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An Investigation of Teachers' Understanding of the Connection Between Technology and Higher Level Questioning

Dr. Karen S. DiBella, Dr. Kimberly G. Williams
Associate ProfessorUniversity of Tennessee at Martin239B Gooch HallMartin, TN 38238United States
Associate ProfessorUniversity of Tennessee at Martin239D Gooch HallMartin, TN 38238United States
Corresponding Author: Dr. Karen S. DiBella

ABSTRACT*: Twenty-first century learners are digital natives who are expected think critically, engage in problem-solving, and maximize their potential in real-world situations. Educators face the challenge of designing curriculum and delivering instruction to develop these competencies, while meeting the demands of standards-based instruction. Effective implementation requires a deep understanding of higher-level questioning strategies as well as technology proficiency. Researchers created professional development workshops to challenge current and future educators to maximize instructional time through challenging web-based activities. Using a Likert-scale survey coupled with open-ended questions, researchers investigated teacher perceptions of technology and higher order questioning after a workshop focused on Webb's Depth of Knowledge (1997) using web-based tools to facilitate higher levels of questioning. Quantitative and qualitative data revealed participants were more prepared to use technology to encourage higher-level thinking. Researchers will share the study methodology as well as common themes that emerged from the data.*

Keywords*: critical thinking, technology, questioning*

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I. INTRODUCTION

Literacy and mathematics remain the two most highly tested areas of student performance and yet, unfortunately, still remain areas of grave concern in this country. Rigorous standards-based instruction is the norm in today's classrooms and literacy underlies all academic subjects including mathematics, science, social studies, career-readiness, and technical paths. Ensuring students are literate is no longer solely the role of reading and writing specialists. Literacy standards are incorporated into all academic areas, creating the need for all elementary, middle, secondary, and post-secondary teachers to purposefully incorporate strategies into classroom instruction to ensure today's students are college and career ready.

It is imperative that today's educators be adequately prepared to implement strategies that promote higher level thinking in these areas of high need. This research study offers and encourages a rich dialogue, which targets literacy, mathematics, and science instruction, higher level thinking, intervention plans, differentiation, and methods of improving overall student performance through the integration of technology.

THE RESEARCH PROBLEM AND PURPOSE OF THE STUDY

The purpose of this study was to engage teachers in a workshop focused on developing critical thinking skills by utilizing technology tools. Literacy and mathematics are two of the most highly tested areas of student performance and data supports that twenty-first century learners are underperforming in these areas. According to the Tennessee Higher Education Commission 2014 Report Card on the Effectiveness of Teacher Training Programs, "Program completers from UTM tend to be less effective than teachers statewide in … 4th-8th grade TCAP composite and math. [Additionally] UTM has a lower numbers of completers in the most effective quintile as compared to all teachers' performance distributions across the state in 4th-8th grade TCAP reading" (p. 1). The demands of rigorous standards with infused classroom technology apply not only to P-12 classroom teachers, but also to instructors in higher education. This project provided technology resources for classroom teachers that not only engage today's students but also focus on higher levels of cognitive challenge.

II. LITERATURE REVIEW

Today, we continue to see a focus on the declining reading scores and literacy rates among students in the U.S. In fact, the National Assessment of Educational Progress (NAEP, 2009) reported that only one-third of all students entering high school are proficient in reading, or are reading at grade level, which suggests that two-thirds of students entering high school are reading below grade level. With the adoption of the CCSS (2010), there is a focus towards students' ability to read more complex texts, an increased exposure to informational

texts, ability to cite evidence, collaborate, and present findings as well as become critical thinkers, who will demonstrate the ability to be college or career ready. Integration of the Common Core Mathematical Practices supports the disconnect between where we are and where we would like to be by recognizing the implementation of reading strategies into the mathematics classroom.

The shift from basic calculations to rigorous problem solving is the foundation of today's mathematics instruction. According to Larson, et al., (2012) "to comprehend problems effectively, students have to employ strategies they have learned during reading instruction … [which] include identifying relevant details, noting relationships, predicting, making inferences, synthesizing, visualizing, and distinguishing between mathematics terms and general vocabulary" (p. 30). Recognizing that literacy and numeracy are interwoven will have a significant impact on student performance as well as their future goals. A majority of both male and female students today exhibit a negative attitude towards mathematics, which affects their future career choices (Charles, et al., 2014). Establishing a positive classroom environment that integrates both literacy and problem solving, using research-based teaching strategies, will foster student understanding of mathematics, which may lead to students choosing mathematics as a career path.

Self-efficacy can be the determining factor in a student's interest in an academic path. Katz (2015) postulates that achievement can be tied to students' individual beliefs about a certain subject. Mathematics is a subject that many students feel they struggle with because of the way teachers present the material. Through differentiation, connection of literacy, and technology, teachers are able to present material in ways that nurtures students' abilities and fosters literacy and promotes higher-level thinking.

OVERVIEW OF THE STUDY

This mixed-methods study investigated teachers' perceptions of enhancing higher-level thinking through technology integration. Following exposure to a questioning and technology workshop, researchers used an anonymous survey to determine if educators believed they are adequately prepared to challenge their students through rigorous web-based activities. Workshop content was designed to specifically target the development of higher order thinking and problem-solving in all content areas. Using a 12 item Likert-scale survey and five open-ended questions, researchers sought to answer the following:

Research Question 1: How does the integration of technologyenhance higher order thinking?
Research Question 2: How will the integration of technology tools for literacy, mathematics, and science impact current classroom or future classroom practices?

III. METHODOLOGY

Participants were invited to voluntarily participate in hands-on workshops in the Summers of 2016 and 2017 offered by the researchers. A primary component was a session focused on how to create higher level questions using Webb's Depth of Knowledge (1997) followed by an introduction to technology tools that reach the highest cognitive levels. Participants engaged in writing higher level questions prior to being presented with technology applications to support rigor in the classroom. Instructional technology tools were modeled using each Depth of Knowledge (DOK) level (Webb, 1997) to engage participants in applications of higher order thinking through the impetus of technology. At the conclusion of the workshop, participants were equipped with tools that could immediately be implemented into their classrooms. Immediately following the conclusion of the workshop, participants responded to an anonymous survey instrument using Qualtrics as a data collection point. Although data was collected over two summers, there were no variations in delivery by the researchers. The sample population consisted of 77 teachers who had varied years of experience and diverse teaching assignments as represented in Table 1. Additionally, 69% of all participants were alumni of the University where research was conducted. Survey results were analyzed to determine trends among ages, years of teaching, and grade level taught.

Table 1*Sample Population: Number of Years Teaching and Grade Level Taught*

Years Teaching	1-4	5-8	9-12	13-20	+20
Grades Pre-K-1(n=9)	8	1	0	0	0
Grades 2-3(n=22)	7	5	1	5	4
Grades 4-5(n=42)	16	7	4	8	7
Grades 6-8(n=2)	2	0	0	0	0
Academic Coach(n=2)	0	0	0	0	2
Total (n=77)	33	13	5	13	13

Note: n=77 participants; Data was collected in Summer 2016 and 2017.

IV. RESULTS AND DISCUSSION

Data were analyzed to determine teacher perceptions using the Likert-scale responses and common themes were identified using the open-ended questions to answer the following:

Research Question 1: How does the integration of technologyenhance higher order thinking?

Research Question 2: How will the integration of technology tools for literacy, mathematics, and science impact current classroom or future classroom practices?

Results of each Likert-scale item are reported in Table 2. When asked the question, "Do you feel more prepared to use technology in an effort to encourage higher-level thinking after participating in this workshop?" 91% of respondents stated, "yes" while seven participants chose not to respond to this question. Additionally, all respondents agreed or strongly agreed to the statement, "I can adapt the use of technologies that I am learning about to different teaching activities."

Table 2

Participants' Technology and Higher Level Questioning Survey Responses

Question	SD	D	N	A	SA	NR
I have the technical skills I need to use technology.			5	36	35	1
I know about technologies that I can use for understanding and doing mathematics.			4	41	31	1
I know about technologies that I can use for understanding and doing literacy.			4	46	27	
I can choose technologies that enhance the teaching approaches for a lesson and integrate higher level questioning.			2	42	33	
I can choose technologies that enhance students' learning for a lesson and encourage higher-level thinking.		1	1	41	33	1
I am thinking critically about how to use technology in my classroom by integrating Webb's Depth of Knowledge.		1	4	32	39	1
I can adapt the use of technologies that I am learning about to different teaching activities.				42	35	
I can teach lessons that appropriately combine mathematics, technologies, and teaching approaches.			4	38	35	
I can teach lessons that appropriately combine literacy, technologies, and teaching approaches.			4	40	33	
I can select technologies to use in my classroom that enhance what I teach, how I teach, and what students learn.			1	40	36	
I can provide leadership in helping others to coordinate the use of content, technologies, and teaching approaches at my school.		3	11	34	28	
I can choose technologies that enhance the content of a lesson.		1	3	40	32	

Note: n=77 participants; SD=Strongly Disagree; D=Disagree; N=Neither Agree/Disagree; A=Agree; SA=Strongly Agree; NR=No response

Analysis of responses to the question, "How can the implementation of technology tools enhance literacy and numeracy as well as impact overall learning?" revealed two common themes as follows:

Theme 1: Participants discussed the value of technology for student engagement.
Theme 2: Participants discussed the need to motivate today's digital natives through the use of technology.

One teacher stated, "If students are engaged, students are learning. Technology allows so many ways to reach high levels of DOK." Another participant stated, "There are a variety of learning methods. Some students are visual; some are auditory; or both. Using technology only increased the learning experience."

Although data support that the majority of participants exhibited confidence with using technology and higher-level questioning, some responses indicated that teachers were unsure of how promote higher-level questions using Webb's Depth of Knowledge. The researchers were informed that all schools in the surrounding counties had been trained on questioning but this does not appear to be true for all schools and districts. Continued support from all stakeholders is essential to provide a technology-rich environment for all students that supports the critical thinking and problem-solving skills expected from today's twenty-first century learners.

V. CONCLUSION

Ensuring follow-up opportunities are provided for teachers to continue to develop their technological proficiency is crucial. One can never assume a one-time workshop is sufficient to prepare for effective incorporation of technology resources. Becoming a "risk-taker" in the classroom may seem overwhelming for some educators, but with support, they can accomplish any task they choose. Additionally, modeling is critical for administrators, higher education faculty, and workshop facilitators.Like all initiatives, there must be time for development, so that educators have adequate time to perfect their practice, be reflective in their efforts, and positively impact student learning.

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