The OHIO Journal of Teacher Education

FALL 2016. VOLUME 30. NUMBER 2

The OHIO Journal of Teacher Education

FALL 2016 . VOLUME 30 . NUMBER 2

PUBLISHED BY THE OHIO ASSOCIATION OF TEACHER EDUCATORS

Dr. D. Mark Meyers, Xavier University
Dr. Jean F. Eagle, Miami University
EDITORS

CONTENTS

A MESSAGE FROM THE EDITORS

Welcome from the The OHIO Journal of Teacher Education Editorial Team. We are honored and privileged to shepherd this journal for the educational community of Ohio

The OHIO Journal of Teacher Education (OJTE) is an online journal We invite all forms of article formats, as seen in the publication and manuscript guidelines included inside the journal. However, we do invite authors to utilize the online format. The use of links and other interactive devices will allow the online journal to be more than simply a pdf of articles that you can print at your own workstation. In the future, the hope of the editorial team is to develop a truly functional online journal experience which can open the world of practice to our readership.

We will strive to build upon the solid foundation left by the previous editorial teams and move the OHIO Journal of Teacher Education forward as a resource for pre-service teachers, in-service teachers, and all with an interest in teacher education.

Dr. Jean Eagle and Dr. Mark Meyers, Co-Editors

EDITORIAL BOARD

A CALL FOR EDITORIAL BOARD MEMBERSHIP

The Ohio Journal of Teacher Education (OJTE) is looking for interested individuals to join the Editorial Board of the journal. We are looking to establish a board that represents the Colleges and Universities of Ohio as well as offers a broad spectrum of content expertise.

If interested, please submit a one page letter of intent that includes your College or University, your educational background, and your content area of interest to the co-editors.

Dr. Mark Meyers and Dr. Jean Eagle at
oatejournal@gmail.com

We look forward to hearing from you.

Transitioning to edTPA: A Middle Grades Teacher Education Program Looks Back and Ahead

Stacie Pettit, Ph.D., and Laura Rychly, Ed.D.

.

.

* Correspondence:
Dr. Stacie Pettit.
Augusta University
Department of Teacher Education
523 Mauldin Dr
Evans, GA 30809
spettit@gru.edu
706-294-9136
Full list of author information is available at the end of the article

Abstract:

States around the nation are in the process of adopting or implementing a new teacher performance assessment, edTPA, into their requirements for new teacher certification. Part of the transition from in-house to off-site assessment should entail faculty in these teacher preparation programs learning how to translate between evidence in the assessment portfolios and the language on the local evaluation rubrics. This study uses qualitative and quantitative evidence to inform best practice for teacher preparation by sharing and discussing data on whether or not local evaluations in one Department of Teacher Education differed from those assigned by SCALE.

INTRODUCTION

States around the nation are in the process of adopting a new Teacher Performance Assessment, known as edTPA, into their requirements for new teacher certification. edTPA is a nationally available performance assessment used to measure novice teachers' readiness to teach. It is designed with a focus on student learning and principles from research and theory (SCALE, 2015). Teacher preparation programs have, for a long time, been required to demonstrate that their beginning teachers meet standards established by professional groups such as the Center for the Accreditation of Educator Preparation (CAEP, formerly National Council for Accreditation of Teacher Education, NCATE). Many institutions accomplished this by having student teachers compile an exit portfolio, the requirements for which aligned with program outcomes that had been defined by the individual teacher preparation programs and defended to the accrediting body. These portfolios were graded in-house, by each student teacher's university supervisor. The new edTPA is graded off-site by scorers trained by the Stanford Center for Assessment, Learning and Equity (SCALE). Scorers use 15 rubrics for each "middle childhood" portfolio.

Not surprisingly, the literature reflects a mixed response to edTPA. Some welcome a standardized, high-stakes, externally-scored assessment for new teachers because there is a sense that this will finally help the field extract neutral elements of “good teaching” that work anywhere, with any K-12 learners (Peck, Singer-Barella & Sloan, 2014, Darling-Hammond, 2012). Once these elements have been proven to be the ones that lead to universal achievement, then it will be an easy next step to ensure all new teachers experience training programs that understand and inculcate these well. Others resist an assessment system that looks all-too familiar in the ways that it resembles the high-stakes tests that have been a part of every public school child’s life since No Child Left Behind mandated that all students would be on grade level by 2014 (Sandholtz & Shea, 2012). Such an emphasis “artificially decontextualizes teaching practice and encourages candidates to ‘teach to the test’” (Dover, Schultz, Smith & Duggan, 2015). This resistance claims that it is unreasonable to impose a one-size-fits-all assessment instrument on teacher candidates who teach diverse student populations in diverse places (Sato, 2014; Au, 2013; Madeloni & Gorlewski, 2013). Another vivid concern about edTPA is its relationship to the Pearson corporation, as it is difficult to trust a corporation to keep local, public contexts at the heart of its private decisions and actions (Au, 2013).

We believe that part of the transition to a standardized, externally-scored assessment should entail faculty in these teacher preparation programs learning how to make connections between the language of the rubrics and evidence in the assessment portfolios. Historically, as can be seen from a response to the standardized testing movement that resulted from No Child Left Behind, assessments of this type cause educators to feel simultaneously frustrated and obligated to "teach to the test," because, while we want to retain autonomy over our content and methods, we ultimately want our students to “achieve” based on national test scores that rank them against their peers. We think that in this space of simultaneous frustration and obligation there is much room for growth, as those who work to prepare new teachers adopt the new, standardized edTPA.

Our state adopted edTPA and made it consequential for new teacher certification as of fall, 2015. For two years leading up to this new circumstance, faculty at our institution began receiving training on the assessment, its accompanying rubrics, and edTPA-specific jargon (such as the phrase "language function" as a name for the verb from a lesson's learning objective). We were not permitted to use the 5-point rubrics that official edTPA scorers use, but Pearson made available condensed 3-point versions that we could use to practice scoring portfolios completed by our student teachers. This scoring practice is referred to as "local evaluation." As a result of the opportunity we had been given to locally evaluate portfolios several semesters before the state would hold candidates responsible for their scores, we designed a study to compare the local evaluation results to the official scores assigned by SCALE. The purpose of this study was to gather data on whether or not the local evaluations differed from those assigned by SCALE and, in cases where there were differences, identify possible reasons why these discrepancies exist. Faculty in the Department of Teacher Education were asked to share their findings after they compared the scores they assigned to teacher education candidates' edTPA portfolios to the scores assigned by the official scoring agency SCALE. Our results could be used to inform revisions to our middle grades teacher education program and/or curriculum, if needed.

This study uses qualitative (and some quantitative) evidence to inform best practices for teacher preparation. The act of requiring faculty to evaluate students on a high-stakes assessment for which faculty will be preparing students is an exemplary practice. All institutions using edTPA would benefit from planning opportunities for training and experiences similar to our current study.

Looking Back: Best Practices Prior to edTPA

How were high standards for new teachers' knowledge and skills being met before the transition to edTPA? As it turns out, at the particular university in this study, educating pre-service teachers was going well. NCATE accreditation was received with "no improvements needed" just a year before edTPA implementation. Teacher candidates were already required to complete a performance assessment evaluating their teaching effectiveness called the Impacting Student Learning (ISL) portfolio. The ISL portfolio provided evidence that candidates had developed into new teachers shaped by our conceptual framework: Prepared, Able, and Responsive. Interestingly, this assessment did address many of the same elements as edTPA now has in its rubrics. The ISL contained five sections: Context, Classroom Management, Pre-assessment, Lesson Plans, and Analysis of Student Learning. edTPA requires three tasks: Task 1 Planning, Task 2 Instructing, and Task 3 Assessing. Table 1 shows which sections of the ISL accomplished which task of edTPA and how both fit under our conceptual framework.

Table 1

Conceptual Framework	Prepared	Able	Responsive
Impacting Student Learning portfolio	Sections 1-4: Context, Classroom Management, Pre-assessment, Lesson Plans	Section 5: Analysis of Learning	Section 5: Analysis of Learning
edTPA	Task 1: Planning	Task 2: Instructing	Task 3: Assessing

Comparing the work required of student teachers by both projects helped us to understand the differences between what we were already asking them to do and what they are now being asked to do. Four of the five sections of the ISL focused on context and planning, including a large emphasis on quantitative pre-assessment data on middle grades students' existing knowledge and/or skills related to the planned unit objectives and an entire section on a classroom management plan. edTPA expects student teachers to plan responsive "learning segments," and asks for a description of middle grades students' existing knowledge and skills, but student teachers are not asked to provide an administered pre-assessment. Only one-third of the edTPA is devoted to what made up four-fifths of the ISL. The remaining two-thirds of the edTPA were previously addressed in the final fifth of the ISL. This shift means that our prior emphasis was on the process of collecting and documenting evidence of learners' needs and then planning lessons that accounted for these needs, while edTPA places more equal emphasis on pre-instructional planning, instruction itself, and post-instructional feedback and reflection.

Perhaps the biggest difference between the two projects is that the edTPA requires student teachers to submit video evidence of their instruction and interactions with students, and students' experiences with the content. Student teachers write responses to prompts that ask for specific evidence, from the video, of required knowledge and skills for new teachers (as defined by the assessment). We feel this is an improvement to traditional teacher education practices that perhaps needed a little push toward this sort of innovation in order to shorten the distance between our university classrooms and the public school classrooms. Also, while we recognize this point of contention in our field, the fact that the portfolio is externally scored by strangers, and that standardized expectations are set up for each student teacher (including details such as font sizes and file names), could potentially add a level of professionalism and accountability that will benefit the profession.

The Transition: Training and Data Collection

We first began to understand the impact the edTPA would have on our graduates in the fall of 2013. Faculty began to attend training sessions in December of this semester. In spring of 2014, faculty attempted to address edTPA requirements in courses by adding new assignments or revising existing ones to include some of the language as described above and the skills needed for videotaping lessons. A number of student teachers completed edTPA as part of their requirements for graduation by substituting this portfolio for the regularly-required ISL. Twelve portfolios were sent to Pearson for scoring. Two or three faculty members (working independently) used the local evaluation (3-point) rubrics to assess each submission. Early in the fall 2014 semester, after official scores from SCALE were received, faculty teams reviewed both sets of scores on the portfolios, discussed discrepancies, and compared the scores they gave to the the ones SCALE gave.

In fall of 2014, some modifications to edTPA related coursework were made, and all student teachers completed edTPA (none completed the ISL). Of these, 15 portfolios were sent to Pearson for scoring. Each semester, 19 faculty members scored portfolios using the 3-point local evaluation rubric provided by SCALE. Faculty meetings were held to compare local evaluations to official SCALE scores. In the fall of 2015, edTPA became consequential, which means all teacher candidates must pass in order to earn teacher certification from our state.

Lessons Learned: Intentions Versus Reality of Our Study

The fact that we had four semesters of preparation time before our candidates would have to pass edTPA to earn teacher certification meant that we had a big opportunity to gather data on faculty's responses to how official scores sent back from SCALE aligned with the local evaluation results that we assigned. We composed a short survey to give faculty after they had been able to compare these two scores. The survey consisted of two open ended questions and two closed questions that asked if a discrepancy existed, how surprised the local scorer was in the difference or lack of difference in scores, and what he or she believed was the cause of the discrepancy. Survey results were read, and themes and unique ideas were highlighted. We also looked at scores submitted both by teacher education faculty and SCALE and provided some descriptive statistics concerning how closely the local evaluation matched with the SCALE scores.

In some areas, the local evaluators scored students higher (58%), and in some areas the local evaluators scored lower than the official scorers. When asked about discrepancies, 11 participants reported that discrepancies existed, and six reported that there were no discrepancies. As for how surprised local scorers were in the official scores, the answers ranged as follows: Three were "very surprised," two were "somewhat surprised," and six were "not surprised" by discrepancies.

Based on the qualitative survey data, two main themes emerged: (1) Faculty are not sure they are interpreting the language of the rubrics in the same way as SCALE and (2) Faculty feel their expectations and those of the official scorers are different. The general impression of the local scoring was that the whole process is very subjective because the two scorers are grading on different scales. Participants said that the people at Pearson have been professionally trained to score, and they have not. The participants write that they would never agree with the official SCALE scorers, so that leads to differences between the fundamental philosophical directions from which we are coming. Interesting quotes from local scorer participants are included in the list below. These statements represent the themes concerning differing expectations and training levels.

- The process was a piece of cake. I don't understand why some people made a big "hullabaloo" (fuss and stress) about it.

- It would be helpful if we were trained from Stanford.
- We were more demanding than those from CA.
- My expectations were too high compared to SCALE.
- I did not understand the tasks and did not understand the student's explanations as well as I thought I did.
- Grading constructed responses is subjective.
- We aren't professionally trained.
- We have different perspectives; we will never agree.
- I don't like that we have to send them away; it implies that we aren't qualified.

Limitations

Over the course of our study we encountered a few challenges that in some ways limited the conclusions we are able to draw. First, we only had a 50% response rate on our survey. We feel this makes sense given the sentiments shared in statements such as those included above. It is unknown, however, whether the 50% who didn't reply would have contributed a more positive outlook on the shift to edTPA, or did or did not encounter larger or smaller scoring discrepancies. A second challenge occurred in the fact that the two sets of rubrics being compared used different scales (SCALE uses a 5-point rubric, and we were provided with a modified 3-point version). In an attempt to make comparisons, we converted SCALE scores to the 3-point scale used for local evaluation in this way: 1's and 2's = 1, 3 = 2, 4's and 5's = 3. A third unforeseen challenge, related to the above scale differences, is that an occasional official score came back as a ".5." This further complicated our attempts to translate between the 3-point scores and the 5-point scores.

Where We are Now: How Data was Used to Inform Program Changes

Our first response, as we anticipated the point at which our student teachers' edTPA scores would be consequential for certification, was to embed whole edTPA-like tasks into the courses we believed would provide the best practice with those concepts. For example, we added two projects to our general curriculum planning course, one that resembled the edTPA planning task (Task 1) and one that resembled the instructing task (Task 2). An assignment that addressed knowledge and skills required for the assessing task (Task 3) was created for our assessment and differentiation course. One way these assignments took shape was by modifying some of the language from edTPA rubrics that dealt with content in a particular course, modifying it, and scoring students on a three-point scale on how well they addressed the criteria. For instance, we might write "Teacher candidate justifies lesson plan changes using principles of research and/or theory" (rubric 10) on a class assignment scoring guide for a written reflection on a lesson plan taught in a field experience classroom.

Embedding whole tasks this way proved to be quite cumbersome. For one thing, each course already had appropriate assignments that instructors had to decide to keep, modify, or replace with the new assignment. Secondly, there was a general sense of displeasure about what felt like "teaching to the test." Additionally, putting two tasks in one course was very overwhelming for both faculty and students, especially because one of these two involved the video recording project, and this involved a lot of new learning for all involved. As we began to receive official scores, we have been able to more strategically embed work that gives candidates practice with knowledge and skills required for successful edTPA submission but that does not eat into existing courses quite so much.

Looking Ahead: Data Driven Program Improvement

Our practice with edTPA so far has provided, as several promised it would, evidence of opportunities to refine, and in some cases create, experiences for our candidates that will better explicitly prepare them to write strong commentaries, design and teach effective lessons, and plan for learners to apply formative feedback. We describe here three ways we have modified coursework to best maximize its potential to expose our candidates to edTPA concepts and provide them with meaningful practice. These are 1) providing formative feedback and 2) using the language of edTPA in peer and faculty observations of lab teaching.

"Glows and Grows"

Across our programs, we are working on candidates' abilities to provide objective-based feedback on formative assessments. For example, in instances where the following activity has been a good fit, primarily in content methods courses, Laura has implemented an assignment that asks teacher candidates to observe one another teaching and give objective-based feedback. The objective against which the candidates are looking for strengths and weaknesses comes from standards set by professional organizations such as the National Council for the Social Studies (NCSS). NCSS has a document, as do all of the national content organizations (National Council for Teachers of Mathematics, National Council for Teachers of English, and National Science Teachers Association), that provides standards for what quality teaching of the particular discipline would "look like" or entail. The NCSS document "National Standards for Social Studies Teachers," in the section on "time, continuity, and change," stipulates that teachers should "guide learners in exploring characteristics, distribution, and migration of human populations on Earth's surface" (NCSS, 2002, p. 23). For our observation assignment, we begin with this standard and then collaborate to write a behavioral objective that teacher candidates, as they learn to achieve this standard, can clearly meet. This objective might read something like: "Teacher candidates will be able to make connections between the causes of human migration and the places to and from which this migration takes place." Translating the standard into an objective in this way is useful practice for being able to do this in candidates' own lesson planning. Additionally, and more importantly in the context of edTPA, when candidates take their standard-based objective with them into their peer's classroom and note strengths and weaknesses that pertain directly to this objective, they are practicing the kind of specific, objective-based feedback that they are expected to provide to their own learners in Task 3 (and Task 4 for elementary teacher candidates). Our intention is for this to phase out the kinds of feedback we are used to seeing, i.e. "Good job!," "Nicely done!," "Uh oh, better try harder next time!" and instead germinate reflexive skills for creating feedback that will help K-12 learners recognize what they can do well related to specific learning objectives and approach their struggles from these strengths. Generic teacher-responses such as the ones identified above do not help learners build on what they can do well, and do not meet expectations as set forth by edTPA.

Observations of Teaching

Candidates in our program have at least two, and usually three, opportunities to teach and receive feedback prior to student teaching. This is because they are given a lab placement each semester upon admission to the program, and all courses have lab requirements. Each candidate is assigned to a university supervisor who conducts at least one formal observation of teaching during lab weeks. Also, coincidentally, we are in the process of transitioning our program into a Professional Development School model. One significant difference this creates for our candidates is that instead of spreading out to various schools in our cooperating districts, a large group of candidates stay together at one school for lab weeks. Given this, we have begun requiring candidates to observe a peer at least once per semester.

We recently began revising our observation feedback form to better reflect the language candidates will have to be able to think in when they write their edTPA commentaries. For example, most elements associated with classroom management can be written about under an edTPA prompt that asks how a positive learning environment, respect, and rapport were established. Where our previous feedback form listed "Classroom Management" as a category for feedback, our new form says "Candidate demonstrates rapport with and respect for his/her students." It is our belief that after receiving feedback in this way a minimum of two times per semester prior to student teaching, candidates will be more fluent than they otherwise would have been without reading feedback organized in this way. This is doubly true given that, not only does each candidate receive this feedback to read and internalize for him/herself, but because faculty and candidates are using the same form to give feedback, candidates will have to think in these terms in order to write feedback for their peers, too.

New Identified Opportunities

As faculty continue to become more familiar with the new edTPA requirements, new questions and ideas are discovered. For example, in task 3, candidates have to articulate a plan for how their learners will implement the formative feedback they receive. As of yet we have not identified an assignment, or an ideal course to embed one in, that gives candidates meaningful practice with this skill. Moreover, this is the type of requirement that, as with feedback opportunities, seems well suited for faculty to model for candidates. Over the course of a semester candidates could experience a well-designed example of receiving, and then understanding a plan for implementing, formative feedback toward course objectives. Then, at the end of this project, candidates could reflect on what difference it made for their learning and how they could see themselves doing the same thing with middle grades learners. A project such as this could have powerful implications for new teachers' ability to coach their learners by using formative feedback effectively and purposefully, and it is our aim to embed such a project in one of our courses.

Another opportunity that has emerged is due to alignment between the knowledge and skills sought by the edTPA and those new teachers are held accountable for on our state's teacher evaluation form, or Teacher Keys Effectiveness System (TKES). The TKES evaluation has ten standards, most of which are locatable somewhere in the fifteen rubrics for edTPA. For example, two of the TKES standards are "positive learning environment" and "academically challenging learning environment." These concepts are sought by the sixth edTPA rubric, which looks for a "safe and respectful learning environment that supports young adolescents' engagement in learning." Given our emergence into a PDS as described above, opportunities might exist for candidates and their cooperating teachers to look together at their respective evaluation instruments to look for similarities that might share different labels, or themes that both supervisory organizations have used to define good teaching. This sort of "heads together" collaboration for the purposes of mutual growth are exactly what accreditation bodies (such as CAEP) are looking for in teacher preparation.

Conclusion

edTPA is a new, standardized assessment that all teacher candidates in our state must successfully complete in order to begin their teaching careers. Because it is a new assessment, many questions exist about how well current practices will align with new expectations. Our faculty and candidates were fortunate to have opportunities to send practice portfolios away for official scoring. This helped us develop knowledge about external scorers' expectations and our existing strengths and weaknesses. Exploring the perceptions our faculty had about the causes of discrepancies between the scores they assigned to edTPA portfolios and official scores received from SCALE helped us target changes to our program to best prepare our candidates for this new assessment.

Seeking the insight of faculty who teach the courses that prepare teacher candidates to successfully complete this assessment helped us uncover important data about how well the assessment aligns with what teacher education faculty believe new teachers should know and be able to do. We recognize that the absolute value of edTPA as being a positive or a negative addition to teacher preparation is indeterminable, at least at this time. In our state, however, the assessment is a reality, and we certainly want our students to do well. Over future semesters, we will continue to use candidates' scores to identify what we are doing well and what we should strengthen, in the context of edTPA's definition of good teaching.

REFERENCES

Au, W. (2013). What's a nice test like you doing in a place like this?: The edTPA and corporate education "reform." *Rethinking Schools, 27*(4).

Darling-Hammond, L. (2012). The right start: Creating a strong foundation for the teaching career. *Phi Delta Kappan, 93*(3), 8-13.

Dover, A. G., Schultz, B., Smith, K. & Duggan, T. J. (2015). Who's preparing our candidates? edTPA, localized knowledge and the outsourcing of teacher education. *Teachers College Record.* Retrieved from http://www.tcrecord.org ID Number: 17914

Madeloni, B. & Gorlewski, J. (2013). Wrong answer to the wrong question: Why we need critical teacher education, not standardization. *Rethinking Schools, 27*(4).

Peck, C. A., Singer-Gabella, M., Sloan, T., Lin, S. (2014). Driving blind: Why we need standardized performance assessment in teacher education. *Journal of Curriculum Instruction, 8*(1), 8-30.

Sandholtz, J. H. & Shea, L. M. (2012). Predicting performance: A comparison of university supervisors' predictions and teacher candidates' scores on a teaching performance assessment. *Journal of Teacher Education, 63*(1), 39-50.

Sato, M. (2014). What is the underlying conception of teaching in the edTPA? *Journal of Teacher Education, 65*(5), 421-434.

Stanford Center for Assessment, Learning, and Equity (SCALE, 2015). *Making good choices: A support guide for edTPA candidates*. Board of Trustees of the Leland Stanford Junior University. Retrieved from https://www.edtpa.com/Content/Docs/edTPAMGC.pdf.

About the Authors:

Contact Author:
Stacie Pettit, Ph.D.
Augusta University
Department of Teacher Education
email: spettit@gru.edu
Business phone: 706-667-4500
Cell phone: 706-294-9136
Mailing address: 523 Mauldin Dr., Evans, GA 30809
Laura Rychly, Ed.D.
Augusta University
Department of Teacher Education

Stacie K. Pettit is an Assistant Professor of Teacher Education at Augusta University. She has 15 years experience as a middle school (ESOL, mathematics, English Language Arts, and gifted) teacher and college professor. She received her Ph.D. in Middle Grades Education from The University of Georgia. Her research interests include teaching English Language Learners in mainstream middle school classrooms and using social media in education. stacie.pettit@gmail.com @PettitStacie

Laura Rychly is an Assistant Professor of Teacher Education at Augusta University. Her teaching career began 12 years ago with 7th graders, and currently she is the Middle Grades Program Coordinator at Augusta University. She received her Ed.D. in Curriculum Studies from Georgia Southern University. Her research interests are the points at which language, culture, and learning intersect. She can be reached at lrychly@gru.edu

Assessing and Overcoming the Barriers Impeding Inquiry Based Education

Kaitlin S. Shurts

* Correspondence:
Kaitlin S. Shurts.
Miami University
4015 Benjamin St.
Cincinnati, Ohio 45245
pyleks@miamioh.edu
513-947-7400
Full list of author information is available at the end of the article

Abstract:

This case study aims to 1) assess the relationship between teachers' conceptions of inquiry and the number of perceived inquiry barriers and 2) provide solutions to overcome the inquiry barriers perceived by teachers in the case study. Though no relationship was discovered there were important trends in the concepts and barriers analyzed. Perceived inquiry barriers can prevent teachers from implementing inquiry using the barriers as evidence for why the methodology is not effective. It is essential that teachers are provided professional development opportunities to overcome the barriers of inquiry in order to provide students with authentic learning experiences.

INTRODUCTION

The drive for an educational revolution stems from Paulo Freire's call for students to have a voice in their education, rather than the typical teacher-directed education which deposits recall knowledge into the "bank" known as students' brains (Freire, 1970). Morrison (2014) states that throughout the United States, high school teachers are expected to move away from just depositing information and instead implement inquiry into the science curriculum as required by the National Science Education Standards and the Ohio Department of Education.

Inquiry instructional standards can help ensure that teachers provide students with an opportunity to experience and explain phenomena that occur naturally around them (Rascoe, 2010). The result of inquiry teaching allows students to ask questions about the real word, develop experiments, and analyze different explanations for the data they gather (Mumba, Mejia, Chabalengula, & Mbewe, 2010).

Morrison (2014) states it is essential for inquiry to be authentic to students. This means students' questions and investigations should be derived from their own personal experiences while their teachers are merely acting as a facilitator (Myers, Myers, & Hudson, 2009). The scientific processing skills (Ergul et al., 2011) and problem solving skills students develop when immersed in authentic inquiry are beneficial to their lives (Burton & Frazier, 2012). These skills aid in the development of becoming participatory citizens by making personal and politically-based decisions (Hart, 1997); further preparing students for life outside of high school and life in the real word.

Levels of Inquiry

There are four different levels of inquiry which can be embedded into science investigations ranging from closed to open inquiry such as: confirmation, structured, guided, and open-ended (Mumba et al., 2010). Confirmation inquiry is the lowest level of inquiry as it is a teacher centered approach in which students follow cookbook procedures to complete a science investigation (Gengarelly & Abrams, 2008). Open-ended inquiry is the highest level of inquiry as it is a student centered approach in which students develop the investigation, methods and form conclusions based on data analysis with the teacher as a facilitator (Gengarelly & Abrams, 2008). Hart (1997) illustrates that the highest level of student participation is achieved when students initiate their own research and share the responsibility of decisions in learning with the teacher in the classroom consistent with open-ended inquiry.

Issues with Inquiry Education

Freire (1970) suggests that in order to cease student oppression the solution is to transform the structure of education through inquiry, such that students can be free from the marginalization of traditional teaching. The goal of education reform in America is to progress from passive to active learning through inquiry based teaching as describe in the NSES and ODE standards. Despite inquiry being a science education standard by ODE and NSES, many teachers do not implement it for multiple reasons (Ohio Department of Education, 2011; Lotter, Rushton, & Singer, 2013; Morrison, 2014; Gengarelly & Abrams, 2008) even though teachers recognize the effectiveness of inquiry as a teaching approach (Gengarelly & Abrams, 2008). Koballa, Dias, and Atkinson (2009) concur by stating that numerous barriers exist that thwart teachers from implementing inquiry in the classroom. Barriers such as: standardized testing, availability of resources, lack of time, student incapability, loss of classroom management, and lack of professional or personal inquiry experiences.

These inquiry barriers can alter a teacher's conception of inquiry resulting in the abandonment of inquiry based teaching in high school classrooms. Ozel & Luft (2013) suggest that a direct correlation exists between teachers' conceptualization of inquiry and its implementation in the classroom. Evidence from Ozel and Luft (2013) year long study showed that science teachers with closed inquiry conceptions also practice closed inquiry instruction in the classroom with little growth during the school year. This paper aims to review the barriers of inquiry that impede its implementation by describing a case study I conducted in 2015 assessing conceptions of inquiry based teaching.

Methods

In order to investigate the impact of teachers' inquiry conceptions and inquiry implementation in secondary science education, quantitative data was collected in the form of questionnaires. This case study aims to determine whether a relationship exists between teachers' conceptions of inquiry and the number of inquiry barriers perceived in the classroom. It is expected that the more negative the conceptions of inquiry the more inquiry barriers will be perceived and the more positive the conceptions of inquiry the fewer inquiry barriers will be perceived.

Population and Sampling

The investigation was conducted in a school district located in southeast Cincinnati, Ohio in collaboration with two suburban public high schools, with a population consisting of secondary educators. A total of 120 teachers provide services to students while 17 teach science as a core subject. The grade levels and subject taught by each science teacher are dependent on certification and course content availability.

Participants

Of the total population of science teachers, seven volunteered to participate creating the sample of this investigation. There was both a quantitative and qualitative part of the investigation, which included the survey based questionnaire and the classroom observations respectively. Seven teachers participated in the quantitative portion of the investigation through completion of an online survey while zero teachers volunteered to participate in the qualitative portion of the investigation, classroom observations; therefore the classroom observation methods was omitted from the paper and no qualitative data was gathered.

Data Collection

The first objective of the investigation was to measure teachers' conceptions of inquiry by dispersing a survey based questionnaire to collect quantitative data. The science teachers were given the survey electronically through Google forms. The survey consists of 29 items, in which 20 used a 5-point Likert scale with the following options: 1) Strongly Agree, 2) Agree, 3) Neutral, 4) Disagree, and 5) Strongly Disagree. The key features of inquiry were reworded to form the 20 likert questions in the survey distributed to the science teachers. These questions were created from and used to measure participants' conceptions of inquiry using the "essential features of classroom inquiry and their variations" rubric adapted from the National Research Council (NRC) (2000) (Appendix A). One question allows survey participants to quantify the barriers that impede inquiry-based education, which was used to assess possible explanations for negative inquiry conceptions (Koballa, Dias, & Atkinson, 2009). Of the remaining questions, one question identifies consent for participation, six questions gather demographic information, and one is open ended for comments regarding inquiry.

Analysis

The "essential features of classroom inquiry and their variations" rubric (NRC, 2000, p. 29) was utilized to assess survey responses to identify each teacher's conceptions of inquiry. Each block from the "essential features of classroom inquiry and their variations" rubric (NRC, 2000) represented the key features of inquiry. To analyze the survey responses, each answer to the 20 Likert questions was compared to the "essential features of classroom inquiry and their variations" rubric aligned with each key feature (NRC, 2000). A circle on the "essential features of classroom inquiry and their variations" (NRC, 2000) rubric indicated their acceptance of a key feature of inquiry. Each key feature of inquiry had responses for each variation of inquiry such as: variation A indicated open inquiry, variation B indicated guided inquiry, variation C indicated structured inquiry, and variation D indicated verification inquiry. From variation A to variation D student centeredness decreases as teacher directedness increases (Appendix A).

Science teachers with a positive conception of inquiry would agree with the statements under variation A and variation B of the "essential features of classroom inquiry and their variations" rubric (NRC, 2000) while disagreeing with more statements under variation C and variation D. Science teachers with a negative conception of inquiry would agree with the statements under variation C and variation D of the "essential features of classroom inquiry and their variations" rubric (NRC, 2000) while disagreeing with more statements under variation A and variation B.

Results

Conceptions of Inquiry. Seven teachers responded to the survey administered to the 17 teachers in the science department. Four of the seven were females while the remaining three were males. Due to the zero participants for classroom observations, only the survey was used to evaluate the conceptions of inquiry.

During the analysis of each Likert question, some of the teachers agreed with multiple statements for each key feature of inquiry indicating support of multiple variations of inquiry. In this case, any statement in which a teacher strongly agreed negated all other agreed upon statements. A teacher's conception of inquiry was determined based upon how many strongly agreed or agreed upon statements there were per each variation of the "essential features of classroom inquiry and their variations" rubric (NRC, 2000). According to this analysis method, there were: five teachers with conceptions aligning with variation A, open inquiry; one teacher with conceptions aligning with variation C, structured inquiry; and one teacher in which the results were inconclusive because all responses were in agreement with each statement of the "essential features of classroom inquiry and their variations" rubric (NRC, 2000).

Table 1: The Variations of Inquiry and Teachers' Conceptions

Variations of Inquiry	Teacher 1	Teacher 2	Teacher 3	Teacher 4	Teacher 5	Teacher 6	Teacher 7
A (Open)	x	x		x		x	x
B (Guided)							
C (Structured)			x				
D (Verification)							

Three teachers offered comments when asked if there are other thoughts or feelings regarding inquiry that was not targeted in the survey. Teacher 1 stated, "[inquiry is] a time consuming technique and we need to spend lots of time to teach the students this strategy from the grade school all the way to high school." Teacher 3 discussed the implementation of inquiry as independent subject dependent stating, "In chemistry, it is much more difficult to allow the students' to pose his/her own questions to test and give them the freedom to work with chemicals. Through guided experiments, they still have freedom to collect and process data. [Students] still need to be able to analyze the data and draw conclusions based on scientific evidence."

Teacher 4 identified the same concern as Teacher 1 in which students lack the practice needed to understand and complete inquiry activities. Teacher 4 states,

> *"I find that students do not have enough "practice" learning through inquiry to fully implement this style of teaching in my classroom. While I frequently use POGIL (Process Oriented Guided Inquiry Learning) assignments to begin units, as far as laboratory activities go, inquiry-based learning can be a challenge. Students do not know where to begin or how to continue when presented with a true inquiry lab. It is my experience that most students even have great difficulty following a "cookie-cutter" laboratory activity where procedures are fully communicated in the lab procedure. My honors students, though, seem to do better when asked to manipulate a lab variable or create their own experiment. Consequently, I think the biggest barrier to inquiry implementation is low-performing students (and lack of experience)."*

The reflections from Teachers 1, 3, and 4 indicate that despite the analysis of each survey using the "essential features of classroom inquiry and their variations" rubric (NRC, 2000) negative conceptions of inquiry are still present in two of the five teachers considered to have conceptions that align with variation A, the most student centered variation. Teacher 7, one of the three remaining teachers in variation A, holds a more positive conception of inquiry stating, "Inquiry-based teaching is a wonderful approach to student-centered learning." However, teacher 7 recognizes that there are barriers in place that can prevent a teacher from always using inquiry stating, "a teacher must cover a specific amount in content in a given amount of time, it becomes difficult to devote the time to the process."

Barriers of Inquiry

In this case study of only seven teachers, there was no correlation between the number of inquiry barriers and conceptions of inquiry although trends were noted. A large sample size may results in a correlation between the number of inquiry barriers and conceptions of inquiry. Table 2 illustrates each teacher's perceived barriers to inquiry. It is evident from the data table that all seven teachers perceive time constraints as a barrier to the implementation of inquiry and all seven teachers do not perceive that the reason inquiry is not implemented in science classroom is due to the teachers inability to understand how to implement inquiry or the lack of professional development regarding inquiry based teaching. It is also important to note that Teacher 7, who provided the most positive and open conception of inquiry due to the comments on the open ended portion of the survey, only noted one barrier, time.

Table 2: Perceived Barriers Implementing Inquiry in the Science Curriculum

Inquiry Barriers	Teacher 1	Teacher 2	Teacher 3	Teacher 4	Teacher 5	Teacher 6	Teacher 7
Limited Material and Resources		x	x	x			
Time Constraints	x	x	x	x	x	x	x
Loss of Classroom Management		x	x				
Low Performing Students	x		x	x		x	
Pressure of High Stakes Testing		x		x	x	x	
Lack of Professional Development							
Lack of Understanding							

Discussion

Barriers of Inquiry Based Education

Limited time and classroom resources. Three of the seven teacher saw that classroom resources were a barrier to inquiry while all seven teachers noted limited time as a barrier to inquiry education suggesting a commonality in all the potential barriers. Lotter, Rushton, and Singer (2013) conducted a year long study following 36 teachers in which each teacher implemented inquiry based lessons into their classrooms succeeding a two-week professional development session during the summer. Workshops were provided throughout the school year and teachers were observed twice during the academic year yet the teachers considered to have more negative conceptions of inquiry, stated that lack of time and materials prevented them from using inquiry in their classrooms throughout the year (Lotter et al., 2013). This claim is supported by Morrison (2014) who conducted a similar study in which participants frequently mentioned time as a constraint as well as limited materials for students to use to continue exploring concepts following lessons.

Classroom management

Two of the seven teachers found classroom management to be a barrier for inquiry implementation. Many teachers fear that using inquiry means losing control over classroom management (Gengarelly & Abrams, 2008). This was expressed by a teacher in Morrison's study (2013), who stated that she loses complete control over the class when allowing students the freedom to explore content further through inquiry. However, Morrison (2013) notes that the teachers in her study most afraid of classroom management issues were the teachers that implemented the least inquiry in the classroom.

Low academically performing students

Four teachers of seven found low academically performing students as a barrier for implementing inquiry in their classroom. This suggests that teachers stray from using inquiry in the classroom because students are not considered high level performers resulting in low student motivation and further classroom management issues. Teachers who tend to marginalize students' academic abilities see inquiry as something done to students rather than a process carried out by the students (Koballa, Dias, & Atkinson, 2009). A teacher in Lotter, Rushton, and Singer's (2013) study stated that her students skills are so low that she had to instruct them what to do rather than guide them, suggesting students prefer to be told what to do rather than think for themselves (Mumba, Mejia, Chabalengula, & Mbewe, 2010). Due to the pressures of adapting to inquiry practices, some students grow frustrated causing adverse reactions to inquiry such as insecurity, confusion, and rebellion (Heppner, Kouttab, & Croasdale, 2006) which increases the burden of classroom management on the teacher (Geier et al., 2007).

Pressure of high stakes standardized testing

At a National Science Teacher Association Convention in Georgia, session leaders recognized that increased high stakes testing is a common barrier preventing teachers from implementing inquiry (Koballa, Dias, & Atkinson, 2009). Four of the seven teachers in this case study agreed that high stakes testing was a barrier of implementing inquiry. High stakes testing creates pressure on teachers and administrators as state funding is allocated and statutory accreditation is based upon student's tests scores (Geier et al., 2007) resulting in teacher directed instruction, termed "teach to test" to raise test scores rather than achieve content understanding (Blanchard et al., 2010). A teacher in Morrison's study (2013) stated that inquiry uses more time and limits the amount of content covered per lesson, placing them behind the district curriculum pacing guide for end of the course exams. Even teachers considered emerging enactment teachers, a higher conception of inquiry, in Lotter, Rushton, and Singer's (2013) study, feared meeting the standards required for high stakes tests, suggesting that high stakes testing worries teachers who are successfully implementing inquiry and thwarts other teachers from trying to implement it.

Lack of professional development and scientific inquiry understanding

A review of the 10 most highly recognized government-based reports on inquiry as education reform by Burton and Frazier (2012) revealed that teachers need year round support in the implementation of inquiry based teaching methods. Similar results were founded from the review of the NSTA session leaders; 50% of the session leaders noted that teachers are inexperienced with inquiry and therefore are uncomfortable teaching inquiry, ultimately ignoring inquiry based teaching methods in the classroom (Koballa, Dias, & Atkinson, 2009). To implement inquiry, teachers must overcome a series of obstacles such as: the addition of a new teaching role, content knowledge, and skills (Jones & Eick, 2007). Without professional development and ongoing support throughout the academic year inquiry teaching methods are often ignored due to the teacher's lack of comfort. Comfort levels continue to decline when teachers experience a lack of support and understanding from the administration level, jeopardizing teacher's confidence in trying a new teaching method such as inquiry (Morrison, 2013).

Pozuelos, Gonzales, and Canal de Leon (2010) found variance in teachers' professional development suggesting the departments of science teachers are not homogeneous in their ability to implement inquiry. Though variance in professional development exists, none of the seven teachers in this case study thought they lacked the professional development or understanding as a barrier impeding the implementation of inquiry based instruction. A study by Kazempour (2009) found that teachers needed effective inquiry-based professional development opportunities to affect the conceptions of inquiry-based teaching and increase its implementation in the classroom.

None of the seven teachers in this case study thought they lacked the experience or professional development needed to implement inquiry. Is it possible that teachers think they have the experience needed to implement inquiry or do teachers not want to admit that they lack the experience needed to implement inquiry? Or did previous professional development sessions address the barriers of inquiry and provide solutions for how to overcome those barriers to effectively implement them?

Overcoming Barriers of Inquiry

Low academically performing students

It is possible that the first time a teacher tries inquiry in their classroom that it is the first time the students have been exposed to this teaching method. Hart (1997) urges teachers that it takes time to shape and develop students to successfully implement inquiry as noted by his hierarchical ladder of organizational principles defining the levels of student participation. Heppner, Kouttab, and Croasdale (2006) also suggest teachers considered developmental levels of students for at earlier levels, students cannot recognize that knowledge is experimental and the teacher is a facilitator rather than just the expert (Freire, 1970). This results in teachers avoiding inquiry, accrediting its failure to their students inability to "do" inquiry. Even though this barrier exists, Griset (2010) urges teachers to use inquiry in the classroom stating that students may not respond to it at first but after time inquiry becomes routine. Routine in any classroom creates a safe and successful environment for students to learn and grow accustomed to inquiry based teaching.

Resources and high stakes testing

Teachers can gain professional support through curriculum based programs to assist with providing inquiry learning experiences to students which are aligned with state and national standards ensuring standards are met for high stakes testing. The Center for Learning Technologies in Urban Schools (LeTUS) developed learning technologies along with supplementing curriculum design, development, and enactment while providing professional development to teachers (Geier et al., 2007). LeTUS provided Detroit Public Schools (DPS) a series of 8- to 10-week units on air quality, water quality, and Newton's Laws (Geier et al., 2007).

Curriculum based inquiry units along with professional development for proper implementation provide teachers with a supportive structure and the resources needed to implement inquiry (Jones & Eick, 2007). Geier et al. (2007) conducted a three year study working with LeTUS and DPS which impacted 37 teachers and approximately 5,000 students enrolled in 18 different middle schools. Concluding each academic, year all students in DPS participated in the Michigan Education Assessment Program (MEAP), which are considered high stakes tests in the state of Michigan affecting the accreditation and funding of all Michigan Schools (Geier et al., 2007). Results compare students involved in LeTUS units to other DPS students not taking LeTUS units. Cohort 1 took the MEAP 2000 test and had a 19% increase in passing rate while Cohort 2 took the MEAP 2001 test and had a 14% increase in passing rate compared to other DPS non- LeTUS students (Geier et al., 2007).These results suggests that inquiry does not hinder high stakes testing score but increases the likelihood to pass compared to other students who lacked inquiry teaching methods. Also discredited by these results is the fact that students have to be of high performance to successfully "do" inquiry. Many of the students in the DPS district have a substantially high amount of student dropout rates and low performing at risk students.

Professional Development.

Bottom-Up Approach. The purpose of professional development is to implement ideal teaching methods to actual classroom experiences (Jones & Eick, 2007). However, many professional development sessions tend to focus on a top-down approach, which is defined by Jones and Eick (2007) as a lecturer discussing curriculum and pedagogy. In order to obtain sustainable education reform through inquiry based teaching, professional development sessions must utilize a bottom-up approach, focusing on pragmatic issues (Jones & Eick, 2007) conceived as inquiry barriers. Lotter, Rushton, and Singer (2013) also state that successful professional development sessions take account of teacher's beliefs and transmit those beliefs into classroom practice. As Butron and Frazier (2012) indicate the need for students to experience authentic learning through inquiry Morrison (2013) states it is vital for teachers to experience authentic inquiry themselves to achieve education reform and potentially alter the negative connotation associated with the term inquiry.

Collaboration. An overwhelming amount of evidence suggests that professional development of inquiry methods are most successful when teachers partner with scientists, professors, curriculum programs, and other teachers. In a study conducted by Morrison (2013), high school teachers job shadowed scientists and interviewed scientists about their views pertaining to: the nature of science, science education, and the importance of students learning science. When teachers were not observing scientists, teachers and scientists both participated in group discussions, authentic inquiry activities, and designing inquiry based lessons. Concluding the professional development summer program teachers attended follow-up workshops in which scientists would assist in small group discussion and continued a bottom-up approach of authentic inquiry activities (Morrison 2013). The comparison of Views of Scientific Inquiry (VOSI) survey supports partnering professional development with scientists as 43% of teachers had a good, great, or outstanding view of scientific inquiry on the pre VOSI Survey moved to 100% on the post VOSI survey (Morrison, 2013).

Similar results were found in Jones and Eick (2007) where professional development programs provided opportunities co-teaching in the classroom with collaboration of a pre-service teacher, in-service teacher, and a university professor enhancing learning through inquiry activities. Results from this collaboration illustrate efficient management of the following: materials, class time, students, and complex procedures or apparatuses (Jones & Eick, 2007). The relationship between the preservice and inservice teacher enriched the scientific content of each lesson as preservice teachers had different backgrounds in education than their inservice teachers thus deepening student learning (Jones & Eick, 2007). In the current education of preservice teachers, they are encouraged to make connections to learning inquiry as a student and teaching inquiry as a teacher (Kang, Bianchini, & Kelly, 2013), which many inservice teachers lack due to changing professional development practices to meet inquiry based reform in universities. Co-teaching alleviates the perceived challenges derived from implementing inquiry and enables learning to go beyond instruction which engages students and deepens their learning (Jones & Eick, 2007).

Conclusion

Inquiry-based education aims to reform current teaching practices to provide students with authentic learning experiences of real world phenomena and an opportunity to develop explanations through scientific investigations. Despite the research recognizing the many benefits of inquiry based education, teachers are choosing to forgo inquiry teaching practices for more teacher directed methods. There are pragmatic issues that teachers face when implementing inquiry that often form barriers ceasing inquiry practices. The barriers that impede inquiry implementation can be overcome through appropriate professional development sessions in which teachers experience authentic inquiry themselves. Partnership with scientists and collaboration with co-teachers alter teachers views on inquiry and ensures the effectiveness and sustainability of inquiry teaching. When professional development includes curriculum based resources it not only provides specific and well developed support for teachers implementing inquiry. These resources also raise high stakes test scores improving school districts' ratings. Professional development has the opportunity to empower teachers, supporting their efforts to successfully implement inquiry without barriers to sustain authentic learning experiences for students. Though the teachers in this study may believe they are above the norm in terms of professional development, the trends found among the seven teachers that participated in the case study should be examined further on a larger scale.

Appendix A:

Essential Features of Classroom Inquiry and Their Variations (adapted from NRC 2000)

The variation in each box are the different ways that the essential features of inquiry might be demonstrated in student investigations.
The observer will circle the variation that was most prevelant in the lesson.

Key Features of Inquiry	Variation A	Variation B	Variation C	Variation D
Student engages in scientifically oriented questions.	Student poses a question.	Student selects among questions and poses new questions.	Student sharpens or clarifies questions provided by the teacher or materials and other resources.	Student engages in a question that is provided by the teacher or materials and other resources.
Student gives pirority to evidence in responding to questions.	Student determines the evidence to be collected and how to collect it.	The student is directed to collect certain data by the teacher.	The student is given data and asked to analyze it.	The student is given data and told how to analyze it.
Student formulates an explanation from the evidence collected.	Student formulates an explanation after summarizing evidence.	Student is guided in the process of formulating an explanation from the evidence.	The student is given possible examples to use evidence to formulate an explanation.	The student is provided with evidence only.
Student connects explanations to scientific knowledge.	Student independently examines other resources and forms connections to scientific knowledge.	Students are directed toward areas and sources of scienctific knowledge.	The student is given possible connections.	The student is told possible connections.
Student communicates and justifies explanation.	Student forms a reasonable and logical argument to communicate an explanation.	Students are coached in the development of communication.	The student is provided broad guidelines to sharpen communication.	The student is given a series of steps and procedures for communcation.

Teacher Centered →
Student Centered ←

REFERENCES

Baker, C. A. (2012). Social identity theory and biblical interpretation. *Biblical Theology Bulletin*, *42,* 129–138. doi:10.1177/0146107912452244

Beart, S. (2005). 'I won't think of meself as a learning disability. But I have': Social identity and self-advocacy. *British Journal of Learning Disabilities, 33,* 128–131.

Berkay, P. J., Gardner, J. E., & Smith, P. L. (1995). A scale for assessing hearing adults' beliefs about the capabilities of deaf adults. *Journal of the American Deafness and Rehabilitation Association, 29,* 33–44.

Besley, T., & Peters, M. (2007). *Subjectivity and truth: Foucault, education and the culture of the self*. New York, NY: Peter Lang Publishing.

Blumer, H. (1969). *Symbolic interactionism: Perspective and method*. Englewood Cliffs, NJ: Prentice-Hall.

Brekhus, W. H. (2008). Trends in the Qualitative Study of Social Identities. *Sociology Compass, 2,* 1059–1078.

Bronfenbrenner, U. (1979). *The ecology of human development.* Cambridge, MA: Harvard University Press.

Bruce-Rosser, K. (2009, January 12). Circle supports deaf girls. *Stonnington Leader*, p. 13. Retrieved from http://www.deafchildrenaustralia.org.au/sites/ deafchildrenaustralia.org.au/files/Circle%20Supports%20deaf%20teengirls.pdf

Brueggemann, B. J. (2009). *Deaf subjects: Between identities and places*. New York, NY: New York University Press.

Burgess, E. W. (1925). The growth of the city: An introduction to a research project. In R. Park, E. Burgess, & R. McKenzie (Eds.), *The city* (pp. 47–62). Chicago, IL: University of Chicago Press.

Burke, P. J. (2004). Identities and social structure: The 2003 Cooley-Mead award address. *Social Psychology Quarterly, 67,* 5–15.

Cole, S. H., & Edelmann, R. J. (1991). Identity patterns and self- and teacher-perceptions of problems for deaf adolescents: A research note. *Journal of Child Psychology & Psychiatry & Allied Disciplines, 32,* 1159–1165.

Cooley, C. H. (1902). *Human Nature and the Social Order*. New York, NY: Scribner.

Corker, M. (1996). *Counseling—The deaf challenge*. London, England: Jessica Kingsley Publishers.

Cornell, S. L., & Lyness, K. P. (2004). Therapeutic implications for adolescent deaf identity and self-concept. *Journal of Feminist Family Therapy: An International Forum, 16*(3), 31–49.

Creswell, J. W. (2007). *Qualitative inquiry and research design: Choosing among five approaches* (2nd Ed.). Thousand Oaks, CA: Sage.

Dalton, C. J. (2011). Social-emotional challenges experienced by students who function with mild and moderate hearing loss in educational settings. *Exceptionality Education International, 21*(1), 28–45.

Fernandes, J., & Myers, S. (2010). Inclusive deaf studies: Barriers and pathways. *Journal of Deaf Studies & Deaf Education, 15,* 3–16. doi:10.1093/deafed/enp018

Gallaudet Research Institute. (2001, January). *Regional and national summary report of data from the 1999–2000 Annual Survey of Deaf and Hard of Hearing Children & Youth*. Washington, DC: Author, Gallaudet University.

Gallaudet Research Institute. (2003, December). *Regional and national summary report of data from the 2002–2003 annual survey of deaf and hard of hearing children and youth*. Washington, DC: Gallaudet University.

Gallaudet Research Institute. (2011, April). *Regional and national summary report of data from the 2009–2010 annual survey of deaf and hard of hearing children and youth*. Washington, DC: Gallaudet University.

Gergen, K. J. (1991). *The saturated self: Dilemmas of identity in contemporary life*. New York, NY: Basic Books.

Gesser, A. (2007). Learning about hearing people in the land of the deaf: An ethnographic account. *Sign Language Studies, 7,* 269–283.

Glickman, N. S. (1986). Cultural identity, deafness, and mental health. *Journal of Rehabilitation of the Deaf, 20,* 1–10.

Glickman, N. S., & Carey, J. C. (1993). Measuring deaf cultural identities: A preliminary investigation. *Rehabilitation Psychology, 38,* 275–283.

Grushkin, D. A. (2003). The dilemma of the hard of hearing within the U.S. deaf community. In L. Monaghan, C. Schmaling, K. Nakamura, & G. H. Turner (Eds.), *Many ways to be deaf: International variation in deaf communities* (pp. 114–140). Washington, DC: Gallaudet University Press.

Handel, G. (1985). *The psychosocial interior of the family* (3rd ed.). New York, NY: Aldine de Gruyter.

Hays, W. C. (1977). Theories and theoretical frameworks identified by family sociologists. *Journal of Marriage and the Family, 39,* 59–65.

Horejes, T. P. (2010). Constructions of deafness and deaf education: Exploring normalcy and deviance. *US, ProQuest Information & Learning,* 71.

Humphries, T., & Humphries, J. (2011). Deaf in the time of the cochlea. *Journal of Deaf Studies and Deaf Education,* 16(2), 153–163.

Jackson, C. W., Traub, R. J., & Turnbull, A. P. (2008). Parents' experiences with childhood deafness: Implications for family-centered services. *Communication Disorders Quarterly, 29,* 82–98.

Ladd, P. (2005). *Understanding deaf culture: In search of deafhood*. Cleveland, OH: Multilingual Matters.

Lane, H., Hoffmeister, R., & Bahan, B. (1996). *A journey into the Deaf-World.* San Diego, CA: DawnSignPress.

Leigh, I. W. (2009). *A lens on deaf identities: Perspectives on deafness.* New York, NY: Oxford University Press.

Lichtman, M. (2006). *Qualitative research in education: A user's guide*. Thousand Oaks, CA: Sage.

McIlroy, G. (2010). *Discovering deaf identities: A narrative exploration of educational experiences on deaf identity*. Saarbrucken, Germany: Lambert Academic Publishers.

McIlroy, G., & Storbeck, C. (2011). Development of deaf identity: An ethnographic study. *Journal of Deaf Studies and Deaf Education, 16,* 494–511.

Mead, G. H. (1934). *Mind, self & society from the standpoint of a social behaviorist*. Chicago, IL: University of Chicago Press.

Moores, D. (2004). The future of education of deaf children: Implications of population projections. *American Annals of the Deaf, 149,* 3–4.

Most, T., Wiesel, A., & Blitzer, T. (2007). Identity and attitudes towards cochlear implant among deaf and hard of hearing adolescents. *Deafness & Education International, 9,* 68–82.

Mottez, B. (1990). Deaf identity. *Sign Language Studies, 68,* 195–216.

National Institute on Deafness and Other Communication Disorders. (2013). *Quick statistics*. Retrieved from http://www.nidcd.nih.gov/health/statistics/Pages/quick.aspx

Orrange, R. M. (2003). The emerging mutable self: Gender dynamics and creative adaptations in defining work, family, and the future. *Social Forces, 82,* 1–34.

Padden, C. A., & Humphries, T. (2005). *Inside deaf culture*. Cambridge, MA: Harvard University Press.

Pray, J. L., & Jordan, I. K. (2010). The deaf community and culture at a crossroads: Issues and challenges. *Journal of Social Work in Disability & Rehabilitation, 9,* 168–193.

Reagan, T. (1995). A sociocultural understanding of deafness: American Sign Language and the culture of deaf people. *International Journal of Intercultural Relations, 19,* 239–251.

Schlesinger, H. S., & Meadow, K. P. (1972). *Sound and sign: Childhood deafness and mental health.* Berkeley, CA: University of California Press.

Shakespeare, T., & Watson, N. (2002). The social model of disability: An outdated ideology? *Research in Social Science, 2,* 9–28.

Sharagorodsky, J., Curhan, S. G., Curhan, G. C., & Eavey, R. (2010). Change in prevalence of hearing loss in US adolescents. *Journal of the American Medical Association, 304,* 772–778.

Simmel, G. (1971). *On individuality and social forms*. Chicago, IL: Chicago University Press.

Skelton, T., & Valentine, G. (2003). It feels like being deaf is normal: An exploration into the complexities of defining D/deafness and young D/deaf people's identities. *Canadian Geographer, 47,* 451–466.

Strauss, A., & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory.* Thousand Oaks, CA: Sage.

Tajfel, H., & Turner, J. C. (1986). The social identity theory of intergroup behavior. In W. G. Austin & S. Worchel (Eds.), *Psychology of Intergroup Relation* (pp. 33–47). Monterey, CA: Brooks/Cole.

U.S. Centers for Disease Control and Prevention. (2009). Summary of 2008 National CDC EHDI Data, Version A. Retrieved from http://www.cdc.gov/ncbddd/hearingloss/2009-Data/2009_EHDI_HSFS_Summary_508_OK.pdf

U.S. Department of Education, National Center for Education Statistics. (2012). *Digest of Education Statistics, 2011* (NCES 2012-001), Chapter 2.

White, K. R. (October, 2010). *Twenty years of early hearing detection and intervention (EHDI): Where we've been and what we've learned*. ASHA Audiology Virtual Conference.

Woodcock, K., Rohan, M. J., & Campbell, L. (2007). Equitable representation of deaf people in mainstream academia: Why not? *Higher Education, 53,* 359–379.

Woodward, J. C. (1972). Implications for sociolinguistic research among the deaf. *Sign Language Studies, 1,* 1–7.

Wrigley, O. (1996). *The politics of deafness*. Washington, DC: Gallaudet University Press.

Zerubavel, E. (2007). Generally speaking: The logic and mechanics of social pattern analysis. *Sociological Forum, 22,* 131–145.

About the Author:

Kaitlin S. Shurts: BS in Life Science Education

4015 Benjamin Street

Cincinnati, Ohio 45245

pyleks@miamioh.edu

Home Number: 513-417-4011

Business Number: 513-947-7400

Miami University

Biographical Sketch: It was in my Graduate Program at Miami University's Project *Dragonfly*, that I first experienced authentic learning through inquiry based methods. During a spirited debate about inquiry based teaching at the Galavon Ranch in Baja Mexico for a field expedition (2014) with Miami University, I discovered my passion for inquiry-based learning in the midst of an internal debate of a possible career change from teaching. In this moment, as I stood up for the voice of my past and future students, I decided my Master Plan through the Project *Dragonfly* Program had to revolve around the benefits of inquiry-based teaching. Through my graduate program, teachers criticized inquiry and called me brave for trying it. I found that there is a bigger issue than to implement inquiry or not to implement inquiry but rather why teachers are so against it. It is through this pursuit that as a 4th year teacher from Ohio, I have been asked to lead future professional development sessions on inquiry at the district level and speak to incoming teachers in our district through the Resident Educator Summative Assessment program, which serves as a four year induction to support and mentor new teachers.

Improving Teaching Practices of STEM Teachers: The Teacher Synergistic Institute in Warren County

Jennifer Blue, Ph.D., Lana Rocks, Ph.D., & Charles Setterfield, M.Arch.

.

.

* Correspondence:
Dr. Jennifer Blue.
Miami University
217 Kreger Hall
500 E. Spring Street
Oxford, OH 45056
bluejm@miamioh.edu
513-529-1380
Full list of author information is available at the end of the article

Abstract:

The Teacher Synergistic Institute, funded by the National Science Foundation's Advanced Technological Education directorate, provided professional development for high school teachers in Warren County for four years. There were two-week periods of professional development in the summers, which most teachers followed up with involvement in iDiscovery, an online collaborative learning community for teachers. The teachers involved reported satisfaction with the summer workshops and iDiscovery, and they learned instructional strategies and made changes to their teaching practices.

INTRODUCTION

Increasing workforce talent in science, technology, engineering, and math (STEM) disciplines is of profound national importance. To this end, it is critical to create a pipeline, starting in the early grades, to stimulate students' interest in STEM courses and careers and to prepare them to compete for jobs within the expanding STEM frontier. Consequently, there is a need for teachers who are able to "prepare and inspire" students to pursue STEM related fields (President's Council of Advisors on Science and Technology, 2010).

From 2011 to 2014, the Teacher Synergistic Institute (Institute), funded by the National Science Foundation's Advanced Technological Education directorate, provided professional development for high school educators within Warren County, Ohio, located between Cincinnati and Dayton.

The Institute was a partnership between Sinclair Community College and the Warren County Educational Services Center. The primary objective of the project was to equip teachers with the knowledge and skills to infuse more inquiry-based STEM learning into their high school courses towards preparing and inspiring students

To aid in this effort, each year of the project a summer workshop was held for a new cohort of 30 – 40 teachers. In this workshop, teachers learned STEM content, had inquiry-based pedagogy modeled for them, and constructed their own modules. These modules were multiple-day units, designed to teach STEM content to high school students using reformed, inquiry-based pedagogy.

Most of the participants in these summer workshops also went on to participate in a web-based learning community created by the Discovery Center at Miami University called iDiscovery, which took place during the school year following the summer workshop.

The purpose of this article is to outline how the project was implemented and the outcomes of the project on the teachers for other entities to implement a similar program.

II. The Institute

The format for faculty professional development was a combination of face-to-face and distance delivery, with follow-up activities via Internet communications when teachers returned to their home schools. This hybrid model is based on a framework designed by the National Staff Development Council, which promotes online and face-to-face training as two of the most essential elements of effective professional development. The combination "…gives participating teachers opportunities to practice and reflect on what they learn over relatively extended periods of time, and it provides an ideal environment for interaction among participants. In addition, being asynchronous and accessible from any web-connected computer, online professional development provides a level of convenience that conventional professional development does not…" (Harwell, 2003). Moreover, research indicates that the time teachers spend with each other engaged in thinking about teaching and learning is just as important to student learning as the time teachers spend in direct facilitation of learning (Stigler & Hiebert, 1999). The activities within the Institute incorporated time for the teachers to collaborate as a learning community, seek additional personal training, and team with their peers and college and university faculty. A participant who completed all components of the Institute received 200 hours of training, consultation, and collaboration.

A. Summer Workshop

Teacher recruitment involved a project team member personally visiting each high school in Warren County to inform teachers about the project. Additionally, efforts were targeted at the administrative level to secure "endorsements" of the Institute. Teachers were offered incentives to participate, including an $850 stipend, an iPad, opportunity for job shadowing, and a certificate of completion. In addition, their schools received one iPad for each teacher who participated.

The Institute ran for two weeks, from 8:30 am - 3:00 pm with a break for lunch. The first day consisted of introductions to one another, to the Institute, and to teaching inquiry-based instruction. This introduction to teaching inquiry-based instruction consisted of an activity conducted three ways, with different levels of guidance, and discussion.

The rest of the first week consisted of science, math, and engineering lessons taught by expert teachers and by professors from local colleges and universities. During this first week of the workshop, science content was taught in a way that modeled inquiry-based instruction. This delivery method was chosen for two reasons: modeling inquiry for teachers can lead to lasting changes in the way they teach going forward and it is an excellent way for the teachers to learn the content themselves (McDermott, 1990; Supovitz, 2000).

The second week started with field trips to a local community college and to a nonprofit research center. For two days, participants were given time to develop teaching modules for their own courses. These were multi-day lessons, using inquiry-based methods. The participants had access to experts in science, in math, to the Internet, and to their peers as they developed these modules. On the last day, the participants presented their modules to one another and had a small graduation ceremony.

B. Modules

To aid participants in coalescing their understanding of the concepts and processes during the activities, they created modules that had immediate applicability in their classrooms. This unit of integrated science and math problem-based activities was developed with other teachers of about the same grade level. Participants were given a proven module architecture developed with prior NSF funding by Sinclair's National Center for Manufacturing Education, called *Authentic Learning Task* modules. The module architecture "emphasizes a hands-on, competency-based process, where skill-building activities are simultaneously coupled with fundamental theoretical knowledge" (Sinclair Community College, 1996).

C. iDiscovery

iDiscovery is an online collaborative learning community that supports participants and other Ohio educators by allowing for ongoing engagement and support through the academic year. Offered through Miami University, iDiscovery offers seminar courses each academic year that provide graduate credit. Through individual and peer reflection, educators can identify and share strategies for improvement of the teaching practices.

iDiscovery consisted of two semester-long courses. Each course carried graduate credit in Teacher Education at Miami University, and was taken for a letter grade. Students could choose whether or not to take the second course in the spring after they completed the first course in the fall. Each course consisted of nine assignments. Typically a new assignment was due every two weeks. Participants would post their assignments on the course website by the start date, and then spend approximately a week in conversation with one another. Their comments were encouraging, and their questions were insightful and often led to real reflection on the teaching practices of the community. The assignments built towards the posting of original, tested, lesson plans; the participants started with examining resources of the Ohio Department of Education, discussed the learning standards, brainstormed lesson ideas and assessment plans, and then posted lessons. More information about iDiscovery is available at www.iDiscovery.org.

III. Methods

A. Participants

The project was implemented at Sinclair's Courseview Campus in Warren County, Ohio. Located 24 miles from Cincinnati, the Courseview Campus is at an intersection of Interstate 71 in a rapidly growing residential area that attracts 12 new residents per day and grew 27% between 2000 and 2006 (Leyman, 2008). It is located in a major high-tech industrial area that has high demand for STEM technicians employing thousands. Key employers are:

- Proctor & Gamble – multinational consumer and pharmaceutical manufacturer.
- Pioneer – audio-visual equipment.

- Luxotica – ophthalmic manufacturing.
- Sumco Phoenix – integrated circuits and semiconductor devices.
- L3 Cincinnati Electronics – advanced aerospace electronic assemblies.

Warren County is part of the Cincinnati-Middletown Metropolitan Statistical Area, which is one of just three of Ohio's eight Metropolitan Statistical Areas (MSAs) that experienced growth between 2000 and 2008. The area's annual employment growth during 2000-2008 was 5.3% (Ohio Department of Job and Family Services, 2009).

A survey and summary by the Warren County Area Progress Council concluded that Warren County was underserved by Ohio's system of post-secondary education. The county's overall population jumped nearly 40% between 1990 and 2000, to 158,383, while other surrounding county populations declined. However, Warren county has one of the lowest percentages of people 18 to 39 who have a college degree or are enrolled in college, the report said (*Dayton Daily News,* 2003). It was after this report that Sinclair College broke ground on its Courseview campus in Mason, Ohio (https://www.sinclair.edu/courseview/about/history/).

Teachers were initially recruited via email messages, letters sent through the US Mail, announcements on the Warren County Educational Services Center's website, and visits from the Center staff to principal and superintendent meetings and teachers' meetings.

When the project started, the project team had hoped to reach 117 teachers over three years, who would represent 78% of the science, math, and technology 10^{th}-12^{th} grade public school teachers in Warren County. The project team ended up reaching even more teachers. The project ran for four years, from 2011-2014. During this time, a total of 178 teachers participated: 76 (47%) math teachers, 84 (43%) science teachers, and 18 (10%) other teachers. The teachers came from nine of the ten high schools in Warren County, OH and from adjacent counties. Among them, they teach more than 4000 students a year.

B. Data Gathering

At the end of each learning experience a questionnaire was disseminated to assess satisfaction with the experience, attitudes about the topic, intentions to incorporate lessons within one's pedagogical approaches, and demographic information. While there was slight modification across cohorts in the number of items, the questionnaire related to the Institute and iDiscovery contained approximately 50-60 items.

IV. Results

The planned outcomes for teachers included (1) increased comfort with incorporating authentic, interdisciplinary learning activities into instruction and assessing related student performance and (2) increased pedagogical skill in using hands-on, inquiry-based teaching strategies (Clasen & Rucks, 2014).

A. Satisfaction with the Workshop

Indicators of overall satisfaction increased across the four iterations of the Institute (see Figure 1). These findings are consistent with feedback from the project team indicating that they used the results from the questionnaire to improve on the workshop each summer. Indeed, examining the same dimensions just outlined, there was an average increase of 17.4% in the percent of participants who strongly agreed to the five dimensions previously highlighted.

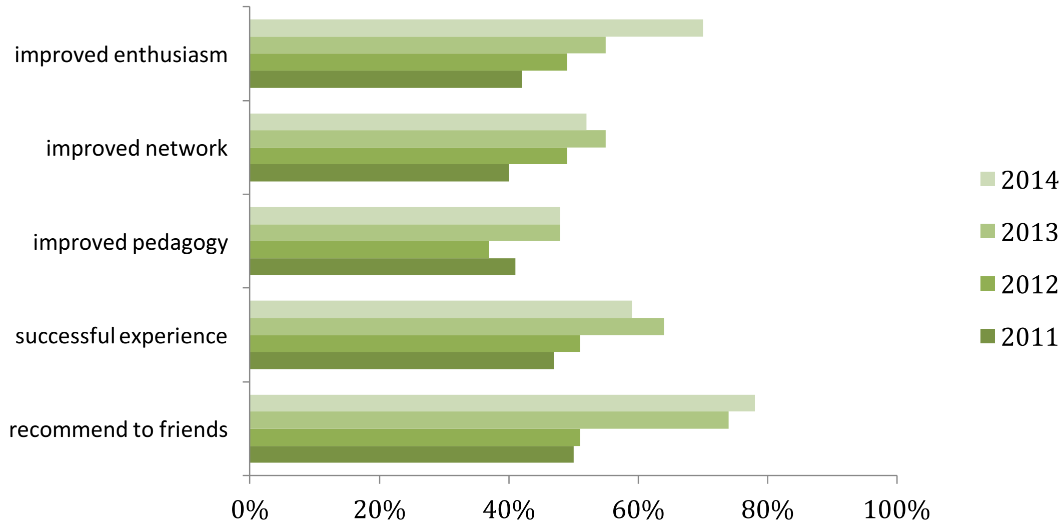

Figure 1. Percentage of participants in Cohorts 2011-2014 who strongly agreed with each statement reflecting overall satisfaction (taken from Clasen & Rucks 2014)

Strength of agreement with statements reflecting the conduct of the workshop itself as illustrated in Figure 2. Again, there was general improvement in agreement with statements reflecting the quality of the workshop across the four (4) years of the Institute, suggesting that the project team was successful in using feedback to improve the workshop. For instance, in 2011 only 7% of participants strongly agreed that the “workshop reflected careful planning and organization,” while in 2014, 70% of participants strongly agreed with this statement.

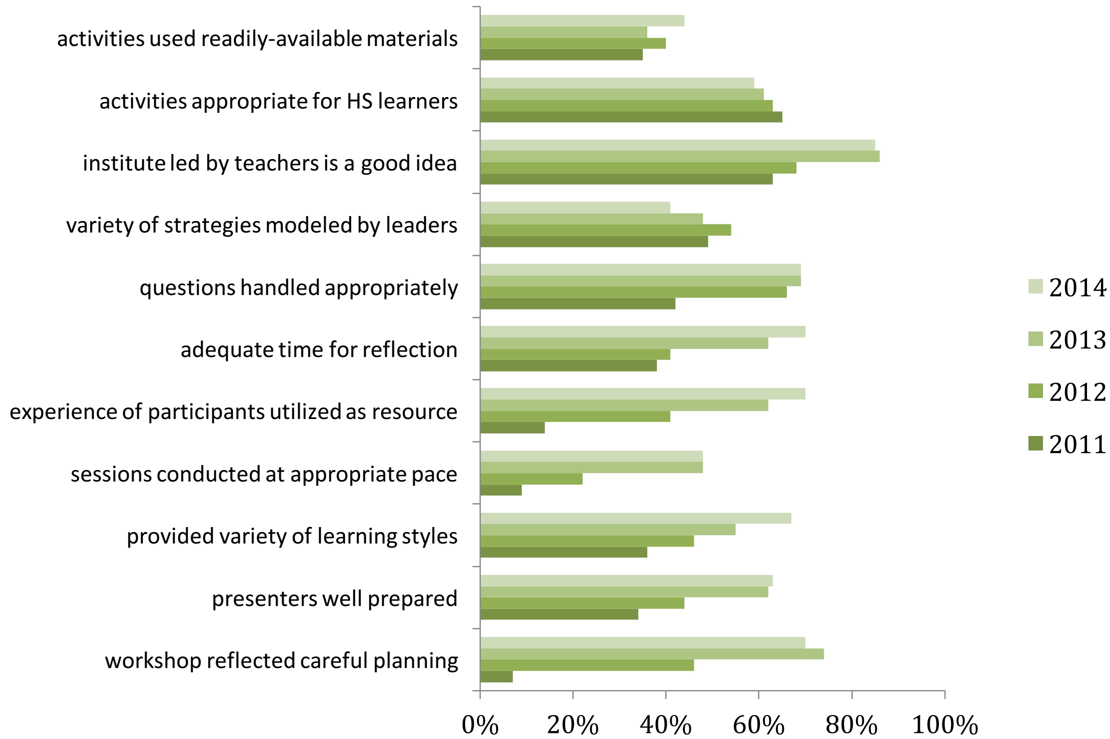

Figure 2. Percentage of participants in Cohorts 2011-2014 strongly agreeing with statements reflecting conduct of workshop (taken from Clasen & Rucks 2014)

Of note, there were several indicators that did not reveal much variation across cohorts. Two statements to which fewer than 50% of participants strongly agreed and which did not vary much between cohorts were "A variety of inquiry-based strategies were modeled effectively by the leaders of the institute," and

"Activities used simple, readily available materials." For a third statement, over 50% of participants in each cohort strongly agreed that "Activities were generally appropriate for high school learners." In addition to evaluation of the Summer Institute, an evaluation of the iDiscovery component was completed in October 2013 by Ohio's Evaluation & Assessment Center for Mathematics and Science Education at Miami University (Morio & Li, 2013). This assessment (see

Table 1) noted that a majority (over 75%) of participants reported that, as a result of iDiscovery, they learned how to use technology in the classroom, new instructional approaches and teaching strategies, and inquiry-based, hands-on activities to use in the classroom, and that participation in iDiscovery professional development improved their teaching and increased their enthusiasm for teaching. Fewer (<74%) agreed that they learned new content (concepts, facts, definitions), multiple ways to assess student learning, or effective questioning techniques.

The professional development (*iDiscovery*) . . .	Strongly Disagree / Disagree	Neither Agree nor Disagree	Agree / Strongly Agree
	N (%)	N (%)	N (%)
enhanced the prerequisite professional development	0	8(16%)	43(84%)
motivated me to implement what I learned in the prerequisite professional development	2(4%)	6(12%)	42(84%)
provided support as I implemented what I learned in the prerequisite professional development	1(2%)	8(16%)	42(82%)

Table 1: Reponses regarding PD after teacher participation in iDiscovery, iDiscovery post-survey, 2011-2013 (taken from Morio & Li 2013)

This evaluation also found that, after participation in an iDiscovery seminar, teachers were significantly more likely to communicate with teachers from a previous professional development institute and to engage in online chats with other teachers about a teaching issue or idea. However, they were not significantly more likely to share teaching plans with colleagues or have colleagues share teaching plans with them. While the reason for the latter finding is unknown, it is possible that while participants in the Institute and iDiscovery did create teaching modules to be posted and shared on-line, teachers do not commonly share teaching plans with each other on a one-to-one basis, and this habit is what was reflected in the response to this question.

B. Change in Knowledge

An increase in strong agreement with statements reflecting increased knowledge of STEM, inquiry based learning, and instructional strategies as a result of the workshop also occurred in cohorts 2-4. However, there was general agreement on the part of participants that they would have liked the opportunity to learn more STEM content during the workshop (between 43% and 52% strongly agreed with this statement; see Figure 3).

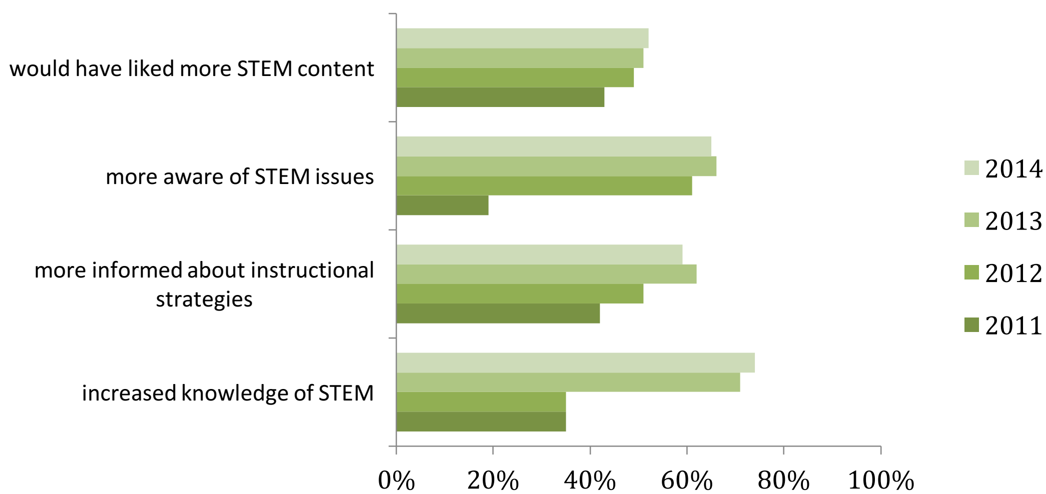

Figure 3. Percentage of participants in Cohorts 2011-2014 who strongly agreed with each statement reflecting change in knowledge (taken from Clasen & Rucks 2014)

C. Change in Teaching Practices

Most participants (50-89%) reported strong agreement with intentions to change their teaching practices (will use the lesson/activity developed in my upcoming classes, will use inquiry-based activities in my classes more often, will use a wider variety of inquiry-based strategies in my classroom) as a result of the Institute (see Figure 4). This finding is particularly pronounced when participants were explicitly asked about their intention to use the lessons/activities developed in the workshop for future classes.

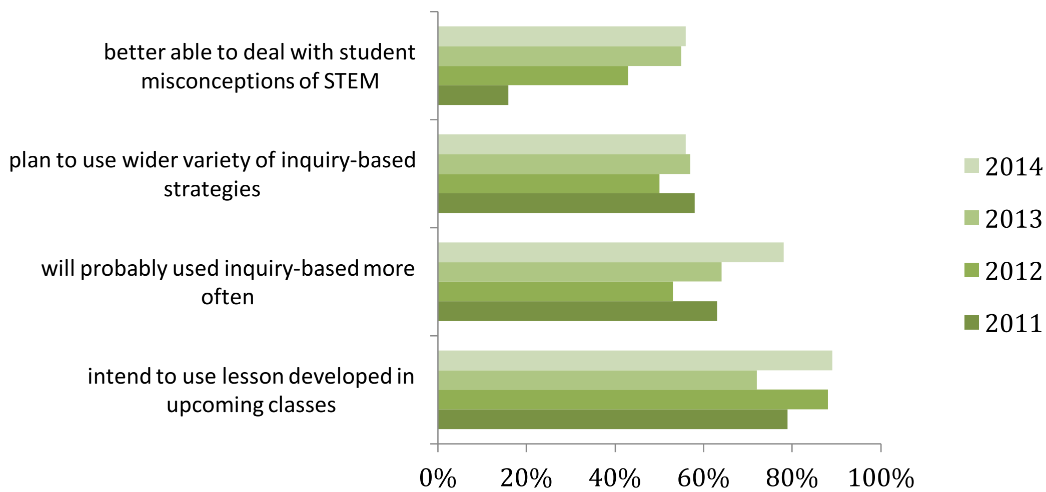

Figure 4. Percentage of participants in Cohorts 2011-2014 who strongly agreed with each statement reflecting intention to change teaching practices (taken from Clasen & Rucks 2014)

To find out what difference the project made for teachers in their knowledge and use of inquiry-based pedagogy, questionnaires given before and after the Institute were analyzed, and limited classroom observation of teachers who had completed the Institute were made. Pre- and post-questionnaires were analyzed for significant changes using ANOVA. Because analysis of all cohorts did not differ significantly from analysis of cohort 4 alone, the analysis discussed and shown in the tables below reflects all cohorts. While results should be viewed with caution because of the small sample sizes completing the post-test, the general trend of the results suggests that teaching knowledge and use of inquiry-based pedagogy did indeed increase.

The pre- and post-workshop questionnaires asked participants about their perceptions of the effect the project had on their knowledge of and ability to teach inquiry based learning and STEM-related issues, their networking with colleagues, and their pedagogical practices. In general, the workshop apparently had the greatest effect in increasing knowledge of STEM and inquiry-based learning and in increasing understanding of skills, standards and techniques. There appeared to be little effect on teachers' frequency of use of various teaching methods, and surprisingly, a decrease in reported networking and sharing with colleagues.

There was a small but statistically significant increase in reported knowledge of STEM and inquiry-based learning, and in ability to deal with student misconceptions of STEM, and a larger increase in reported awareness of STEM issues. Teachers did not report a significant increase in their knowledge of a variety of instructional techniques, presumably because they already felt they were well informed before the workshop (see Table 2).

I . . .	Pre Mean (N = 41)	Post Mean (N = 36)	p-value
Have increased my knowledge of STEM and inquiry-based learning	3.92	4.37	0.026
Am able to deal with student misconceptions of STEM	3.31	4.04	0.002
Am informed about a variety of instructional techniques	4.44	4.52	0.578
Am more aware of STEM-related issues	3.28	4.04	0.006

Table 2. Knowledge of STEM and inquiry-based learning (taken from Clasen & Rucks 2014) (Rated from 1 – "disagree strongly" to 5 – "agree strongly")

There was either virtually no change or a decrease in the frequency with which workshop participants reported interaction and networking with teaching colleagues, a difference statistically significant for four of the seven statements (see Table 3). This result was unexpected, because part of the purpose of the workshop and the follow-on opportunity with iDiscovery was to model and foster networking and sharing among high school STEM teachers. One possibility is that before experiencing the sharing and communication of the workshop and follow-on component, teachers believed that they networked more than they actually did, and reported more accurately post-workshop. Another is that networking among teachers is a long-term behavioral change that is relatively unaffected by a two-week workshop or that will take longer to manifest. Yet still another feasible interpretation is that perhaps teachers perceive module similarly to lesson plans, which are highly individualized. As a consequence, there is not much sharing of this type of material.

I . . .	Pre Mean (N = 41)	Post Mean (N = 36)	- p-value
In general maintain contact with teachers from other previous professional development workshops	2.71	2.07	0.024
Communicate with instructors/faculty from a previous professional development institute	2.79	2.41	0.261
Share inquiry-based learning teaching plans with my colleagues	3.84	3.41	0.072
Have colleagues share inquiry-based learning teaching plans with me	3.65	2.89	0.009
Participate in online chats about inquiry based teaching issues	1.68	1.78	0.725
Am interested in networking with teachers and other professionals about inquiry-based learning	4.05	3.15	0.000
Receive feedback from other teachers about inquiry-based learning instructional issues in a timely manner	2.73	2.12	0.048

Table 3. Interaction and sharing with teaching colleagues (taken from Clasen & Rucks 2014) (Rated from 1 – “almost never” to 5 – “very often”).

While participants reported using inquiry-based teaching methods slightly more often after the workshop, for only one method (having students share/perform experiments and/or problems to confirm results or interpretations) was the increase significant (see Table 4). Activities reported most often both pre- and post-workshop were using evidence to justify responses, using a variety of resources for learning, making connections with previously learned concepts, and asking questions that lead to deeper discussion or further investigation. The teaching method least frequently used was requiring students to reach works by mathematicians and scientists. Frequency of use of listed teaching methods may have been impacted by other factors. For instance, in focus groups conducted as part of the external evaluation by the Evaluation and Assessment Center teachers cited a conflict between the time that inquiry-based instruction takes and the pressure to prepare students for success in testing as quickly as possible (Morio & Li, 2013).

I have my students . . .	Pre Mean (N = 41)	Post Mean (N = 36)	p-value
Use evidence to justify responses	4.18	4.42	0.197
Debate or discuss the interpretation of data, texts, and accepted ideas	3.61	3.81	0.409
Design activities to test their own ideas	3.03	3.30	0.329
Use interactive online simulations or activities	3.16	3.37	0.534
Discuss subject-specific ideas among themselves	3.50	3.81	0.218
Read works of mathematicians and scientists	2.30	2.44	0.639
Use resources outside of the classroom to facilitate learning	3.39	3.41	0.964
Work at their own pace	3.58	3.41	0.552
Seek real-life applications of concepts	3.84	3.93	0.775
Use a variety of resources for learning	4.05	4.33	0.155
Explore higher-order problems before mastering the basics	3.13	3.48	0.252
Share/perform experiments and/or problems to confirm results or interpretations	3.05	3.78	0.006
Make connections with previously learned concepts	4.37	4.52	0.353
Ask questions that lead to deeper discussions or further investigation	3.97	4.19	0.313

Table 4. Teaching methods (from Clasen & Rucks 2014) (rated 1 -5, almost never to very often)

Teachers reported significant increase in comfort in using inquiry/problem solving-based instruction. There was also significant improvement in understanding how to relate classroom activities to Ohio's academic standards, how to assess student learning in multiple ways, and of the methods necessary to teach mathematics and science concepts correctly (see Table 5).

I . . .	Pre Mean (N = 41)	Post Mean (N = 36)	p-value
Have a good understanding of the fundamental core content in science and/or math of the subject(s) I teach	4.18	4.59	0.074
Am comfortable using inquiry-based/problem- solving based instruction	3.95	4.44	0.013
Implement the skills and knowledge mastered during face-to-face professional development programs	3.97	4.11	0.444
Have a good understanding of relating classroom activities to Ohio's Revised Academic Standards	3.50	4.11	0.016
Have a good understanding of how to assess student learning in multiple ways	4.11	4.54	0.038
Have a good understanding of effective questioning techniques and their use in the classroom	4.11	4.37	0.168
Have a good understanding of the methods necessary to teach mathematics and/or science concepts correctly	3.57	4.35	0.003

Table 5: Understanding of skills, standards, and techniques (taken from Clasen & Rucks 2014) (Rated from 1 – "strongly disagree" to 5 – "strongly agree")

It was possible to directly observe a few classroom sessions performed by teachers who had participated in the Institute, using a modified version of the Reformed Teaching Observation Protocol (R-TOP). It should be noted that classroom observations were not part of the original memorandum of understanding for the project and therefore, requests to observe teachers in the classroom were agreed to only through the goodwill of the participating teachers.

The R-TOP consists of five subscales that measure three dimensions of the classroom experience: lesson plan and implementation, content (propositional and procedural knowledge), and classroom culture (communicative indicators and student/teacher relationships). Each of the 25 items of the R-TOP are scored on a Likert scaled from "0 – never occurred" to "4 – very descriptive," yielding a possible high score of 100.

Observation occurred in three classrooms: one in chemistry, one in math, and one in physics. Of the three, the chemistry classes scored lowest on the R-TOP (44 out of a possible 100) while the math and physics classes scored 76 and 71, respectively. The chemistry class may have scored lower because on the day of observation, the students were doing an observation lab, in which the teacher demonstrated the effects of water on highly reactive metals. Though the lesson was not inquiry based, the observer reported that the students were fully engaged in the lesson and demonstration. In the physics class, which covered the independence of horizontal and vertical motion, students calculated when they needed the drop a raw egg from the top of the bleachers to score a direct hit on the head of the (poncho covered and helmet wearing) teacher walking below. In the pre-calculus honors math class, students worked in teams and were responsible for discovering definition of terms and how to perform assigned problems. The teacher primarily kept track of how fully each student was participating in the problem solving, intervening only if difficulties were detected.

V. Future Considerations

While this current project has ended ending, individuals who are interested in building on the success of this project may consider how the next iteration of this project would look. The findings from this project suggest that professional development targeted at additional aspects of inquiry-based learning pedagogy would be beneficial. Inquiry-based learning involves many different components such as the incorporation of modules that lend themselves to being inquiry based, engaging students in debates, allowing students to design their own experiments, etc. The focus of the current project was primarily on the development and incorporation of inquiry-based modules. Results from the project found that teachers are implementing the experimentation component of inquiry-based learning into their lesson plans, which is consistent to the module development focus of the Institute. Providing teachers with strategies to engage other aspects of inquiry-based learning would provide additional ways to enhance the learning experience for students.

Acknowledgement

This work was funded by the National Science Foundation's Advanced Technological Education (ATE) Program, Grant #1003048.

REFERENCES

Clasen, C. and Rucks, L. (2014). Warren County High School STEM Teacher Synergistic Institute, Sinclair Community College: Final Internal Evaluation (2011 – 2014). Dayton, OH: The Rucks Group (unpublished).

Dayton Daily News (2003). Sinclair, Warren County Engage in Expansion Talk: College Officials Weigh Pros and Cons. *Dayton Daily News.* January 26, 2003.

Harwell, Sandra H. (2003). *Teacher Professional Development: It's Not an Event, It's a Process.* CORD 2003.

iDiscovery: www.idiscovery.org

Leyman, Mary Beth (2008). Population Key to Warren County's Industrial Growth. *Dayton Business Journal.* July 18, 2008.

McDermott, L.C. (1990). A perspective in teacher preparation in physics and other sciences: The need for special science courses for teachers. *The American Journal of Physics* **58**, pp. 734-742.

Morio, K.L. and Li, Yi. (2013). Report of teacher reflections on the STEM Teacher Synergistic Institute, Oxford, OH: Miami University, Ohio's Evaluation and Assessment Center for Mathematics and Science Education (unpublished).

Ohio Department of Job and Family Services (2009). *2009 Economic Analysis.* Bureau of Labor Market Information, July 2009.

President's Council of Advisors on Science and Technology (2010). Prepare and Inspire: K – 12 Science, Technology, Engineering, and Math (STEM) Education for America's Future. Retrieved from http://edit.whitehouse.gov/sites/default/files/microsites/ostp/pcast-stem-ed-final.pdf.

Sinclair Community College, Courseview: https://www.sinclair.edu/courseview/about/history/

Sinclair Community College (1996). *A Structured Approach to Competency-Based Curriculum Development.* Dayton, OH. Sinclair Community College.

Stigler, James W. and Herbert, James (1999). *The Teaching Gap.* New York: Free Press.

Supovitz, J.A., Mayer, D.P, and Kahle, J.B. (2000). Promoting inquiry-based instructional practice: The longitudinal impact of professional development in the context of systemic reform. *Educational Policy* **4**, pp. 331-356.

.

About the Authors:

Authors:

1. Jennifer Blue

Terminal Degree: PhD
Mailing address: 217 Kreger Hall, 500 E Spring Street, Oxford, OH 45056
E-mail address: bluejm@miamioh.edu
Business phone number: 513-529-1380
Home phone number (cell): 513-593-3220
Institutional Affiliation: Associate Professor, Physics, Miami University
Short Biographical Sketch: Jennifer Blue is an Associate Professor of Physics at Miami University, with a particular interest in getting more people, particularly those from traditionally excluded groups, into science. Before becoming a professor she was a high school teacher.

2. Lana Rucks

Terminal Degree: PhD
Mailing address: 714 E. Monument Avenue, Suite 222, Dayton, OH 45402
E-mail address: lrucks@therucksgroup.com
Business phone number: 937-242-7024
Institutional Affiliation: Principal Consultant, The Rucks Group
Short Biographical Sketch: Lana Rucks is the founder and Principal Consultant of The Rucks Group, an applied social science research firm. Before founding her own firm, she worked as an adjunct faculty member of Sinclair Community College.

3. Charles Setterfield

Terminal Degree: Master of Architecture (M. Arch.)
Mailing address: 444 West Third Street, 11-432, Dayton, OH 45402
E-mail address: charles.setterfield@sinclair.edu
Business phone number: 937-512-2298
Home phone number (cell): 937-313-8993
Institutional Affiliation: Associate Professor, Architectural Technology, Sinclair Community College
Short Biographical Sketch: Charles Setterfield is an Associate Professor of Architectural Technology at Sinclair Community College in Dayton, Ohio. Before joining the faculty, he worked as a professional architect for eighteen years.

Understanding the Decision Making of First Year Teachers in Ohio Regarding Literacy Instruction and Policy

Amy Mullins, Ph.D., Kathryn Ohle, Ph.D. & Andrew Huddleston, Ph.D.

.
.

* Correspondence:
Dr. Amy Mullins.
Bluffton University
1 University Drive
Bluffton, Ohio 45817
mullinsa@bluffton.edu
419-358-3457
Full list of author information is available at the end of the article

Abstract:

First year teachers encounter and negotiate many influences when making decisions concerning teaching and assessing reading, including district and local policy. Often, as a result, many first year teachers, abandon, limit or modify much of what they learned regarding teaching and assessing reading, from their teacher education programs. This qualitative study examines the decision making of first year teachers regarding literacy instruction and policy.

INTRODUCTION

Researchers have demonstrated that beginning teachers' decisions regarding assessment and instruction are the result of a complex combination of influences consisting of childhood experiences with school, teacher training programs, and current teaching environment (Flores & Day, 2006), as well as their access to mentors (Achinstein, 2012; Olebe, 2001), personalized professional development (Anderson & Olsen, 2006), professional learning communities (Coburn, 2001), and alternative forms of assessment (Kuh & Nelson, 2014). Teachers draw on various personal, professional, and practical funds of knowledge to inform their instruction (Goldstein, 2008; Grisham, 2000,). However, as beginning teachers consider these influences and make decisions concerning assessments they must negotiate a misalignment that often occurs with policy and teacher education program outcomes (DeLuca & Bellara, 2013).

Teacher education programs do make a positive difference in the instructional decisions beginning teachers make (Bauml, 2011; Grisham, 2000; Hoffman et al., 2005; Maloch et al., 2003). McGee and Colby (2014), for example, indicated that teacher candidates' assessment literacy showed statistically significant growth after completing a required assessment course. However, the conditions and degree of the influence of teacher education programs depend on a variety of factors. Some first-year teachers adopt, modify, imitate, or avoid the practices they learn about in teacher education programs (Bauml, 2011). The quality and depth of teacher education programs matter. Maclellan (2014) showed that some novice teachers' knowledge of assessments is underdeveloped. However, those who graduate from excellent programs are more effective in creating and maintaining a high-quality literacy environment than those who do not (Hoffman et al., 2005). Furthermore, Maloch et al. (2003) found that preservice teachers who received a specialization in reading were more likely to make instructional decisions based on their knowledge of students' needs than on dictated requirements in packaged programs. Graduates who teach in schools whose philosophies are congruent with those they learned about in their teacher education programs are more likely to implement the methods they learned about (Deal & White, 2005; Grisham, 2000) as well.

Several studies have found that beginning teachers tend to implement more of what they learn in teacher education programs in their second year, after concerns about classroom management and parental communication have subsided (Deal & White, 2005; Grisham, 2000; Massey, 2006). Indeed, Fantilli & McDougall (2009) found in their study of 54 teachers in their induction years that fifteen different challenges were identified, few of which were even related to implementation practices. However, Kelly (2004) suggested that induction programs support novice teachers' growth in many areas including assessment literacy. Thus, working theories and practices of preservice teachers change in the actual implementation in mentored learning environments. Albeit, limitations created by state and district policies, adopted programs, and high-stakes testing can be a barrier for beginning teachers who wish to implement instructional practices learned in programs (Deal & White, 2005; DeLuca & Bellara, 2013; Grisham, 2000).

The purpose of this qualitative study is to examine the following questions: How do new teachers make decisions about the literacy assessment and instructional practices they use in their classrooms? What role do local, state, and federal policies play in these decisions? To what extent do new teachers implement the assessment and instructional practices they learned about in their teacher education programs?

Method

This is a qualitative study that was conducted by three researchers from different states Texas, Alaska and Ohio. Each researcher recruited 4-5 participants that had recently graduated from their university and was employed at an elementary school. We collected data in three forms: interviews, observations, and documents. Each participant was interviewed 3-4 times throughout the school year using semi-structured life world interviews (Kvale & Brinkmann, 2008). Several of the administrator were interviewed once. The interviews were approximately an hour in length and were audio recorded and transcribed. Additionally, we observed each teacher's reading instruction and assessment 3-4 times throughout the school year. Field notes were taken at each observation.

In addition to interviews and observations, we collected a variety of documents pertinent to our research questions (McCulloch, 2004). This included items such as lesson plans, assessments, policy statements, etc. Lastly, the teachers in the study kept a journal throughout the year that they wrote in on a monthly basis. The journals included some suggested prompts as well as free writing.

We collected the data and analyzed it using the constant comparative method (Charmaz, 2006). This consisted of coding the data to identify recurring themes. These themes were defined and collapsed into more focused categories that were then used to code the remaining data. Each researcher created a codebook providing a name, description, and example of the major categories (Tracy, 2013). These initial analysis informed the remaining data was collected. Second, we compared the key findings and wrote memos to explore similarities, differences, and recurring themes. Finally, we used Bourdieu's (1972/1977) concepts of field, capital, and habitus to further analyze and then theorize the categories developed through the constant comparative method. This analysis consisted of three steps: (a) analyzing the field of education in which these teachers work (b) mapping the various capital that these teachers bring to their teaching, and (c) analyzing the responses (habitus) of the teachers as they make decisions regarding reading assessment and instruction in their classrooms (Bourdieu & Wacquant, 1992).

Participants

There were thirteen first year teachers that participated in this study. Each of the participants were Early Childhood through Grade 6 majors in each of the our teacher education programs. This included 5 participants form Texas, 4 from Alaska and 4 from Ohio. The participants had graduated in December or May and were hired to begin teaching in the following August. In addition, participants who obtained teaching jobs within easy driving distance of our universities and who expressed an interest in participating in the study were recruited. In addition to teacher participants, instructional leaders such as the school principal, served as participants as well to help us better understand any school, district, state, and/or federal policies that inform the literacy assessment and instruction required in the schools in which the participants teach.

Four of the participants were first year teachers in Ohio. They all graduated from their teacher preparation programs in May and obtained employment the following August in elementary classrooms. All four of the participants were females Caucasians. In addition, all four were traditional students in their early twenties.

Setting

The participants in Ohio all taught in Pre-kindergarten through grade 6 buildings located in the rural Midwest. Two of the buildings facilitated around four hundred students. The other 2 buildings facilitated one-hundred to one-hundred and twenty students. The buildings that facilitated around four hundred students there were three sections of students per most grade levels. In the less populated buildings there was only one section of students per grade level. The participants that taught in the larger buildings had access to literacy coaches and title one teachers. The participants that instructed in the less populated buildings did not have access to literacy coaches or title one teachers. All but 1 of the Ohio participants engaged in the Resident Educator program.

Findings

As previously stated this is a qualitative study that includes participants from three states Texas, Alaska and Ohio. Though the findings are similar across the three states, this article will focus on the findings from the participants in Ohio. As teacher educators we are quite familiar with the challenges of making long-lasting impressions upon our preservice teacher candidates. Having been socialized to expect classrooms to look and operate in certain ways (Bourdieu & Passeron, 1970/1977), our teacher candidates often readily what their schools or districts provide with little thought or reflection. Bourdieu (1972/1977) referred to this phenomenon as habitus, the process of in which the objective structures of a social field are transformed onto the subjective structures of agents' thoughts and actions.

Schools are social fields with rules and requirements that teachers and other para-professionals accept unknowingly and thus dictate the decisions that they make in the classroom. Our findings indicate that teachers' decision-making has been largely impacted by district-wide requirements such as mandated curriculum and assessment measures. Mellissa, a teacher in Ohio said, "We have started a district mandated phonemic awareness program. We go through these three page premade lesson plans daily. I do not like the way we are asked to teach reading, because it is not hands-on enough." All the participants in Ohio indicated that they follow a curriculum maps and pacing guides. Several participants suggested that they include strategies learned during their teacher preparation once they have implemented district mandated curriculum. Most participants openly accepted district mandated curriculum and assessment requirements and expressed little uneasiness in following them, largely assuming that this is what real teaching was all about, a process that Bourdieu (1972/1977) referred to this as a doxic relationship. However, a teacher in Ohio expressed concerns regarding the literacy curriculum that she was required to implement. This led to more frustration and the teacher found employment in a different district the following year.

In addition to district wide requirements, we found that peer collaboration was largely influential in new teachers' decisions regarding literacy instruction and assessment. All of the Ohio participants indicated that they participated in district wide and grade level team meetings in which they collaborated to make decisions regarding instruction and assessment. For example, Arlene stated, " Our group meets once a week, and we plan everything, so we have streamlined pretty much that we all do the same thing." All the teachers expressed that they found the time scheduled for collaboration helpful. However, they did not find mandated day long meetings for the Resident

Educator helpful. One teacher found it overwhelming to leave the classroom for the day and suggested that the meetings were not beneficial.

The extent to which these new teachers were able to use the capital obtained in their teacher educator programs largely depended on the context in which they found themselves teaching. Some new teachers received jobs in districts that offered little support for those methods. For example, Lauren, a first grade teacher was required to implement a reading program that did not align with her teaching philosophy and was told not to supplement it with other resources. She stated, "I do not agree with this type of teaching, the children sit in their seats in their seats for over an hour while I teach phonics rules and assess them. I ask the principal questions about the program, and she gets defensive."

Some new teachers, however, received jobs in environments that actually supported methods learned in their teacher education programs. One teacher in Ohio taught in a district that had adopted Fountas and Pinnell (2010) balanced literacy framework. This program emphasizes many of the approaches learned in her teacher preparation program. Sarah explained, "I have a great team and when they said that they implement the Fountas and Pinnell framework, I said, oh I know that already." The congruence between the concepts learned in their teacher education program and the expectations of their new teaching context enabled these teachers to solidify and strengthen these instructional practices.

Discussion

In a time when teacher education is under fire, this area of study is of increasing importance. Understanding how new teachers are making decisions about policy and in particular, reading instruction, provides some insight regarding what role teacher education may or may not play in their decision-making. While some research indicates that teacher education may influence new teachers' decision-making (Bauml, 2011; Grisham, 2000; Hoffman et al., 2005; Maloch et al., 2003), especially if they have come from a high-quality program (Hoffman et al., 2005), it also indicates that there are many factors of influence in these new teachers' professional lives that we in teacher education cannot control, including their contexts (Deal & White, 2005; Flores & Day, 2006), their districts' policies, the curriculum materials they are provided (Valencia et al., 2006), and their access to mentorship, professional development, and formal induction programs (Achinstein, 2012; Anderson & Olsen, 2006; Kelley, 2004; Olebe, 2001). It also indicates that much work still needs to be done, especially as we look at how new teachers specifically navigate through reading instruction and assessment policies.

REFERENCES

Achinstein, B. (2012). New teacher and mentor political literacy: Reading, navigating and transforming induction contexts. *Teachers and Teaching: Theory and Practice*, 12(2), 123-138.

Anderson, L., & Olsen, B. (2006). Investigating early career urban teachers' perspectives on and experiences in professional development. *Journal of Teacher Education*, 57, 359-377.

Bauml, M. (2011). “We learned all about that in college”: The role of teacher preparation in novice kindergarten/primary teachers’ practice. *Journal of Early Childhood Teacher Education*, 32, 225–239. doi:10.1080/10901027.2011.594701

Bourdieu, P. (1977). *Outline of a theory of practice*. Cambridge, England: Cambridge University Press. (Original work published 1972)

Bourdieu, P., & Passeron, J. C. (1990). *Reproduction in education, society and culture*. London, England: Sage.

Charmaz, K. (2006). *Constructing grounded theory: A practical guide through qualitative analysis*. London, England: Sage.

Coburn, C. E. (2001). Collective sense making about reading: How teachers mediate reading policy in their professional communities. *Educational Evaluation and Policy Analysis*, 23, 145-170.

Deal, D., & White, C. S. (2005). Evolving influences and beliefs of two novice literacy teachers: The third year of a longitudinal study. *Action in Teacher Education*, 27(2), 54–67.

DeLuca, C., & Bellara, A. (2013). The current state of assessment education: Aligning policy, standards, and teacher education curriculum. *Journal of Teacher Education*, 64, 356-372. http://doi.org/10.1177/002247=87113488144

Fantilli, R. D., & McDougall, D. E. (2009). A study of novice teachers: Challenges and supports in the first years. *Teaching and Teacher Education*, *25*, 814-825.

Flores, M. A., & Day, C. (2006). Contexts which shape and reshape new teachers’ identities: A multi-perspective study. *Teaching and Teacher Education*, 22, 219–232. doi:10.1016/j.tate.2005.09.002

Fountas, I. C., & Pinnell, G. S. (2010). *The continuum of literacy learning, grades preK-2: A guide to teaching (2nd ed.)*. Portsmouth, NH: Heinemann.

Goldstein, L. S. (2008). Kindergarten teachers making "street-level" education policy in the wake of No Child Left Behind. *Early Education and Development*, 19, 448-478.

Grisham, D. L. (2000). Connecting theoretical conceptions of reading to practice: A longitudinal study of elementary school teachers. *Reading Psychology*, *21*, 145–170.

Hoffman, J. V., Roller, C., Maloch, B., Sailors, M., Duffy, G., & Beretvas, S. N. (2005). Teachers' preparation to teach reading and their experiences and practices in the first three years of teaching. *Elementary School Journal*, *105*, 267–287.

Kelley, L. M. (2004). Why induction matters. *Journal of Teacher Education*, *55*, 438-448.

Kuh, L., & Nelson, C. (2014). Navigating policy and trying out new ways of teaching: Teachers and children becoming experts. *New Educator*. 10(1), 62-69.

Maclellan, E. (2004). Initial knowledge states about assessment: Novice teachers' conceptualizations. *Teaching & Teacher Education: An International Journal of Research and Studies*, *20,* 523-535.

Maloch, B., Flint, A. S., Eldridge, D., Harmon, J., Loven, R., Fine, J., … Martinez, M. (2003). Understandings, beliefs, and reported decision making of first-year teachers from different reading teacher preparation programs. *Elementary School Journal*, *103*, 431–457.

Massey, D. D. (2006). "You teach for me; I've had it!" A first-year teacher's cry for help. *Action in Teacher Education*, *28*(3), 73–85.

McGee, J., & Colby, S. (2014). Impact of an assessment course on teacher candidates' assessment literacy. *Action in Teacher Education*, *36*, 522-532.

Olebe, M. (2001). A decade of policy support for California's new teachers: The beginning teacher support and assessment program. *Teacher Education Quarterly, 28*(1)*,* 71-84.

Tracy, S. J. (2013). *Qualitative research methods: Collecting evidence, crafting analysis, communicating impact*. Chichester, West Sussex, UK: Wiley-Blackwell.

Valencia, S. W., Place, N. A., Martin, S. D., & Grossman, P. L. (2006). Curriculum materials for elementary reading: Shackles and scaffolds for four beginning teachers. *The Elementary School Journal*. 107, 93–120. doi:10.1086/509528

About the Authors:

Amy Mullins, Ph.D.
1 University Drive
Bluffton University
Bluffton, OH 45817-2104
mullinsa@bluffton.edu
Office: 419-358-3457

Biographical Sketch:
Dr. Mullins teaches both graduate and undergraduate courses at Bluffton University. Her research includes phonics instruction, incorporating global competence into classroom instruction and how novice teachers make decisions regarding literacy instruction. She is a frequent presenter at international conferences and has several publications. In addition, Dr. Mullins has served as a consultant for the Asia Society's International Study Schools Network.

Kathryn Ohle
Assistant Professor of Education
University of Alaska Anchorage

Biographical Sketch:

Dr. Kathryn Ohle is an Assistant Professor of Early Childhood Education at the University of Alaska Anchorage. A former kindergarten teacher, she earned her PhD at the University of North Carolina Chapel Hill. Kathryn teaches literacy, math, and science methods courses to undergraduates; her research interests are in education policy and supporting early career teachers. She also works on projects that help revitalize Alaska Native languages using children's books.

Andrew Huddleston
Assistant Professor of Education
Abilene Christian University

Biographical Sketch:
Dr. Andrew Huddleston is an assistant professor of education at Abilene Christian University. He teaches undergraduate courses in literacy. His research interests are in education and policy.

New Trends in Marine Science Teaching: Leveraging Ocean Literacy Principles as a framework for delivering concept learning in a cyber-driven classroom.

Gwynne S. Rife, PhD and Jon Brasfield PhD, .

.

* Correspondence:
Dr. Gwynne Rife.
University of Findlay
College of Education
1000 N Main Street
Findlay, Ohio 45840
rife@findlay.edu
419-434-4724
Full list of author information is available at the end of the article

Abstract:

With global changes taking place to our world oceans, there is a demand for both well-trained scientists and environmental educators who can offer learners a framework for understanding the connectedness of the oceans. The need is crucial for the next generation of citizens who will continue to face challenges related to a changing ocean as part of a changing planet. In NW Ohio, a landlocked state in the United States, there is as much a need for citizens to connect with the global oceans as a scientist working on tropical atoll. To be stewards of a global resource, all global citizens should feel they have a part in being stewards of the oceans. For the past three decades, many university students have been experiencing their connection through university level coursework in a novel and cyber-driven way. Using the Ocean Literacy Principles as a framework, pre and post testing revealed that a cyber-driven, open ended, discovery-based method of course delivery significantly ($p < .001$) increased understanding of the World Ocean and scientific concepts by over a standard deviation across all standards.

INTRODUCTION

With global changes taking place to our world oceans, there is a demand for both well-trained scientists and environmental educators who can offer learners a framework for understanding the connectedness of the oceans. The need is crucial for the next generation of citizens who will continue to face challenges related to a changing ocean as part of a changing planet (Cortese, 1992; Kilduff, 2008). Formal academic programs and informal educators have overwhelming evidence that they must provide more than knowledge of marine science, but problem-solving ability and deeper concept understanding (Alexander, 1992; Baden 2000; Yarroch, 1985; Linn, 1987). Future earth scientists and professionals need to be armed not only with knowledge, but the skills and dispositions to be successful (Carnevale, Smith, & Strohl, 2010; Cook & King, 2004; Wellman et al, 2008).

Recently, teams of scientists, educators and discipline specialists have worked to produce a set of literacy standards for K -12 in multiple areas of Earth Science (Barclay et al, 1999; Chang, Chun-Yen et al, 2007), Ocean Literacy (Cava et al, 2005; Strang & Schoedinger, 2007), Climate literacy (McCaffrey & Buhr, 2008; Cooper, 2011; Harrington, 2008; Dupigny-Giroux, 2008), Energy Literacy (Barrow and Morrisey, 1989; DeWaters & Powers, 2008; Waters & Powers, 2011; DeWaters,Powers, and Graham, 2007; DeWaters & Powers, 2009; DeWaters, 2009; DeWaters & Powers, 2009), and Environmental Literacy Frameworks are also available for guidance (Cole, 2007). Educators (with specialties such as Earth Science, Ocean Science, Environmental Science, and Atmospheric science and now Geoscience, also inclusive of environmental education and stewardship) have a foundation that is global and based on a large scale knowledge base. Because there is so much science to integrate, educators need a framework of knowledge, and a shared group of understandings that concept and models can be based upon. The content support is accessible for most learners through the cyber environment by accessing the Internets or using other media driven means to provide in-depth knowledge with relative ease. The literacy documents serve to focus and structure this cyber environment in ways that allow application of the knowledge to real world understanding and problem solving.

Table 1. Literacy guiding areas for support of formal and informal marine science education

Standard	Sub-criterion	Website
Environmental Literacy	3 areas	http://www.naaee.net/framework
Science Literacy	12 Benchmarks	http://www.project2061.org/publications/bsl/default.htm
Earth Literacy	9 Big Ideas	http://www.earthscienceliteracy.org/
Climate Literacy	7 Principles	http://cleanet.org/cln/climateliteracy.html
Ocean Literacy	7 Principles	http://oceanliteracy.wp2.coexploration.org/
Energy Literacy	7 Concepts	http://www1.eere.energy.gov/education/energy_literacy.html

There is a consensus among researchers that teacher quality matters enormously for science student performance (Hanushek, 1997, 1989; Cochran-Smith, 2003; Lynch, 2001). Students taught by more-effective educators learn substantially more over the course of the year than students taught by less-effective educators (Whitehurst, 2002; Boyd et al, 2006; Goldhaber & Anthony, 2007; Desimone et al, 2002; Rivkin, Hanushek, & Kain, 2005; Everston & Emmer, 1982). Without the frameworks provided by the literacy principles, educators often turn to overall science standards that often are too broad or lack a specific focus for documenting learner outcomes.

Most research on educator effectiveness has focused on teacher attributes, finding that readily measurable characteristics such as experience, certification or licensure, and graduate degrees generally have little impact on student achievement (Clotfelter, Ladd & Vigdor, 2007; Aaronson, Barrow, & Sander 2007; Hanushek & Rivkin, 2006; Boyd et al, 2008; Pascarella, 1980). Relatively few rigorous studies look inside the classroom to see what kinds of teaching styles are the most effective. Even fewer studies investigate the retention of knowledge about specific disciplines once a course or school year has ended. An additional lack of research is in relation to cyber driven learning, with few documented examples of best practice methods.

Effective marine science education, like any science instruction, requires an instructor or informal educator to understand and be responsive to a variety of student learning styles and to be willing to use new and innovative methods of teaching that recognize these various styles (Blasé & Blasé, 2003; Grow, 1991; Jaskyte, Taylor, & Smariga, 2009; Gibson, 2001) and also to identify Best Practice science teaching (Semken & Freeman, 2008; Karukstis & Elgren, 2007; Arrowsmith, Counihan, & McGreevy 2005; Zhu, 2007; Feig, 2011) which identifies using problem-based and inquiry-based teaching methods to address the needs of a range of student learning styles.

Problem-based learning involves students being supplied with a problem or real world scenario to investigate or address through the process of locating appropriate resources, analyzing and synthesizing data and communicating the results. This type of learning experience often occurs in small group format and can occur in both the lecture and lab setting, but can be facilitated by use of the online environment as well. In some cases, global concept can best be shared by use of technology and multimedia presentations.

Inquiry-based learning involves students creating research questions, locating resources to address the questions, communicating the results of their investigation and evaluating their results. This type of learning can be introduced in the classroom by delivering lectures as a series of questions, by conducting in-class debates and small group exercises. One type of inquiry-based lab exercise used in a first year course involves the creation of research questions on a particular topic (e.g. earthquakes) and written answers to those questions. Independent research projects conducted by senior undergraduate students are also considered as inquiry-based learning exercises.

The many advantages of incorporating innovative methodologies in marine science teaching include enhanced student participation and retention of material learned, increased opportunities for students to apply their own learning styles, development of self-confidence and instructor engagement and development (see Table 3).

In Northwest Ohio, a landlocked state in the United States, there is as much a need for citizens to connect with the global oceans as a scientist working on tropical atoll. To be stewards of a global resource, all global citizens should feel they have part in being stewards of the oceans (Smith, Barber, Duguay and Whitley, 2012). For the past three decades, many university students have been experiencing their connection through university level coursework in a novel way. When the course titled "Oceanus" was first offered in 1980, it was described as a "tele-course". The popularity of this course rapidly grew as part of a state universities' offerings, and its interdisciplinary focus was especially new in the 1980's. Students did not only experience a "sage on the stage," teacher-centered lecture but also viewed a series of television shows broadcast through the campus public service station. Twice a week, 30 minutes shows swept the landlocked students to coastlines, the deep sea, the tropics, and to marine science institutions such as Woods Hole oceanographic and Scripps institution of oceanography. Students in the marine science course would hear from significant marine scientists including Willard Bascom, Syliva Earle, and others about a variety of scientific endeavors related to the global ocean.

As the technology moved on, the tele-series went to VHS tapes, CD-ROM, DVD and finally streaming video delivered through an Learning Management System (LMS) in a fully online classroom. With a revision of the video series in the late 1990s, the course continued to be relevant and focused offering a cross-disciplinary and basic set of understandings of the physical, biological, and human related topics of the global ocean as a resource. The current series, titled "the Endless Voyage" continues to transport students to famous scientists and ocean environments virtually.

As a course offering, this course with its myriad topics and effective format for delivery became an ideal type of science general requirement. The scope and breadth of the course allowed multiple science disciplines to be introduced with basic understandings in place. The thematic nature of marine science makes this an ideal format for enhancing the science literacy of the students who experience it.

It is not enough to assume that students are becoming more proficient in their learning, but the same reason that makes the oceans a good topic to focus in an integrated science course, makes a marine science course difficult to assess from a general viewpoint. What was missing for years was a framework to use that would identify major understandings gained from experiencing this learning.

The ocean literacy framework, while designed for K – 12 audience, summarizes the baseline literacy accepted for a citizen to attain. Consider the 7 Principles:

Ocean Literacy is an understanding of the ocean's influence on you - and your influence on the ocean.

- Standard 1. The Earth has one big ocean with many features. (8 sub standards)
- Standard 2. The ocean and life in the ocean shape the features of the Earth. (5 sub standards)
- Standard 3. The ocean is a major influence on weather and climate. (7 sub standards)
- Standard 4. The ocean makes Earth habitable. (2 sub standards)
- Standard 5. The ocean supports a great diversity of life and ecosystems. (9 sub standards)
- Standard 6. The ocean and humans are inextricably interconnected. (7 sub standards)
- Standard 7. The ocean is largely unexplored. (6 sub standards)

Each of these 7 principles have a set of sub standards that can be assessed as outcomes. There is a need for research models that use the ocean literacy principles to determine the best ways to use this framework to inform and enhance understanding of the planets greatest physical feature and it connectedness to all global citizens.

Methods:

Pre- and post-tests were designed with 44 items (one for each substandard) and delivered to course participants in a natural science general education course at a small landlocked private university over a 3-year period (August 2012 thru August 2015). 20 sections of the course, yielding 438 completed pre- and post-tests, were used to track the increased learning for students.

The course, delivered 100 percent online, was asynchronous and designed around the idea of best practice science instruction modeled on the 5E system for inquiry and concept acquisition (Bybee, 1997). Since the course was delivered to both science and non-science majors, assignments and course design was scaffolded to move the learners toward greater understanding regardless of where their content knowledge was at the point of entry into the course.

The first task for students was to take the 44 item pre-test (plus 6 opinion or demographic responses), then each learning sequence included this structure:

Students viewed a video from the series The Endless Voyage (approx. 30 minutes) after doing brief introductory activity and course reading. The videos could be watched as many times as the student desired. Students then experienced an audio driven instructor designed multimedia presentation (PowerPoint) including key content points. Next students were directed to take an assignment comprised of 5 open ended questions per Module topic/Video topic. Then, using a content textbook and internet research they responded to questions with different levels of questioning following the 5E philosophy (see Table 2).

Table 2 – A brief explanation of the 5E philosophy of science instruction (Bybee, 1997) and the assessment focus for assigned questions

Engage	Question used to engage students.
Explore	Question used to direct students to explore the general topic through multi-media, textbook, lecture, and internet survey.
Explain	Questions used to require students to explain their understanding of concepts and processes and new concepts and skills are introduced as conceptual clarity and cohesion are sought.
Elaborate	Questions require students to synthesize and apply knowledge to concepts in contexts, and build on or extend understanding and skill.
Evaluate	Questions encourage students assess their knowledge, skills and abilities and offer their personal perspective on current real world issues.

Twenty-six learning segments organized into 7 modules, each with a disciplinary theme (Module 1: World Ocean and Historical Perspectives Module 2: Geology of Ocean and Basins Module 3: Tides, Waves and Currents Module 4: Earth Systems Module 5: Ecosystems Module 6: Life in the Oceans Module 7: Human Impacts on the oceans) are delivered. Periodically through the course, different additional support and activities are offered including opportunities for student to interact in the discussion/Chat areas or respond to mystery bonus questions. At the end of the Modules, the post test was delivered (same 44 items plus 6 different opinion and culminating questions) is the final course tasks.

Results:

The test responses were analyzed to determine performance. Additionally, students were asked to submit an image to summarize their current feelings at the completion of the course, and a brief statement about what they remembered most. The images were categorized and tied to the principles to determine the areas most selected or focused on.

Table 3. Ocean Literacy Standards and percentage of correct responses pre and post test.

Standard	Pre-test % correct	Post-test % correct	Increase in % correct					Increase in SD units
1	0.44	0.67	0.23	0.522727	0.23	0.25	0.24	0.958333
2	0.46	0.78	0.32	0.695652	0.28	0.26	0.27	1.185185
3	0.67	0.82	0.15	0.223881	0.21	0.18	0.195	0.769231
4	0.59	0.78	0.19	0.322034	0.36	0.3	0.33	0.575758
5	0.51	0.74	0.23	0.45098	0.19	0.21	0.2	1.15
6	0.73	0.8	0.07	0.09589	0.22	0.16	0.19	0.368421
7	0.67	0.81	0.14	0.208955	0.24	0.18	0.21	0.666667

As seen in Table 3, average percent correct on each standard increased from pre-test to post-test. For example, students showed an increase in percent correct on Standard 1 from a mean of 44% correct on the pre-test to 67% correct on the post-test, an increase of 23 percentage points and 0.96 of a standard deviation. Percentage point increases ranged from a low of 7% (Standard 6) to 32% (Standard 2).

The highest-increasing standards were Standard 2 (an increase of 1.19 standard deviations) and Standard 5 (an increase of 1.15 standard deviations). The average raw score increased from 25.4 to 33.6, an increase of 8.2 points, a 32.2% increase, an increase of 1.15 standard deviations.

Table 4. Paired t-test for Ocean Literacy Standards pre and post test.

		Mean	N	Std. Deviation	*t*	df	p
Overall Raw Score	Pre-test	25.416	478	7.1608	-21.81	477	<.001
	Post-test	33.623	478	7.0136			
Standard 1	Pre-test	3.538	478	1.8359	-17.39	477	<.001
	Post-test	5.362	478	2.0138			
Standard 2	Pre-test	2.29	478	1.421	-21.64	477	<.001
	Post-test	3.89	478	1.300			
Standard 3	Pre-test	4.68	478	1.492	-13.76	477	<.001
	Post-test	5.74	478	1.279			
Standard 4	Pre-test	1.19	478	.716	-9.90	477	<.001
	Post-test	1.56	478	.597			
Standard 5	Pre-test	4.60	478	1.715	-19.86	477	<.001
	Post-test	6.63	478	1.864			
Standard 6	Pre-test	5.14	478	1.512	-6.09	477	<.001
	Post-test	5.60	478	1.090			
Standard 7	Pre-test	3.99	478	1.411	-12.71	477	<.001
	Post-test	4.85	478	1.061			

Paired t-tests were conducted on each of the seven standards for all 478 students taking the course over twenty sections across three years. Results shown in Table XX show that all score differences were statistically significant at $p < .001$. Although statistical significance may have been driven higher by the large sample size, effect size results from table 3 show that student gains were both statistically and substantially significant.

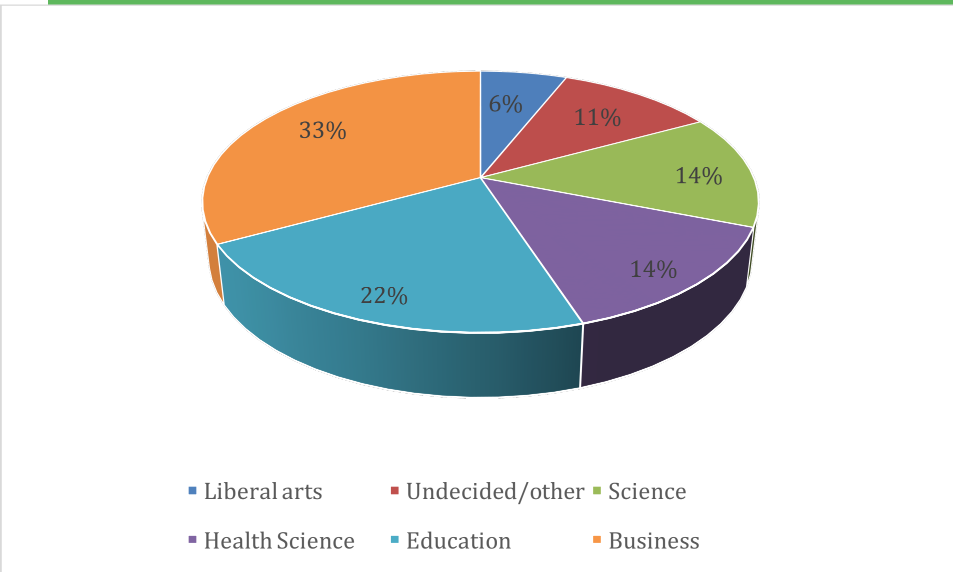

Figure 4. Percentage of university majors sampled. N = 478.

Discussion:

Overall results appear to support the model for deliver in enhancing student knowledge of the ocean literacy principles, with no particular area significantly noted as an area for deeper understanding. This would suggest that the model of delivery is effective, and that the increases in student understanding of both content and concept have been supported. Leveraging the available methods for cyber driven teaching, and following the best practice science instruction philosophy appear to be highly appropriate and supportive of diverse learners for delivery of ocean literacy to post-secondary and adult learners.

It is likely that this model may not be appropriate for HS student, as it requires a disposition of self-motivated learning, however, the next step for continued research would be to deliver this instructional model to HS student and compare the results. When utilizing technology with any of the mention resources any methodology can be utilized with a learning management system (LMS) supported by Moodle, Blackboard, Big Blue Button, and Elluminate/Collaborate to incorporate the strategies below (see Table 3).

Audience response systems such as clickers are effective in getting to know what your students have already learned about a particular topic, quiz students on what they know or to check understanding informally during a lesson. For educators who do not want to purchase clickers, mobile phones can be utilized in the classroom with Poll Everywhere or similar clicker methodologies (Woelk, 2008; Briggs & Keyek-Franssen, 2010). The advantage to poll everywhere is that student can use their mobile devices and do not need to purchase a clicker system.

Table 5. Methods and strategies for learner-centered science education.

SQ3R	http://learningcenter.fiu.edu/Class%20Support2/science.pdf
5E Lesson Planning	http://www.geosociety.org/educate/resources.htm
Two-Column Notes	http://www.readingeducator.com/strategies/two.htm
Graphic Organizers-	http://www.inspiration.com
Just in Time teaching	http://serc.carleton.edu/introgeo/justintime/index.html
Interactive lectures	http://serc.carleton.edu/introgeo/interactive/index.html
Clicker/Poll systems	http://www.polleverywhere.com
Jigsaw teaching	http://www.jigsaw.org/tips.htm
Concept test	http://serc.carleton.edu/introgeo/interactive/conctest.html

In order to increase student comprehension as students are reading content online or in a textbook, various content reading strategies can be incorporated. These strategies can be utilized face-to-face or online.

SQ3R-This strategy is Survey, Question, Read, Recite and Review. This method can be used in a face-to-face environment as well as online. An effective learning management system allows you to pair students or allow them to work in groups online. Students begin by previewing the text and making predictions in order to develop appropriate questions related to the content they are reading. As they read the content students can actively search for answers and summarize what they read, review and share with a peer.

Think-pair-share-This strategy can be used to stimulate discussion in small groups or whole class environments. The educator can provide a topic and have students write what they know or what they would like to learn about a particular topic, they then read a selection assigned by the educator. Students pair up with a peer and share what they have learned from the reading and original misconceptions they may have had about the topic. From pairs, topics can then be shared with the larger group.

Two-Column Notes-This is an effective strategy to allow students to critically think about the text they are reading. Students divide their paper into two columns. The left column is labeled Main Idea and the right column is labeled details. As the student reads and takes notes, they can write down the main idea and details that follow in each of the columns. This can be varied by having students label columns opinion and proof when reading text that encourages critical thinking or problem-solving.

Graphic Organizers-This strategy can be used alongside two column notes as a way for students to represent information in a clear, logical manner. Graphic organizers help show relationships between ideas and can emphasize interrelationships in science topics. Graphic organizers can be creative in format such as a wheel, flow chart, ladder, Venn diagram, web, sequence charts or timelines. Programs such as Inspiration (www.inspiration.com) can help students create graphic organizers electronically and then share with peers.

Just in Time teaching (Marrs & Novak 2004; Higdon & Topaz, 2009) can motivate students and feedback between classroom activities and the work that students do at home in preparation for the classroom meeting. The goals are to increase learning during classroom time, to enhance student motivation, to encourage students to prepare for class, and to allow the instructor to fine tune the classroom activities to best meet students' needs. This can be called a "flipped" classroom where lectures are viewed as homework and the hands-on activities are completed during class with the instructor.

Interactive lectures (Van Dijk, Van Der Berg, & Keulen, 2001; Duggan, Palmer, & Devitt, 2007; Snell & Steinert, 1999) encourage the instructor to incorporate engagement triggers and breaks the lecture at least once per class to have students participate in an activity that allows them to work directly with the material. The engagement triggers capture and maintain student attention and the interactive lecture techniques allow students to apply what they have learned or give them a context for upcoming lecture material. Newcomers might want to begin with one activity during a class period, but may eventually call upon a blend of various interactive lecture techniques all in one class period. Breaking up the lecture with these techniques not only provides format change to engage students, these activities also allow students to immediately apply content and provide feedback to the instructor on student understanding.

Two other methods for teaching are easily modified for geoscience. They are Jigsaw teaching (Slavin & Sharan, 1990; Slavin, 1988; Constantopoulos ,1994; Doymus, 2008; Slavin, 1989; Ferguson, 1990) and group interactive exams (Hake, 1998; Fay, Garrod, & Carletta, 2000; Biner et al, 1997). Both methods motivate and challenge the student to guide their learning and spend time learning not just facts, but practice in application of science content in novel ways.

There are many supports for using cyber-driven methods to guide learning beyond geosciences content. If an educator seeks to offer well organized, inquiry, and problem-based methods to guide learners they will do more than memorize and forget the things they learned soon after. Geoscience educators both formal and informal need to help their learners develop the skills and dispositions needed to apply that knowledge to real world issues on a global scale. A recommended sequence for an educator who is ready to change or move closer to this type of teaching would be to first consult the literacy principles and science standards identified for your particular course (Table 2). Second, consider a progression of learning staring with a 5 E learning cycle with special attention to technology driven supports and problem based and inquiry structures that place the learner in the center (see Table 2). In taking the “sage” off the “stage” and on the sidelines, educators can guide the next generation to become science professionals ready for a changing planet in a well informed and thoughtful way.

REFERENCES

Aaronson, D., Barrow, L. and Sander, W. (2007). Teachers and student achievement in the Chicago public high schools. *Journal of Labor Economics, 25* (1), 95-135.

Alexander, P. A. (1992). Domain knowledge: Evolving themes and emerging concerns. *Educational Psychologist, 27* (1), 33-51.

Arrowsmith, C., Counihan, A. and McGreevy, D. (2005) Development of a multi-scaled virtual field trip for the teaching and learning of geospatial science. *International Journal of Education and Development using ICT, 1* (3).

Atkin, J., Myron, P. B. and Coffey, J. (2001). *Classroom assessment and the national science education standards*. Washington, DC: National Academies Press.

Barclay, K., Benelli, C. and Schoon, S. (1999). Making the connection!: Science & literacy. *Childhood Education, 75* (3), 146-152.

Barrow, L. H. and Morrisey, J.T. (1989). Energy literacy of ninth-grade students: A comparison between Maine and New Brunswick. *The Journal of Environmental Education, 20* (2), 22-25.

Biner, P. M., Welsh, K. D., Barone, N. M., Summers, M. & Dean, R. S. (1997). The impact of remote-site group size on student satisfaction and relative performance in interactive telecourses, *American Journal of Distance Education, 11* (1), 23-33.

Blase, J. and Blase, J. (2003). *Handbook of instructional leadership: How successful principals promote teaching and learning*. Thousand Oaks, CA: Corwin Press.

Boyd, B., Grossman, P., Lankford, H., Loeb, S. & Wyckoff, J. (2006, Spring). How changes in entry requirements alter the teacher workforce and affect student achievement. *Education Finance and Policy,* 1 (2), 176-216.

Boyd, D., Lankford, H., Loeb, S., Rockoff, J. & Wyckoff, J. (2008, Fall). The narrowing gap in New York City teacher qualifications and its implications for student achievement in high-poverty schools. *Journal of Policy Analysis and Management, 27* (4), 793-818.

Briggs, C. L., and Keyek-Franssen, D. (2010). Clickers and CATs: Using learner response systems for formative assessments in the classroom. *Educause Quarterl, 33* (4), n4.

Bybee, R. W. (1997). *Achieving scientific literacy: From purposes to practices.* Westport, CT: Heinemann.

Bybee, R. W. (1995). Achieving scientific literacy: Using the national science education standards to provide equal opportunities for all students to learn science. *Science Teacher, 62* (7), 28-33.

Carnevale, A. P., Smith, N. & Strohl, J. (2010). *Help wanted: projections of job and education requirements through 2018*. Indianapolis, IN: Lumina Foundation.

Cava, F., Schoedinger, S., Strang, C. & Tuddenham, P. (2005). *Science content and standards for ocean literacy: A Report on Ocean Literacy*. Berkeley, CA: College of Exploration.

Center for Science, Mathematics, and Engineering Education. Committee on Development of an Addendum to the National Science Education Standards on Scientific Inquiry. (2000). *Inquiry and the National Science Education Standards: A guide for teaching and learning*. Washington, DC: National Academies Press.

Chang, C.Y., Barufaldi, J. P., Lin, M.C. & Chen, Y. C. (2007). Assessing tenth-grade students' problem solving ability online in the area of Earth sciences. *Computers in Human Behavior, 23* (4): 1971-1981.

Clotfelter, C. T., Ladd, H. F. and Vigdor, J. L. (2007). Teacher credentials and student achievement: Longitudinal analysis with student fixed effects. *Economics of Education Review, 26* (6), 673-682.

Cochran-Smith, M. (2003). Teaching quality matters. *Journal of Teacher Education, 54* (2), 95-98.

Cole, A.G. (2007). Expanding the field: Revisiting environmental education principles through multidisciplinary frameworks. *Journal of Environmental Education*, *38* (2), 35-44.

Collins, A. (1998). National science education standards: A political document. *Journal of Research in Science Teaching, 35* (7), 711-727.

Constantopoulos, T. L. (1994). A Cooperative approach to teaching mineral identification. *Journal of Geological Education, 42* (3), 261-63.

Cook, B. & King, J. E. (2004). *Low-income adults in profile: Improving lives through higher education*. Washington, DC: American Council on Education, Center for Policy Analysis.

Cooper, C. B. (2011). Media literacy as a key strategy toward improving public acceptance of climate change science. *BioScience, 61* (3), 231-237.

Cortese, A. D. (1992). Education for an environmentally sustainable future. *Environmental Science & Technology, 26* (6), 1108-1114.

Couch, C., Fagen, A. P., Callan, J. P. & Mazur, E. (2004). Classroom demonstrations: Learning tools or entertainment? *American Journal of Physics, 72* (6), 835-838.

Crawford, K. & Deer, C. E. (1993). Do we practice what we preach?: Putting policy into practice in teacher education. *The South Pacific Journal of Teacher Education*, 21 (2), 111-121.

Desimone, L. M., Porter, A. C., Garet, M. S., Yoon, K. S. & Birman, B. F. (2002). Effects of professional development on teachers' instruction: Results from a three-year longitudinal study. *Educational Evaluation and Policy Analysis, 24* (2), 81-112.

DeWaters, J. E. & Powers, S. E. (2009, May). Development and use of an energy literacy survey. *Proceedings of the 38th ASES National Solar Conference*.

DeWaters, J. E. & Powers, S. E. (2011). Energy literacy of secondary students in New York State (USA): A measure of knowledge, affect, and behavior. *Energy Policy, 39* (3), 1699-1710.

DeWaters, J. E. & Powers, S. E. (2008, October). Energy literacy among middle and high school youth. *Frontiers in Education Conference, 2008. FIE 2008. 38th Annual*: T2F-6-T2F-11.

DeWaters, J. E. & Powers, S. E. (2009, June). Using a real-world, project-based energy module to improve energy literacy among high school youth. *Proceedings* 14 Jun. 2009: 14-17.

DeWaters, J. E., Powers, S. E. & Graham, M. (2007, June 23). Developing an energy literacy scale. *Proceedings: 2007 ASEE Annual Conference and Exposition* 23 Jun. 2007.

DeWaters, J. E. Energy literacy. *Presentation at the Invitational Working Conference on Energy Literacy in Secondary Education*.

Doymus, K. (2008). Teaching chemical equilibrium with the jigsaw technique. *Research in Science Education, 38* (2), 249-260.

Duggan, P., Palmer, E. & Devitt, P. Electronic voting to encourage interactive lectures: a randomised trial. *BMC Medical Education, 7* (1), 25.

Dupigny-Giroux, L. L. (2008). Introduction—climate science literacy: A state of the knowledge overview. *Physical Geography, 29* (6), 483-486.

El-Khawas, E. H., DePietro-Jurand, R. & Holm-Nielsen, L. (1998). *Quality assurance in higher education: Recent progress; challenges ahead*. World Bank, Human Development Network, Education.

Everston, C. M. & Emmer, E. T. (1982). Effective management at the beginning of the school year in junior high classes. *Journal of educational psychology, 74* (4), 485.

Fay, N., Garrod, S. & Carletta, J. (2000). Group discussion as interactive dialogue or as serial monologue: The influence of group size. *Psychological Science, 11* (6), 481-486.

Feig, A. D. Methodology and location in the context of qualitative data and theoretical frameworks in geoscience education research. *Geological Society of America Special Papers 474*, 1-10.

Felder, R. M. & Silverman, L.K. (1988). Learning and teaching styles in engineering education. *Engineering education, 78* (7), 674-681.

Felder, R. M. (1993). Reaching the second tier. *Journal of College Science Teaching, 23* (5), 286-290.

Ferguson, P. (1990). Cooperative team learning: Theory into practice for the prospective middle school teacher. *Action in Teacher Education, 11* (4), 24-28.

Foster, I. (2003). The grid: A new infrastructure for 21st century science. *Grid computing: Making the global infrastructure a reality*, 51-63.

Gall, M. D. (1970). The use of questions in teaching. *Review of educational research, 40* (5), 707-721.

Galton, M. & Eggleston, J. (1979). Some characteristics of effective science teaching. *European Journal of Science Education, 1* (1), 75-86.

Gibson, I. W. (2001). At the intersection of technology and pedagogy: Considering styles of learning and teaching. *Journal of Information Techology for Teacher Education, 10* (1-2), 37-61.

Goldhaber, D. & Anthony, E. (2007). Can teacher quality be effectively assessed? : National board certification as a signal of effective teaching. *The Review of Economics and Statistics, 89* (1), 134-150.

Green, K. C. (1999). High tech vs. high touch: The potential promise and probable limits of technology-based education and training on campuses. *Competence without credentials* .

Grow, G. O. (1991). Teaching learners to be self-directed. *Adult education quarterly, 41* (3), 125-149.

Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American Journal of Physics, 66* , 64.

Hanushek, E. A. & Rivkin, S. G. (2006). Teacher quality. *Handbook of the Economics of Education, 2* , 1051-1078.

Hanushek, E. A. (1997). Assessing the effects of school resources on student performance: An update. *Educational evaluation and policy analysis, 19* (2), 141-164.

Hanushek, E. A. (1989). The impact of differential expenditures on school performance. *Educational Researcher, 18* (4), 45-62.

Hanushek, E. A. (2005). Why quality matters in education. *Finance and Development, 42* (2), 15-19.

Harrington, J. (2008). Misconceptions: Barriers to improved climate literacy. *Physical Geography, 29* (6), 575-584.

Harris, A. (1998). Effective teaching: A review of the literature. *School Leadership & Management, 18* (2), 169-183.

Higdon, J. & Topaz, C. (2009). Blogs and wikis as instructional tools: A social software adaptation of just-in-time teaching. *College Teaching, 57* (2), 105-110.

Hofstein, A. & Lunetta, V. N. (2003). The laboratory in science education: Foundations for the twenty-first century. *Science education, 88* (1), 28-54.

Jaskyte, K., Taylor, H., & Smariga, R. (2009). Student and faculty perceptions of innovative teaching. *Creativity Research Journal, 21* (1), 111-116.

Karplus, R. (1964). The science curriculum improvement study. *Journal of Research in Science Teaching*, *2* (4), 293-303.

Karukstis, K. K. & Elgren, T. E. (2007). *Developing and sustaining a research-supportive curriculum: A compendium of successful practices*. Washington, DC: Council on Undergraduate Research.

Kilduff, J. (2008, October). Workshop synopsis: Frontiers of environmental engineering education. *Frontiers in Education Conference, 2008. FIE 2008. 38th Annual*: S3E-9-S3E-14.

King, A. (1993). From Sage on the Stage to Guide on the Side. *College Teaching*, *41* (1), 30-35

Kirst, M. W. & Bird, R. L. (1997). *The politics of developing and maintaining mathematics and science curriculum content standards*. Wisconsin: National Institute for Science Education, University of Wisconsin-Madison.

Layman, J. W. (1996) *Inquiry and Learning: Realizing Science Standards in the Classroom. The Thinking Series.* New York, New York: College Board.

Lewis, S. (1996). Intervention programs in science and engineering education: From secondary schools to universities. *Equity in the classroom: Towards effective pedagogy for girls and boys*, 191.

Linn, M. C. (1987). Establishing a research base for science education: Challenges, trends, and recommendations. *Journal of Research in Science Teaching, 24* (3), 191-216.

Lynch, S. (2001). "Science for all" is not equal to "one size fits all": Linguistic and cultural diversity and science education reform. *Journal of Research in Science Teaching, 38* (5), 622-627.

Marrs, K. A. & Novak, G. Just-in-time teaching in biology: creating an active learner classroom using the internet. *Cell Biology Education, 3* (1), 49-61.

McCaffrey, M. S. & Buhr, S. M. (2008). Clarifying climate confusion: Addressing systemic holes, cognitive gaps, and misconceptions through climate literacy. *Physical Geography, 29* (6), 512-528.

National Research Council (US). (1993). National Committee on Science Education Standards, and Assessment. *National science education standards*. Washington, DC: National Academies.

National Science Teachers Association. (2000). *NSTA pathways to the science standards elementary school edition.* Arlington, VA: NSTA Press.

javascript:swapDiv(671337,true)Novak, G. & Middendorf, J. (2004). *Just-in-time teaching Volume IV*. Washington, DC: Project Kaleidoscope.

Pascarella, E. T. (1980). Student-faculty informal contact and college outcomes. *Review of educational research, 50* (4), 545-595.

Rivkin, S. G., Hanushek, E. A. & Kain, J. F. (2005). Teachers, schools, and academic achievement. *Econometrica, 73* (2), 417-458.

Salter, L., Levy, E. & Leiss, W. (1988). *Mandated science: science and scientists in the making of standards*. New York, New York: Springer.

Saulnier, B. C. (2009). From "sage on the stage" to "guide on the side": Revisited: (un)covering the content in the learner-centered information systems. *Course.Information Systems Education Journal*, *7* (60). http://isedj.org/7/60/. ISSN: 1545-679X. A

Semken, S. & Freeman, C. B. (2008). Sense of place in the practice and assessment of place-based science teaching. *Science Education, 92* (6), 1042-1057.

Slavin, R. E. & Sharan, S. (1990). Comprehensive cooperative learning models: Embedding cooperative learning in the curriculum and school. *Cooperative learning: Theory and research,* 261-283.

Slavin, R. E. (1988). Cooperative learning and student achievement. *Educational Leadership, 46* (2), 31-33.

Slavin, R. (1989). A cooperative learning approach to content areas: Jigsaw teaching. *Content Area Reading and Learning: Instructional Strategies. Englewood Cliffs, NJ: Prentice-Hall*, 330-45.

Smith, L. K., Barber, M., Duguay, L. and Whitley, L. (2012). Using the ocean literacy principles to connect inland audiences to the global oceans. *Current the Journal of Marine Education, 28* (2), 2-7.

Snell, Y. & Steinert, L. S. (1999). Interactive lecturing: Strategies for increasing participation in large group presentations. *Medical Teacher, 21* (1), 37-42.

Strang, G., DeCharon, A. & Schoedinger, S. (2007). Can you be science literate without being ocean literate? *Current: the journal of marine education, 23* (1).

Surry, D. W. & Land, S. M. (2000). Strategies for motivating higher education faculty to use technology. *Innovations in Education and Teaching International, 37* (2), 145-153.

Tuss, P. (1996, June). From student to scientist: An experiential approach to science education. *Science Communication, 17* (4), 443-481.

Van Dijk, L. A., Van Der Berg, G. C. & Van Keulen, H. (2001). Interactive lectures in engineering education. *European Journal of Engineering Education, 26* (1), 15-28.

Wellman, J. V., Desrochers, D. M. & Lenihan, C. M. (2008*). The growing imbalance: Recent trends in US postsecondary education finance.* Indianapolis, IN: Lumina Foundation for Education.

Whitehurst, G. J. (2002, March). Scientifically based research on teacher quality: Research on teacher preparation and professional development. *White House Conference on Preparing Tomorrow's Teacher*.

Woelk, K. (2008). Optimizing the use of personal response devices (clickers) in large-enrollment introductory courses. *Journal of Chemical Education*, *85* (10), 1400.

Yarroch, W. L. (1985). Student understanding of chemical equation balancing. *Journal of Research in Science Teaching, 22* (5), 449-459.

Zhu, E. (2007). Teaching with clickers. *Center for research on learning and teaching occasional papers, 22*, 1-8.

Zohrabi, M., Torabi, M. A., & Baybourdiani, P. (2012). Teacher-centered and/or student-centered learning: English language in Iran. *English Language and Literature Studies, 2* (3), 18.

.

About the Authors:

Mailing Address:
College of Education, 1000 N Main Street, The University of Findlay, Findlay, OH 45840, United States
email: rife@findlay.edu and brasfield@findlay.edu

Rife business phone: 419.434.4724

Institutional affiliation: The University of Findlay (both Drs. Rife and Brasfield)

short biographical sketches:

Gwynne Rife, PhD, is a marine scientist and marine educator. She currently teaching at the University of Findlay in Northwest Ohio and as science educator works with teachers to enhance their science teaching skills. Her specialties include deep sea ecosystems, terrestrial isopods, and freshwater zoology.

Jon Brasfield, PhD, is an assistant professor of education at the University of Findlay. His primary research interests are teacher evaluation – specifically value-added modeling and standards-based observation. He also has a strong interest in the roles of counselors and librarians in school settings. Jon is active in the American Educational Research Association, , Mid-Western Educational Research Association, Association of Teacher Educators, and Kappa Delta Pi.

PUBLICATION GUIDELINES

for the OHIO Journal of Teacher Education

The following guidelines are presented for publication opportunities for OJTE (the OHIO Journal of Teacher Education.

The OHIO Journal of Teacher Education provides a forum for the exchange of information and ideas concerning the improvement of teaching and teacher education. Articles submitted should reflect this mission. Their focus should concern concepts, practices, and/or results of research that have practical dimensions, implications, or applicability for practitioners involved with teacher education. The journal is regional in scope and is sent as a benefit of membership in the Ohio Association of Teacher Education.

Manuscripts are subject to review of the Professional Journal Committee (co-editors and editor consultants). Points of view are those of the individual authors and are not necessarily those of either Association. Permission to reproduce journal articles must be requested from the editors.

MANUSCRIPT GUIDELINES

Content: Journal issues may be "thematic" or "open." Currently, all future issues are designated "open."

Length: Manuscripts, including all references, bibliographies, charts, figures, and tables, general- ly should not exceed 15 pages.

Style: For writing and editorial style, follow directions in the latest edition of the Publication Manual of the American Psychological Association. Omit the author's name from the title page. Include an 80-100-word abstract.

Please do not use auto-formatting when preparing the manuscript!

Cover page: Include the following information on a separate sheet attached to the manuscript: title of the article; date of submission; author's name, author's terminal degree; mailing address, e-mail address, business and home phone numbers, institutional affiliation; and short biographical sketch, including background and areas of specialization.

Submission: Submissions must be word processed using Microsoft Office Word (Microsoft Excel tables are permitted). Submit the manuscript as an attachment to an e-mail to oatejournal@gmail.com

EDITORIAL PROCEDURES

Authors will be notified of the receipt of the manuscript. After an initial review by the editors, those manuscripts which meet specifications will be sent to reviewers. Notification of the status of the manuscript will take place after the deadline date for each issue. The journal editors will make minor editorial changes; major changes will be made by the author prior to publication. Manuscripts, editorial correspondence, and questions can be directed to Dr. Mark Meyers and Dr. Jean Eagle at oatejournal@gmail.com

IMPORTANT DATES OF NOTE:

January 6, 2017	Closing date for acceptance of manuscripts for Spring Journal 2017
Publication Date:	**March, 2017 at OCTEO Conference**
August 1, 2017	Closing date for acceptance of manuscripts for Fall Journal 2017
Publication date:	**October, 2017 at OCTEO Conference**

MEMBERSHIP

Interested in becoming a member of OATE (Ohio Association of Teacher Educators)? Please visit the following website for current information: https://sites.google.com/site/ohioate/home

Additionally, information about OCTEO (Ohio Confederation of Teacher Education Organizations), Fall and Spring OCTEO Conferences, and presentational opportunities, can be found at the following site: http://www.ohioteachered.org.

Our organization looks forward to your interest in OATE and OCTEO in 2016 and 2017.