation of findings through merging differing perspectives and data. When the perspectives and the data converge, this is commonly viewed as the greatest point of validity (Jakob, 2001). As a result, triangulation has widely become an accepted practice in social research.

Throughout the course of this yearlong action research project, teachers participated in questionnaires and interviews. From October 2017 to June 2018, I carried out this process in a repetitive fashion, always revisiting the main research questions and continually revisiting and revising my path. The support given to each teacher was unique to their individual studies, learning styles, and their experience with research. Detailed records of our course work, notes taken during and after our meetings, collected audio recordings, and my recorded observations were reviewed to accompany what was happening in each action research study. Several overarching topics were used to guide meeting times with the teacher/researchers, including: 1) teacher prior-experiences 2) research questions, 3) self-reflection based on data collection, 4) pedagogical changes/challenges/questions 5) action research influence on other areas of teaching (i.e.: student learning), and 6) thoughts about action research in general. The meetings included questions about the decisions that teachers were making in their research, as well as expectations they had of their students, and advice they might give other teachers engaging in action research. These overarching topics and questions were used to loosely guide the conversation, though the meetings were not scripted in anyway. Each meeting was audio-recorded and transcribed. The data generated was reviewed and ultimately discussed with the school curriculum developer, who acted as a collaborator throughout the course of this project. As we reviewed and grouped common ideas, themes began to emerge. Using theoretical sampling, a “process of data collection directed by evolving theory rather than by predetermined” set of ideas, common refrains became evident (Strauss, 1987). The following themes emerged from the process: teacher confidence, teacher/student relationship, and teacher desire to publish work.

Research Questions. As I moved through the research, considering two simple questions helped to guide my decisions on how to best support action research in the classroom.

1) Does action research affect teacher ability to support student learning in math, music, and outdoor education?
2) What role does action research play in teacher knowledge and confidence surrounding their research area/interest?

In exploring the relationship between action research and teacher growth, I began with theory classes (carried out like a university level course) in which I shared current action research (AR) findings, explained the significance and methods for this kind of research, and engaged in critical conversations about AR. Thereafter, we conducted shared-research as a group, gathering data and compiling our research together. Finally, each of the three
teachers carried out individual action research studies. What follows is a detailed account of our experiences together.

*The Participants.* This research was conducted in a private independent Christian school in middle Tennessee. The population was predominantly upper-middle class Caucasian families. There were approximately 500 students enrolled in grades K-6. There, 50% of the 60 teachers held advanced degrees. Each grade level had four classes, with a student to teacher ratio of 8:1. Teachers at this private, independent school engaged in approximately 3,550 hours of professional development each year.

Purposeful sampling was utilized to select the teacher researchers. Of six teachers who were initially presented with the opportunity to participate in this action research group, four teachers agreed to join. Three female teachers (myself included) and one male teacher participated in this research.

This study, was a call to action responding to the need for teacher voice in the theory landscape. Pertaining to action research, this investigation hoped to show that teacher research positioned within a community of practice, can contribute to and influence teacher praxis. The study, therefore, was socially situated in a community of learners (both expert and novice, teacher and student) who work together in a relationship founded on mutual respect (Brown & Campione, 1994; Lave & Wenger, 1991; Rogoff, 1994; Wenger, 1998).

*The Teachers. Sarah’s Profile.* At the time of this research, Sarah had been a teacher for eighteen years. She attained her undergraduate degree at Louisiana State University in Communication Disorders. She has taught in rural Mississippi and Memphis. Early on in Sarah’s career, her Master’s degree work brought her to a private school in Memphis where she was first introduced to Reggio Emilio philosophies of teaching (Hewitt, 2001). While pursuing her Master of Early Childhood Instruction and Curriculum Leadership degree, University of Memphis, Sarah observed in a school where the outdoor education program combined Montessori and Reggio Emilio philosophies. Sarah credits these experiences with her love for outdoor, inquiry-based learning. Sarah was a Kindergarten teacher at the school where this research took place.

*Jaclyn’s Profile.* At the time of this research, Jaclyn had been a teacher for eight years. Jaclyn attended Perdue University and acquired a Speech, Language and Hearing Sciences undergraduate degree. She went on to graduate from Indiana University with a Masters of Arts in Speech Language Pathology. In 2010, Jaclyn began teaching at a school for students with learning differences and unique learning styles in Tennessee. It was during this time that she honed her skills as a Speech Language Pathologist. Later, she moved to the K-6 private school where this research took place and was serving as a Learning Specialist teacher.

*Jerry’s Profile.* At the time of this research, Jerry had been a teacher for 10 years. While in his teenage years, Jerry was a member of the prestigious Chattanooga Boys Choir. The choir performed all over the world. Jerry went to the University of the South for his undergraduate degree in Arts with a focus on Vocal Performance. He later attended middle Tennessee State University and attained a Master of Arts in Music Education degree. Early
on is Jerry’s career, he was the travelling music teacher for an entire school district, providing over 1800 students with music education classes. For four years, Jerry held the music teacher and choral director position at the private school in middle Tennessee where this research took place.

As part of this action research project, the school curriculum developer sought to oversee the entire project. Together, we met a total of 6 times to discuss each research project. Our conversations tended to focus on teacher growth.

Schedule. The group met bi-weekly for the entire school year and for two 30-hour work weeks when the school year had ended. In all, each teacher spent over 120 hours devoted to the action research project.

Table 1: Action Research Timeline

<table>
<thead>
<tr>
<th>Month</th>
<th>Week</th>
<th>Focus</th>
<th>Questions/Themes</th>
</tr>
</thead>
<tbody>
<tr>
<td>October</td>
<td>1 &amp; 2</td>
<td>Theory</td>
<td>• What is action research? &lt;br&gt;• Why should teachers research? &lt;br&gt;• What’s not working as it should in your classroom? What could be improved?</td>
</tr>
<tr>
<td>November</td>
<td>3 &amp; 4</td>
<td>Theory and Practice</td>
<td>• What does school action research look like? &lt;br&gt;• How do you know when you’re on the right path? &lt;br&gt;Working toward a research question. &lt;br&gt;Unpacking data &lt;br&gt;Staying focused during research</td>
</tr>
<tr>
<td>December</td>
<td>5</td>
<td>Team Research</td>
<td>• Conducting a mini-inquiry as a team &lt;br&gt;• What is a literature review? &lt;br&gt;• How do I write a literature review?</td>
</tr>
<tr>
<td>January</td>
<td>6 &amp; 7</td>
<td>Team Research</td>
<td>• Compiling and coding data &lt;br&gt;• Synthesizing and communicating findings &lt;br&gt;• The writing process</td>
</tr>
<tr>
<td>February</td>
<td>8 &amp; 9</td>
<td>Reflecting and Planning</td>
<td>• Review and reflect on Team Research project &lt;br&gt;Planning for independent research &lt;br&gt;Qualitative or Quantitative? &lt;br&gt;Whole class or small group? &lt;br&gt;Teachers? Students? Administrators? Parents? &lt;br&gt;Approvals and ethics.</td>
</tr>
</tbody>
</table>
From October thru February, the teacher researchers and I met for what will be described as an action research course. The action research course consisted of 90-minute long sessions where action research projects (including videos, journals, presentations, and reflection) were discussed and interpreted. Guided by the work of Kemmis, McTaggart, and Nixon (2014), we considered common obstacles to action research, the advantages of using action research in the classroom, and the ways in which action research could bring about change in our practice. During our first meeting, we named ourselves OHARE, which represented our school name followed by ‘Action Researchers in Education’.

In mid-November and through January, the teacher researchers completed a group action research project that aimed to reduce transition times in classrooms using music as a motivator. Each teacher action researcher read journal articles, compiled rich citations, and conducted their own research. For a total of eight-weeks of mixed methods data collection, we uncovered that music could be an aid when transitioning from the classroom to enrichments and vice versa. Though, in some cases (specifically in learning services), music could also be a distraction to the learning that takes place. Our data brought to surface questions about what to do when the data collected is ambiguous and how a study might change if it were tackled for a second time. Action research in the classroom offers a process centered approach to investigations, it asks teachers to reflect on and make changes to their practice. During our meeting times, the intention was to encourage teacher discussions and comfort with research, so that eventually, each researcher could conduct individual studies with confidence. Our shared action research project helped to ground the teacher researchers in an experience that would closely resemble their eventual solo action research projects. The investigation hoped to show that teacher research positioned within a community of practice could contribute to and influence teacher praxis.

Selecting a topic to research for the solo project started with addressing burning questions that the teachers had with regards to their practice. To do this, we reflected on areas of our teaching that could be improved upon (Herr & Anderson, 2005). Next, we conducted a
review of available literature. Then, we discussed the current research, which helped the teacher researchers to see if their action research would add to the body of research that already exists (Figure 1. shows teacher brainstorming). From here teachers continued to consider and refine their questions. Eventually, each teacher selected participants and obtained necessary consents to participate.

Once teacher researchers had established both a desire and a need for the research they wished to conduct, they began the sometimes-laborious process of exploring research and composing their literature review while simultaneously planning their research projects. Bi-weekly meetings were held to address concerns and guide the planning and delivery process.

During our two weeks of daily work, which took place in May and June, teacher researchers were expected to code and organize data. Each of the teacher researchers wrote literature reviews and explored their findings with a critical lens. Furthermore, the teacher researchers were expected to judiciously review the work of the other teacher researchers to provide feedback.
Results

What follows is a description of the three themes that emerged from my time and work with each of the teachers, teacher confidence, teacher/student relationship, and teacher desire to publish work, that emerged from this research.

Teacher Confidence. While little question remains that teacher confidence contributes to teacher practice, this research helped to show that independent reading, research, and eventual publishing gave teachers a topic certainty they had not previously possessed. When beginning this research endeavor, Jerry commented that he didn’t know exactly what he would do, he only knew that he was passionate about boys singing. Similar to Jerry, Jaclyn and Sarah intended to use this research as an opportunity to explore topics (differentiated learning and outdoor education were their research ventures) that made them both curious and excited.

As our time together took shape, the teachers used individual meetings to pose questions, discuss research, and plan their eventual action research projects. While this was taking place, we carried out a group research project on a topic for which we all shared interest, transition times. All teachers noted that the group research project helped them to explore action research in a safe and ideal fashion. Sarah posited that the writing offered her an opportunity “to practice professional/academic writing before starting my personal action research project. It has been close to 10 years since the last time I conducted any classroom research or used citations.” Practicing the act of researching and writing for a report that would not be published turned out to be a worthwhile endeavor. In order to be most effective, teachers used a similar outline and formatting as they would for their final research project.

This kind of learning community, where teachers are researching their own practice and surroundings, demands that the researcher ground his/her thoughts in theory. Therefore, a review of literature was necessary. The process of reading for and writing the literature review was, at times, tiresome. With an already heavy workload, the teachers in this research were going home at night to read lengthy papers, then reflect on their research and craft. The examination of existing research, however, helped to shape the research and guiding questions. “In completing the literature review,” Jerry wrote, “I gained a large bit of knowledge that I did not have before. Now, I have support for what I assumed, as well as new ideas that I hadn’t thought of.” The teachers all felt that their knowledge of school-based research, such as action research, helped to pivot from a place of assumptions to critical thinking and problem solving. Jaclyn extensively researched the work of Tomlinson (2014) and brought these understandings to her work and research. In reflection, Jaclyn shared that she was “definitely more confident. I still have room to grow and learn but I feel more knowledgeable now than when I started. I feel I can better help the teachers here and specifically that I could help them with differentiation strategies.”

Teacher/Student Relationship. The teachers in this research had pre-established relationships with their students. All knew their participants (students attending the school) for at least six months, if not longer. This connection, I contend, enabled the teacher
researchers to form a collaborative insider view of particular happenings in their classrooms (Schon, 1983). In a self-reflection questionnaire, each of the teachers indicated that completing this research not only helped them to better understand their craft, but also helped them know and understand the needs of their students. In response to the question of whether this research had any supplementary benefits, Jerry expressed, “this research improved my relationship with this group of boys. I think that just noting that I wanted to help them was a good thing for the students to see. They saw that I was interested. The students commented that they knew that I cared about them and wanted them to do well.” Later, Jerry explained that prior to this research he had not conversed with the students about his fondness of sports. During one of the boys’ singing group sessions, the boys began conversing with Jerry about their pastimes outside of school. To the surprise of his students, Jerry conveyed that he played baseball and was on the wrestling team as a teenager. “Even just that conversation” he rationalized, “drew us all closer together.”

When her research began, Sarah was collecting social emotional data following kindergarten recess and forest play time, respectively. Like Jerry, Sarah also felt that the research helped her to better know her students. More specifically, the data drew her attention to the fact that kindergarten play is more than jungle gyms and swinging. She explained, “Children, at this level (kindergarten) cannot be indoors, or even on the playground all day, for that matter. They need to be exploring, they need to have some autonomy and new experiences- experiences where I am not standing in front of them and telling them what to do and how to do it.” Witnessing both these special moments of growth and the social emotional benefits contributed to her understanding of what her kindergarten students required. Through research, Sarah knew that stepping back would provide opportunities for inquiry-based learning, student led discussion, and the close observation of students. In addition, Jaclyn shared how new understandings and knowledge with regards to the students she served aided her practice. When planning for her math unit research project, Jaclyn utilized individual pre-test data to create the groupings and content for the lessons. While the process of grading over 70 pre-tests was time consuming, Jaclyn indicated that it increased her understanding of where each child was, needed to be, and what gaps existed in a particular unit of study. “I’ve gained a deeper understanding of just how needs-tailored learning helps students to grow.” Without this information, Jaclyn expressed, the job of differentiating would have been made near impossible.

Teachers as Publishers. Let me explore this section by first stating that two of the teachers, prior to this action research project, had completed some action research work. Each teacher had completed written projects and assignments for their graduate degrees, though the work was not in the form of a thesis or an article for publication.

Early on in our time together, it became apparent that some apprehension with regards to writing existed. Each of the teachers expressed concerns about who would read the research and jokingly questioned if there would be an editor for their work. Sarah attributed some of this weariness to her lack of practice in writing for an adult audience of educators. She noted, “most of the writing I do now is for report cards or for my personal files. I am out of practice.” Within our small group “there existed a perception that writing and publishing papers was a daunting task. Many educators wanted to write, yet felt they didn’t know how
to gather ideas worthy of publishing or what to do with their paper once finished” (Pecaski McLennan, 2013, p.2). As a group we discussed the importance of writing and reading, for the elementary students in our classes and then wondered why we, as teachers, choose not to write more ourselves.

Later, in expressing her viewpoints on the writing process, Jaclyn shared that the act of writing out her observations helped her to make sense of and reflect on her experiences. “Writing helps me to understand what I’ve done. Writing the literature review and writing about the research helped me...I think it will help all of us to speak about [our research] with more confidence. We learned by doing.” Jerry added, “Getting it on paper, going through the revising process, and knowing that we were going to edit each other’s work helped me...It helped me not to feel set in one way...I knew this was a process.”

After reviewing the data and writing their articles, each of the teacher researchers conveyed a hope that more teachers would engage in this type of research. Jerry recognized that he had undergone a transformative year in taking on this research, “The research has opened my mind to possibilities I might not have considered in my teaching. Teachers need to do this because it brings a closer connection to students and understanding where they are”.

**Discussion**

In revisiting my research questions, one of the main hopes of this research was to support student learning. Teachers who are engaging in a continuous cycle of improvement and reflection (planning, doing, studying and acting) commit to actions which are vested in a hope to improve their own craft and their students’ learning. Teachers in this research saw various improvements in student learning. In kindergarten, Sarah noted that the students were less frustrated and more amicable when working through problems. She explained that the students were more attentive and responsive to her directions and questions during action research related interventions. In learning services, Jaclyn’s math intervention yielded a post-test improvement of over 30%. The students in her math groups completed targeted math work each day and students shared that they enjoyed completing the agenda exercises. Finally, through his music group, Jerry gathered that boys engaging in the choir desired more involvement with song choice and more time singing in their own (all boy) ensemble. The action research conducted has helped to improve teacher knowledge, focus teacher attention on an area of question, and it has given the teachers an opportunity to engage in conversations about their practice; all of which has improved each teacher’s ability to assist students on an individual level and support their learning.

Another hope for the time that we spent together as the OHARE group was grounded in desires of greater knowledge and confidence. What was once just talk of the action research done outside of our school gradually advanced into a more sophisticated, personal dialogue. Our conversations were full of theoretical references to teaching, theory in relationship to student potential and growth, and personal interests. The merging of theory and practice could both be seen (in our research) and heard (during our conversations). Together, we progressed from a group of teachers who wished to conduct research, to a group of teachers who were actively engaging in and writing about research. The teachers in this school-based action research project indicated personal growth and improved confidence.
In particular, one teacher wrote, “I have enjoyed our time together, and felt like it was very personally rewarding and beneficial to my teaching. I would like to do another project at some point.” Another participant felt that our small group created an intimacy that provided an immediate sense of trust and togetherness. In a final round table discussion, the teachers shared feelings of satisfaction and pride for having completed this project. Several shared that, at times, they had worried about the end project. Having reached the final objective, completed research and a published journal article, all of the teachers indicated that although the process of conducting action research was not always easy, it was a productive and meaningful journey - both for their teaching practice and personal understandings.

Implications

A number of implications for research and practice arise from my research. I identify limitations in the following discussion of implications for research.

*Increasing sample size.* In future research, an increase could be made to the sample size, perhaps by involving several schools, thereby increasing the number of teachers across a range of grades and/or within single grades. This would increase the generalizability of the findings, and might contribute to understandings about action research in different school settings.

*Involving multiple subject areas.* Teacher action research can serve as a strategy for pedagogical improvement in areas beyond those explored in this study (kindergarten, math, and music). The research described in this article did not involve art, drama, physical education, science, or other such content-area classes. In the future, action research in these and other content areas may open-up greater knowledge of practice, confidence, and student success.

*Extending the study longitudinally.* Given the positive results of this yearlong study, I believe that further research examining how teachers continue to approach action research over several years would be beneficial. For example, teachers might continue the research or extend the research and resume data collection with the same or different groups of children. It would be interesting to examine the challenges that teachers face when utilizing action research in their classrooms and the ways in which they either overcome or succumb to those challenges.

Conclusion

Learning to teach is a complex process, a process that some would argue never ends. Though this was a small-scale study with limited size and low generalizability, the findings demonstrate how group reflection, focus on practice, and engaging in research encourage growth amongst teachers. More specifically, this research shared a year-long process where four teachers used action research as a way to expand their thinking. It sought to explore how looking deeply at questions about daily practice could impact teaching. Emerging from this research was the theme of practitioner inquiry as an effective tool for teacher confidence, knowledge of students, and intellectual growth. When teachers engage in
action research, as was seen in this study, “teacher education can move away from the teacher-centered positioning of transmission models towards more student-centered approaches, thus shifting the positioning of teachers from receivers of pedagogical knowledge from outside authorities into creators of such knowledge” (Taylor, 2017, p.16). For Sarah, Jaclyn, and Jerry, this shift in positioning was transformative and their understandings about teaching were expanded. It is my hope that elementary school teachers might, at the very least, read the journeys of Sarah, Jaclyn, and Jerry and give action research a go in their classroom.

About the Author

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TEACHING VOCABULARY TO AT-RISK 3RD GRADE STUDENTS: PAPER-AND-PENCIL ACTIVITIES VERSUS TECHNOLOGY ACTIVITIES

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Abstract In this mixed-methods study, the classroom teacher examined six vocabulary activities to see if consistent practice of academic vocabulary over time would improve students' recall and working knowledge of the academic vocabulary being learned. Additionally, students' preferences to these activities were examined. Twenty-three third-grade students were given a pre/posttest in which they were asked to rate their knowledge of academic vocabulary words using a Likert. Students worked for a nine-week period using both three pencil and paper activities and three corresponding activities using technology. Results showed that the majority of these students more than doubled their understanding of academic vocabulary and students had a strong preference for the technology-based learning activities.

Keywords: teacher action research, academic vocabulary, reading comprehension, educational technology

Introduction

This action research took place in a third-grade classroom. The study was developed because research has shown that vocabulary knowledge matters, as it helps with everyday communication, reading comprehension, and academic achievement (Glende, 2013). Additionally, students need regular opportunities to talk and to write using academic vocabulary in order to internalize their meanings and to use them to express their understanding of the content being learned (Echevarria, Vogt, & Short, 2004; Marzano, 2004; Shanahan, & Beck, 2007). We were curious to see if the implicit instruction and practice of academic vocabulary over time would improve students’ recall and working
knowledge of academic vocabulary and to determine if students preferred paper-and-pencil activities or technology activities the most.

**Purpose of Study.** The U.S. Department of Education in 2013 revealed that students who performed well in vocabulary also performed well in reading comprehension. These findings confirm that vocabulary, which is one of the five pillars of reading, are fundamental for students to be successful in reading comprehension. The questions that led this study were:

- Are there paper/pencil activities that can be matched with technology programs that use the same approach to teach vocabulary?
- Can nine weeks of explicitly working with vocabulary make a difference in vocabulary growth?
- Do third grade students have a preference using paper/pencil or technologies to help with vocabulary growth?
- What activity did third grade students like the most while working with vocabulary?

**Literature Review**

Several theories support this project. First, this study supports the idea that vocabulary development is an essential component of literacy, as supported by the National Reading Panel Report (2000) that found vocabulary to be one of the five pillars of reading. While the ability to decode allows one to break down and recognize written text, knowledge of vocabulary unlocks the actual meaning of the text. “Vocabulary refers to the words we must know to communicate effectively, and applies to speaking, listening, reading, and writing,” (Pinnell, 2008, p. 2).

Second, this study supports the idea of the Mathew Effect (Stanovich, 1986). The Mathew Effect was developed to explain the differences in literacy acquisition. Stanovich stated that reading begets reading, which we believe can be carried over to learning vocabulary words, as learning more words helps with the learning and understanding of even more words. The process of learning new words is important and there are three types of vocabulary words that must be learned. First, there is oral vocabulary. Listening and speaking vocabulary are in the category of oral vocabulary (Learning Point Associates, 2004). Oral vocabulary is the set of words we know well and feel comfortable using in our speech while listening vocabulary are the words we know and understand when others use them. Second, reading vocabulary is the set of words one recognizes and comprehends while reading. Third, writing vocabulary is a set of words that one is able to use while writing. A person is likely to have differing word lists in each of the three. For example, a young child’s reading vocabulary may be more extensive than his writing vocabulary and one’s oral vocabulary is the largest. An individual’s vocabulary is developed over time through both indirect and explicit instruction, (Neuman & Dwyer, 2009).
Importance of Explicitly Teaching Vocabulary. Education has always encountered a small percentage of students falling into the at-risk category. Sadly, this category has had an escalation of students over the last two decades. A majority of these students are at-risk due to their lack of reading and comprehension skills (NAEP, 2011; Nagy & Townsend, 2012).

There are many components involved in the process of reading and comprehension. However, research has provided insight into the expansive differences in the vocabularies of high achieving students versus low achieving students (Careleton & Marzano, 2010; NAEP, 2011; Nagy & Townsend, 2012; Beck et al, 2013). This expansion stretches to roughly 6000 vocabulary words between students in the 25th percentile to students in the 50th percentile on standardized tests in grades four through twelve (Carleton & Marzano, 2010). According to the National Assessment of Educational Progress (NAEP) vocabulary report of 2011, in fourth grade 73% of the students who scored below the 25th percentile on vocabulary were eligible for the free or reduced school lunch program and in eighth grade 68% of these same status students scored below the 25th percentile.

“There are profound differences in vocabulary knowledge among learners from different ability or socioeconomic groups from toddlers to adults” (Beck et.al., 2013, p. 1). “Until schools are prepared to emphasize vocabulary acquisition, especially in the primary grades, less advantaged children will continue to be handicapped even if they master reading written words” (Biemiller, 2006, p. 44). Students and parents alike hear teachers say to read widely. However, Beck (2013) found that “relying on wide reading for vocabulary growth adds to the inequities in individual difference in vocabulary knowledge” (p. 8). If a reader is already struggling and lacking vocabulary schema, then wide reading is not an option. When children arrive at school for the first time, their educational schema varies greatly. Each child comes from a different environment with varying experiences that have been generated from their family culture and home life (DeVries, 2012). Some arrive with much less oral vocabulary than others. This is the reality in our culture, and schools cannot change what occurs before children arrive at their doors. However, schools do have the ability and resources to ensure that students begin and continue to acquire comprehensive vocabulary through their schooling. The further behind a student becomes, the less likely it is they can later catch up to become as successful.

Starting at approximately second grade, children increase their new vocabulary by 1,000 words per year of schooling (Biemiller, 2006). “Vocabulary knowledge is strongly related to one’s reading proficiency and school achievement” (Beck, McKeown, 2013, p. 1). Children encounter a plethora of words in various forms every day. The real question is, how many of those words do they understand well enough to get the gist of the conversation and how many of those words do they understand well enough to use. The truth is there are an inadequate amount of vocabulary words that they understand orally and even fewer words that they can successfully use within a conversation (Beck et al., 2013).

Research completed by the U.S. Department of Education in 2013 revealed that students who performed proficiently on the vocabulary portion of the test also performed proficiently on the reading comprehension portion and therefore validates vocabulary as a
fundamental aspect in the active process of reading comprehension in all levels of schooling. “The new reading framework defines reading as an active, complex process that involves understanding text, developing and interpreting meaning from text, and using meaning as appropriate to type of text, purpose, and situation” (NAEP, 2013, p. 2).

Researchers have found vocabulary to be one of the foundational pillars of reading comprehension (Beck et al, 2013; Nagy & Townsend, 2012; Stein, 2013).

Our background knowledge or schema plays a crucial part in our understanding of oral and textual language. If one’s schema is rich enough within a concept, then that concept becomes relevant and comprehension of the components of that concept occur easily. However, if one’s schema within a concept is inadequate then comprehension becomes difficult with a slower constructive retrieval process, if not impossible. “An important distinction exists between knowing a word meaning well enough to pass a multiple-choice vocabulary test and knowing it well enough to use it in text comprehension” (Beck, et. al., 1982, pg. 507). Therefore, when students face a segment of text that contains a high portion of vocabulary words that are not within their current schema or of familiarity but retrieved with difficulty, there is a discernibly negative effect on the students’ comprehension. This is due to the processing interference of the text, attributed to attention that must be diverted from the construction of meaning to the action of searching for the words’ meaning (Beck, Mckown, & Kucan, 2008; Beck et. al., 1982).

The U.S. Department of Education (2002) mandated technology integration in all content areas for grades K–12. Therefore, teachers are now expected to integrate technology applications into the typical learning day to to create a digital learning environment in the classroom. With the integration of technology instructional planning will become more complex (Davies, 2011). Pechenkina & Aeschliman (2017) completed a study which showed students are currently using technology for educational purposes in minimal ways. Student’s rarely engage with technology in educational settings unless it is presented to them as an important part of their learning. “Furthermore, students of this generation are not necessarily willing to take risks with new or unfamiliar technology unless they are convinced of its positive benefits in educational outcomes” (Pechenkina & Aeschliman, 2017).

Methodology

Instrument. The vocabulary-knowledge-rating-scale (Blochowicz, 1986) can be used before reading to evaluate students’ prior knowledge of words/concepts that are found within the text. Students are given a list of words and asked to rate how well they know each term. Additionally, the list can be used after reading to evaluate students’ word knowledge growth.

The vocabulary-knowledge-rating-scale uses a Likert-scale (0-3) rating to find out students’ knowledge of words. The categories the students could use to describe their knowledge was 0 points = do not know the word; 1 point = have seen or heard the word; 2 points = know something about the word and/or can relate it to a situation; 3 points = know the word well, can explain it and use it correctly.
Data Collection. Data collection was done in two ways. First, the quantitative data was collected using the vocabulary-knowledge-rating-scale (Blochowicz, 1986). Second, the qualitative data was collected by interviewing the third-grade students.

Quantitative Data. The pre/posttest vocabulary list was created by using the academic vocabulary word list from Lead4ward field guide for third grade academic vocabulary. The list contained 30 words, so the total score students could receive ranged from 0-90 points.

Qualitative Data. This data was collected through both teacher observation and interviewing students about their learning of vocabulary words and their preferences for their learning, as seen below:

- Do you think you know more vocabulary words now that we have spent time practicing them?
- Out of all the activities, we did with paper and pencil; which activity was your favorite? Why?
- Out of all the activities, we did on the ipads; which activity was your favorite? Why?
- If you could choose from any of the activities we did, which one would you pick?
- Which activity do you think helped you to learn the most words and their meanings? Why?

Data Analysis. Quantitative data looked at descriptive statistics. As there were differences in mean scores from pre- to posttest, a paired-sample t-test was run using SPSS to determine if the differences were significant. The qualitative data simply looked at responses and tallied the results.

Study Design. This exploratory action research study was designed to use a mixed method approach as well as a pre/post design to determine student’s vocabulary knowledge. The study lasted for a nine-week period for 40 minutes per day in a third-grade classroom.

Participants. The participants were 23 students who attended a third-grade classroom. There were 15 females (65%) and 8 males (35%). All but two students (87%) received free and reduced breakfast and lunch. Ethnicities of the children were varied and included: 23 (40%) African Americans students; 1 (4%) American Indian student; 2 (9%) Asian students; 4 (17%) Caucasian students; and 1 (4%) student marked other. Students involved in pull out programs included 2 (9%) English language learners (ESL) and 3 (13%) dyslexic students. Intervention. For a nine-week period, for 40 minutes a day, time was spent within centers using two interventions. Six activities were purposefully designed to teach the same concepts. However, twenty minutes were spent doing work and reinforcing vocabulary using a paper/pencil approach and twenty minutes were spent doing work and reinforcing vocabulary using a technology approach.
Paper/Pencil Activities. The first paper/pencil activity consisted of working with flash cards. The teacher created a word list and a definition list printed on colored paper. The students were asked to work on a memorization task with a partner to commit to memory vocabulary terms and their matching definitions.

The second paper/pencil activity consisted of working with matching. The teacher created another set of words and definitions again printed on colored paper. The students were asked to work on a matching task in which they could work individually or in pairs to match up vocabulary terms with their corresponding definitions.

The third paper/pencil activity consisted of using the graphic organizer entitled Vocabulary Diagram, which was adapted from the Frayer Model (Frayer & Klausmeier, 1969). The teacher provided copies of the graphic organizer for the students to complete. The students were asked to create a definition using their own words, provide an illustration or example, write at least one synonym, and create a sentence in which the academic vocabulary word was used correctly.

Technology Activities. The technology activities used free online application sources that would match the paper/pencil activities. The first activity was found at quizlet.com. The teacher entered the terms and definitions into the program in order to create an online folder. Then the students were asked to enter the site, select the vocabulary folder, and choose a game to play. The first activity was much like the flash card game. Here, students toggled back and forth between the term and the definition in order to practice memorization of the words and their meanings.

The second activity was created within quizlet.com. Students entered the site, and selected the matching game that would then bring up all the terms and definitions. Once the students matched the term with the correct definition, both disappear from the screen. This continued until all matches were made.

The third activity was found at popplet.com. By using Popplet, students were able to create a graphic organizer identical to that of the paper/pencil Vocabulary Diagram. The students were asked to create a definition using their own words, provide an illustration or example from clipart, write at least one synonym, and create a sentence in which the academic vocabulary word was used correctly.

Results

Quantitative Data. The quantitative data came from the vocabulary-knowledge-rating-scale. The pre/post academic word list contained 30 words in which the students were asked to rate their word knowledge by using a Likert-scale rubric of 0-3. Thus, each child could receive 0 to 90 points as a total score on both the pretest and the posttest. The total scores were figured for all 23 participants as seen in Table 1. The total scores were used to determine a mean score for both the pretest results and the posttest results. It was found that for the pretest, the students mean score were 13.78 while their posttests mean score were 38. A t-test showed that this difference was very significant at p=.000. These results
are shown in Table 1. Students were randomized and then given the vocabulary-knowledge-rating-scale (Blochowicz, 1986) prior to any activities being introduced. Their scores were recorded as their Pretest Results. This Likert-scale rating of 0 – 3 recorded each students’ initial knowledge of the tested words by scoring their current word knowledge as 0 points if they did not know the word at all, 1 point if they had seen or heard the word before, 2 points if they knew something about the word and/or could relate it to a specific situation, and 3 points if they knew the word well and can explain it and use it correctly in a sentence. At the end of the nine-week period students were once again give the same knowledge-rating-scale and scores were recorded as the Posttest-Results. The rate of growth was then extrapolated and recorded in the Growth portion of Table 1.

Table 1: Students Pre/post Vocabulary Growth Results

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<tr>
<th>Student Number</th>
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Qualitative Data. To answer the five qualitative questions, the teacher both observed the students during center activities and also sat down individually with each child for a face-to-face interview. Question #1 asked “Do you think you know more vocabulary words now that we have spent time practicing them?”. Twenty-two (96%) of the students agreed that they had learned “a lot” of new words. The teacher’s observations recorded an increase in students’ ability to orally communicate using the defined vocabulary words. To answer Question #2, which asked, “Out of all the activities, we did with paper and pencil; which
activity was your favorite? Why?”, three students (13%) responded that they liked the matching activity the best while 20 (87%) students responded that they liked the Vocabulary Diagram activity the best. Those students who preferred the matching activity agreed they enjoyed “finding the pieces that go together”. While the majority of students stated they enjoyed the drawing and coloring portion of the Vocabulary Diagram activity. Observations supported evidence that the students showed an increase in enthusiasm toward learning new words when given time to draw and color illustrations of those vocabulary terms. In response to Question #3, “Out of all the activities, we did on the ipads; which activity was your favorite? Why?”, all 23 (100%) students chose the organizing map they could create on popplet.com in order to learn new words and their meanings. Many students explained that they enjoyed “drawing or looking for clip art” to match the vocabulary word. Observations indicated students were most engaged when working with the Poplet program. Fewer class interruptions and off task behaviors were observed. Question #4 asked students, “If you could choose from any of the activities we did, which one would you pick?”. All 23 (100%) students picked the technology activity from popplet.com. Again, this was supported by the teacher’s observation, as students were very excited when given the opportunity to interact with the technology program on a classroom iPad. Finally, Question #5 asked the students, “Which activity do you think helped you to learn the most words and their meanings? Why?”. The Vocabulary Diagram pencil/paper activity was chosen by 4(17%) students, the remaining 19 (83%) students chose Poplet.com and the use of technology, as they liked the program on popplet.com.

Discussion

The first research question asked if there were paper/pencil activities that could be matched with technology programs to teach vocabulary. The classroom teacher found that there were paper/pencil activities that can be matched with technology programs that use the same approach to teach vocabulary. Therefore, time was taken to research technology options that would provide a match to existing paper/pencil activities. This also allowed the teacher to meet The U.S. Department of Education (2002) mandated technology integration in all content areas for grades K–12. The first activity consisted of repeated readings of words and their definitions to increase memorization. The paper/pencil activity provided was working with flash cards and was paired with a free online application source at quizlet.com which functioned much like a flash card game. The second activity worked to enhance the memorization by using matching. The paper/pencil portion was composed of words and definitions printed on colored paper whereby students were able to match the vocabulary words with the definitions. This matching activity was paired with quizlet.com. Using this application students would match the term with the correct definition. When correctly matched both would disappear from the screen. The final activity was geared toward helping the students apply their new vocabulary words. For the paper/pencil activity students completed the graphic organizer to create a definition using their own words, provide an illustration or example, write at least one synonym, and create a sentence in which the academic vocabulary word was used correctly. To correspond with technology, the application popplet.com was utilized. In this application students completed the same paper/pencil tasks via technology.
The second research question led the researcher to examine the impact of explicitly working with vocabulary activities for nine weeks to see if this intervention could make a difference in a student’s word understanding. It was found that 40 minutes a day for nine weeks had a very significant impact on these third-grade student’s vocabulary growths and meaning understanding. Monitoring of students’ vocabulary growth is a must. Students need clear definitions and illustrations to help them understand word meaning. This leads one to believe that if this approach in used for two-semesters or even the whole year, there should be huge gains by all children. These findings do support prior research on the importance of teaching vocabulary explicitly and long-term (Nagy, 2005; Nagy & Townsend; (2012).

The third research question asked if third grade students had a preference when working in vocabulary centers. The answer was a resounding support for technology to help with vocabulary growth over the use of paper/pencil. This makes sense as today’s students have been utilizing technology to play video games, many from before the time they learned to walk. They have become accustomed to the colorful and animated screens that various programs use. Even though, the study completed by Pechenkina & Aeschliman (2017) showed students are currently using technology for educational purposes in minimal ways because they tend to only engage with technology in educational settings when it is presented to them as a required part of their learning, the students still tend to enjoy the technological activities. This could be an effect of the applications being set up and taught in detail prior to its use. Therefore, students were not forced to take any great risks with new or unfamiliar technology (Pechenkina & Aeschliman, 2017)

Implications

Looking to the future and continuing this approach in the classroom, several recommendations are given to classroom teachers. First, a smaller group of words need to be presented weekly rather than using all 30 words simultaneously. Listing the 30 words was overwhelming for some at-risk students even though they knew they would be learning them throughout the semester. Second, other options for activities need to be created and slowly introduced during center time. Finally, as the majority of the students preferred the technology vocabulary programs, more classroom iPads need to be acquired so that more technology activities can be used.

Conclusion

Vocabulary is a foundational pillar of reading comprehension (Beck et. al., 2013); Nagy & Townsend, 2012; Stein, 2013. Pinnell (2008) referred to vocabulary as the words we must understand to be able to speak, listen, read, and write. By exponentially increasing our student’s levels of vocabulary we are also increasing their ability to communicate as a society through speaking, listening, reading, and writing. Vocabulary is important to the overall academic health of our students. Beck et. al. (2013) research showed the extreme variances in vocabulary knowledge among different ability or socioeconomic groups can be equalized by intense vocabulary instruction. By incorporating a steady regiment of vocabulary activities into students already existing center time activities, students’ vocabulary growth rate was more than doubled within a nine-week period.
Technology is already a factor in our student’s daily lives. Allowing them the choice to use existing technology programs to learn new vocabulary words increases the student’s excitement in learning and thereby increases their vocabulary knowledge. The technology was not seen as daunting possibly because it was set up mostly in the form of games and previously taught before expected solo use.

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