DIFFERENCES IN INSTRUCTIONAL METHODS USED BY COLLEGIATE STEM INSTRUCTORS: A COMPARISON OF EDUCATION BACKGROUND VERSUS COURSE DESIGNS FEATURING ACTIVE TEACHING METHODS

Sarah Corke

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Doctoral Committee

Elizabeth Boling, M.F.A.

Daniel T. Hickey, Ph.D.

Gamze Ozogul, Ph.D.

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The purpose of this research project was to investigate a potential relationship between instructor course decisions and education backgrounds within STEM instructors at the University of Notre Dame. These instructors had varying instructional backgrounds including those with formal (F) educational experiences from college courses, informal (I) educational experiences from instruction-based conferences, professional development, or personal investigations into education research, and no formal or informal training (N) education backgrounds, with only content-centered degrees.

Data was collected through a review of course syllabi and an instructor survey regarding past and present education experiences and decisions. The independent variable of this study was the instructors' educational backgrounds (F, I, or N) and the dependent variable was be the use and frequency of use of various instructional designs featuring active teaching methods. Active teaching methods were identified as those incorporating a role for students in thinking, in creating, or in solving authentic problems in and out of the physical classroom setting. The greater the role of the student, the more active the methods were be considered. The basis for assigning more points for each instructional method or strategy followed the rankings of Bloom's taxonomy (Adams, 2015; Bloom, 1956) so that strategies presumed to call for higher levels of learning, and thus instruction, were given more points.

The mean difference of course scores between I and N ($M = -2.30$, $SD = 0.93$) education background instructors was significant ($p < 0.05$) while the mean difference of course scores between F and I education background individuals was not significant ($p > 0.05$). These findings supported the hypothesis of variation between the education groups.

This study and its findings provide quantitative evidence supporting the professional development of STEM instructors with education-based philosophies, teaching methods, and course development innovations. A shift of instructors from the N group to I group could allow for the increase in benefits possible from more frequently utilized active teaching methods. Instructors with no background in education may be seen as a target audience for marketing and course/conference development for the Kaneb Center, the university's faculty and staff teaching center, based on supporting data.

Elizabeth Boling, M.F.A.

Daniel T. Hickey, Ph.D.

Gamze Ozogul, Ph.D.

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Introduction

This applied study focused on a sampling of STEM instructors' choices of teaching methods promoting active teaching methods with the potential to provide supportive research for the Kaneb Center at the University of Notre Dame. Data was collected through a review of syllabi/course descriptions and instructor surveys with questions related to education backgrounds and practices. Guiding concerns for this study included the following questions: Do professors with formal education backgrounds select particular instructional methods for STEM courses that are not chosen by those with strictly content backgrounds? If a difference exists between instructor background groups (F, I, and N) with respect to incorporation of active teaching methods in his or her course designs, is the difference statistically significant from the other groups?

Problem Statement

Science, Technology, Engineering, and Mathematics (STEM) courses are not immune to the high likelihood of predominantly lecture-based, direct instruction that has permeated undergraduate teaching for almost a thousand years (Brockliss, 1996). Increasing evidence (Barthlow & Watson, 2014; Foegen & Hargrave, 1999; McDermott & Redish, 1999; Williams & Zahed, 1996) that these current methods do not guarantee significant understanding by students, may prompt instructors and course designers to rethink this older teaching style and opt for teaching methods that promote more active learning to potentially be conducted in the classroom. Newer, quantitative studies (ex. Freeman et al., 2014) comparing student performance under exposition-centered methods and constructivist methods continue to emerge and increase the supporting data showing student improvements using more active learning methods. Resources such as interactive computer simulations and other virtual tools provide opportunities to implement more active learning methods such as inquiry-based learning of science experimentation to non-laboratory facilities in STEM classes (Heradio et al., 2016).

Course designs of collegiate, in-person, STEM classes from instructors with varying backgrounds in education were studied for this research project. It was initially suspected that there would be a difference between the course designs. This hypothesis was based on a review of the literature focused on professional development and instructional design implementations (Hoffman & Thomas, 2003; Derting et al., 2016; Tatto, 1999), analysis of previous studies tied to student success or satisfaction with various active learning methods (Bush et al., 2017; Faulconer et al., 2018, Bernard et al., 2004; Prince, 2004), personal experience of the variety in collegiate STEM classes as a student, and diversity of educational backgrounds seen as an alumna and non-regular faculty member at the University of Notre Dame.

This study focused on how active teaching methods do or do not differ between instructors with formal (F), informal (I), and no formal or informal training (N) education backgrounds and training. The technical training for degrees in STEM fields typically have less training or content overlap with formal education courses, which should have broadened the difference between the F and N groups when looking for disparities between the groups. Additionally, this study provided a view of a potential trend between instructor education backgrounds and education decisions for their classrooms.

Purpose

The purpose of this research project was to investigate a potential relationship between instructor course decisions and education backgrounds within STEM instructors at the University of Notre Dame. These instructors had varying instructional backgrounds including those with formal (F) educational experiences from college courses, informal (I) educational experiences from seminars and instruction-based conferences, professional development, or personal investigations into education research, and no formal or informal training (N) education backgrounds, with only content-centered degrees.

The I instructors, a group where many faculty members likely reside, was anticipated to already integrating active learning methods in their classrooms and instructional plans. Changes to increase such methods and reap the research-based benefits of active learning would not mean starting from scratch and requiring extensive training. A coordination with the Kaneb Learning Center at the University of Notre Dame to share findings will be conducted following the defense of this research and can hopefully boost instructor participation in workshops and conferences related to course development.

Many studies of science education compare course designs incorporating active learning methods with those based around instructor lectures. Often teachers use the instructional practices and methods by which they were taught with more emphasis on the recitation of facts and standards and less attention to the application of content in real-world situations and instructional manipulatives (Cohen et al., 1993; Darling-Hammond & McLaughlin, 1995; Geret et al., 2001). Most formal literature focused on the comparison between instructional strategies promoting more active learning and less active/passive learning, such as having direct instruction only, converges on the conclusion that several non-lecture course designs can lead to improvements in student success in STEM courses (e.g., Bush et al., 2017; Faulconer et al., 2018, Bernard et al., 2004). While there were some conflicting results in larger, more generalized studies, such as those by Andrews et al. (2011), this appeared to be the minority finding and potentially based on additional confounding variables linked to individual instructors. Research has already begun to expand into looking for different levels of student success or student satisfaction when various active learning methods and various resources or platforms (digital or printed) are used to implement different STEM instructional techniques (Bernard et al., 2018; Gonzalez, 2014). Over time, more studies will likely compare active learning methods that are more clearly defined and universal across STEM curriculum.

The second research stage related into how undergraduate instructors incorporate active evidence of active learning research. Hoffman and Thomas (2003), Derting et al., (2016), and Tatto (1999) noted that instructor participation in educational professional development or training focused on curriculum and case discussions related to the use of such practices. It is unknown how further research may impact the future of STEM instruction. I hope for, and anticipate, an increase in instructional practices based on evidence, rather than simply based on teaching traditions as more evidence is collected and published.

Significance

Professors and university administrators, such as the provost and college deans, at UND, are likely to benefit directly from the research results as these are the individuals most immediately involved in instructional design decisions. It seems more likely, based on previous professional development studies (Hoffman & Thomas, 2003; Derting et al., 2016; Tatto, 1999), that F and I instructors will use a greater total variety of instructional methods, and thus be more likely than N instructors to utilize the methods that promote more active learning. A shift of instructors from the N group to I group could allow for the increase in benefits possible from more frequently utilized active teaching methods. Instructors with no background in education may be seen as a target audience for marketing and course/conference development for the Kaneb Center, the university's faculty and staff teaching center, based on supporting data. Students at the university may also benefit in the long-term perspective if changes in instructional methods are implemented following conclusions and recommendations of active teaching and learning research.

Supporting Research

The sciences are not merely observed and discussed, but are fields of study in which content is manipulated and tasks are often physically completed. A cyclic, rather than linear mapping of thought processes and procedural steps, such as those used in design thinking and transmergent learning strategies (Honebein, 2009) and modification of assignments to increase complexity and thought development (Brown & Wyatt, 2007), are similar to STEM principles of experimentation design and procedure. This commonality between STEM philosophies and active teaching methods indicates a potentially useful approach to implementing new or different instructional methods to in-person, collegiate STEM classrooms.

Active Teaching Methods Versus Traditional STEM

Over the past few decades, studies have looked to quantify performance improvements in STEM students following the implementation of varying instructional methods and techniques which can promote more active learning within the classroom. Numerous studies can be found to support positive effects in student success by means of different units of quantification, such as pre- and post-test assessments and Likert-based satisfaction analyses, focused on increasing the level of active learning by students (e.g., Bush et al., 2017; Faulconer et al., 2018; Bernard et al., 2004). Recitation and traditional lecturing, which can be identified as promoting less active learning, have conversely been shown to not have positive effects on student performance, especially when considering deeper comprehension of knowledge (Halloun & Hestenes, 1985).

Instructional design and implementation of specific interventions correlate to changes in student achievement, when comparing a more teacher-centered, direct instruction with more student-centered, active learning approach. STEM education research appears to often be focused on a comparison between approaches offering more or less active learning opportunities in classrooms. These studies (i.e., Eddy & Hogan, 2014) contrast active learning approaches with lecture-based approaches leading to the conclusion that non-lecture STEM course designs can improve student performance. Multiple instructional options moving away from direct instruction were found to improve student success as a whole (Bush et al., 2017; Lake, 2001) and for students in special interest groups (Cooper & Brownell, 2017; Eddy & Hogan, 2014; Haak et al., 2011). When disparity in findings appeared, contrasting classifications of the instructional methods and later comparisons of multiple active learning models was determined to be the likely source of unexpected results (Ruiz-Primo et al., 2011).

Undergraduate course innovations in STEM courses including technology, conceptually oriented tasks, collaborative learning, and inquiry-based projects had a positive effect on student learning based on a meta-analysis of 310 peer-reviewed journal studies published in English between 1990 and 2007 focused on student-centered innovations in real classrooms (Ruiz-Primo et al., 2011). In addition to a concentration on active learning methods, multiple studies directed statistical analyses of the differential success of particular groups of students following the use of different instructional techniques, especially when compared to student success following direct instruction. Some research suggests that the apparent achievement gap in STEM courses based on ethnicity, LGBTQIA association, socioeconomic status can be reduced or closed based on particular instructional intervention (Cooper & Brownell, 2017; Eddy & Hogan, 2014; Haak et al., 2011).

Supporting Research with Engineering and Mathematics

Reviewing cognitive improvements from methodological choices for an introductory engineering setting, Moreno, Reisslein, and Ozogul (2009) examined learning comprehension via near- and far-transfer tests pertaining to parallel electrical circuit analyses. They found that transference of knowledge was statistically different for more timely assessments with fading form, structured work problems. These differences, however, decreased when time until testing was increased.

Similar findings were noted following problem-solving approaches using both abstract and concrete examples for novel electrical circuit problems (Moreno et al., 2011). This research suggests that individual lesson format can incorporate a variety of methods, and thus the course as a whole may be designed to promote higher cognitive improvements and more active learning. Focusing strictly on Algebra courses, replacing lecturing with active learning with special emphasis on technology integration improved student performance 30 percent in high-enrollment courses following a Roadmap to Redesign Program (Thiel et al., 2010).

Supporting Research with Biology

In a Biology setting, a gamified active learning approach was studied to with a focus on building particular science skills in students. The claim, evidence, reasoning (CER) framework was introduced and utilized in *The Golden Hour*, a game-based learning system to promote scientific argumentation skills related to neuroscience and traumatic brain injuries (Wallon et al., 2018). While not directly measuring content mastery, but scientific method/skill use, this specific STEM lesson design was found to have a positive impact on student success akin to other game-based approaches that improved student participation (e.g., Squire & Jan, 2007).

Bush et al. (2017) focused on a single difference between two classrooms with active learning revolved around inquiry teaching with a global climate model (GCM) developed by the National Aeronautics and Space Administration. Both groups of undergraduate students had biweekly, instructor-led discussions and biweekly, laboratory sessions as well as collaborative research projects. One group used the GCM during the laboratory session and acted as the treatment group. This treatment group was noted to have greater gains based on pre- and post-test scores and higher engagement levels than the control group. Additionally, the GCM group developed reflections on the content more consistent with actual climate change research (Bush et al., 2017). This indicated that authenticity levels of educational technology affected learning trajectories. Overall, the use of specific STEM resources and applicable instructional methods led to differential student success with comprehension of climate change.

Haak, HilleRisLambers, Pitre, and Freeman (2011) focused on highly structured course designs and varying improvements in traditionally disadvantaged students in an introductory biology course. Multiple-choice “clicker questions” and weekly practice exams were considered to promote active learning as they were required course elements repeated regularly. All students, not just those within the target group (students enrolled in the University of Washington’s Educational Opportunity program), linked these resources to an improvement in overall class performance. When compared to equivalent course sections identified as having little or no active learning, the raw achievement gap reduced 45 percent. After controlling for the instructor and student ability, data supported the conclusion that the course structure had a significant impact on the reduction of previously noted achievement gap in the Educational Opportunity Program students. Though the student activity level of responding to questions using clicker devices and completing regular practice exams could be classified as minimal due to the high probability of the questions being multiple choice and a noted difficulty of creating best answer items by instructors. These methods were found to support conclusions linking benefits between design choices and student success.

Modifying large courses to allow the same achievement possible during individual instruction can improve performance in students who are educationally disadvantaged. Haak et al., (2011) identified disadvantaged students as being from "educationally or economically disadvantaged backgrounds" (p. 1214). This target student group's performance in an undergraduate biology course showed improvement with a highly structured course featuring data analysis, daily or weekly practice with problem-solving, and higher-order cognitive skills. This gain was specifically noted to stem from deeper content understanding, not merely from the repetition of assessment. The improvement was disproportionately high for those classified as disadvantaged students when results were compared to similar groups in low structure biology courses. Not only can specific course designs improve student scores and understanding of STEM concepts, but they can also be used to reduce the achievement gap between traditionally advantaged and disadvantaged students.

Supporting Research with Physics

Bumbacher, Saleihi, Wieman, and Blikstein (2018) studied additional confounding variables regarding the use of particular tools used for inquiry-based learning of undergraduate physics concepts. Sixty-eight community college students in a psychology course were observed as they used virtual manipulative experiments (MEs) and physical MEs to learn about electrical circuits and mass and spring systems. Time between manipulations, or intentionality, was deemed an important variable in successful experiments and ties into mental processing development for higher order cognitive skills and concepts (Zacharia et al., 2008). This comprehension was evaluated using pre- and post-test scores. Overall, it was determined that more students engaged in assistive strategies using virtual MEs for electrical circuits and physical MEs for mass and spring systems.

Faulconer et al. (2018) compared traditional face-to-face instruction, online classes, and synchronous video instruction using a post-hoc pair-wise test for an undergraduate, introductory physics course. This research expanded earlier, meta-analysis work comparing lecture and distance-learning course designs (Bernard et al., 2004) and inspired more questions regarding student preference of course models.

Across multiple STEM disciplines, active teaching methods can be applied in a classroom and students can learn more actively to significantly improve learning, engagement, and achievement outcomes.

Background

Defining Active Teaching Methods

Chickering and Camson (1987) looked to classify active learning beyond student activities such as writing and watching, to begin to understand a further connection to problem solving. To be actively involved, students cognitively engaged in lesson elements geared toward higher Bloom's taxonomy tasks of analysis, synthesis, and evaluation. From a biological perspective, active learning has been defined by Cohn, Atlas, and Lander (1994) as a learning procedure that has some control over the inputs it can impact and may occur at high or low levels.

Graham et al. (2013) defined active learning as "an activity in which every student must think, create, or solve a problem" (p. 1456). Grabinger and Dunlab (1995) focused on six fundamental strategies for the promotion of active learning in what they called "rich environments." These strategies included constructivist philosophies and theories, integration of realistic contexts, encouragement of student responsibility, initiative, and decision-making, cultivation of collaborative learning communities, interdisciplinary activities promoting higher cognitive thinking, and assessments through authentic performances. While the "rich environment" descriptions are not, themselves, instructional strategies, they do point to levels of Bloom's taxonomy (Bloom, 1956), specifically the higher levels featuring analysis, evaluation, and creation. Integration of knowledge, the combination of accumulation and modification of existing information in realistic settings rather than overgeneralized or compartmentalized settings can be used to enhance the depth of knowledge transfer, especially when focusing content around cross-curricular themes (Hannafin, 1992).

While different groups define, and thus quantify active learning in different ways, it is important to clarify what methods were viewed as promoting active learning and thus active teaching methods. In this study, active teaching methods were identified as those incorporating a role for students in thinking, in creating, or in solving authentic problems in and out of the physical classroom setting to thus promote active learning in students. Additionally, the greater the role of the student, the more active the methods were be considered. Conversely, the greater the role of the instructor, the less active, and more passive, the methods were classified (see Appendix C). This definition is a conglomerate of descriptions used in studies focused on active learning (Brown et al., 1989; Grabinger & Dunlap, 1995; Graham, 2013; Gurney, 1989; Hannafin, 1992). Methods focused on teacher-centered instruction as opposed to student-centered instruction were not classified as active learning methods in this study, and may be better described as passive learning methods.

Classifying Active Teaching Methods

Some combinations of instructional methods can yield a higher degree of active learning on the part of the student due to providing an increased role in thinking, creating, or solving authentic problems using the presented content. In contrast, other methods can yield lower levels of active learning based on a restriction or minimization of student input and their role in thinking, creating, or solving problems.

Like Bloom's taxonomy, active learning and teaching methods can be viewed on a scale (Bloom, 1956). The lowest activity levels would include inattentive sitting in class with little to no writing or responding to presented information (Bonwell & Eison, 1991). Increasing activity involves note taking, summarizing, and organizing presented materials. Higher activity teaching methods would include presentations, group discussions, and analysis of case studies. The highest classification of active teaching incorporates greater pressure on individual exploration of the content rather than echoed responses to definitive facts.

The scale of student activity in the learning process for this study was represented in a tiered point system surrounding the terminology used by Bloom. This point system ran from one to five with one representing the most potentially passive instruction and five representing methods with higher amounts of student involvement and ownership of evaluating and creating (Appendix C). Active teaching methods featuring collaboration received a higher point value due to the potential for increased understanding and concept retention from peer learning communities (PCAST, 2012; Prince, 2004).

The scoring system used for this study focused primarily on assessment formats and types of student participation rather than specific manipulatives and precise implementation methods. Additionally, this study concentrated on the course design elements rather than the implementation of the methods in a longitudinal study for two reasons. First, the manner in which different types of active learning methods are used and featured within a classroom, even in similar settings, can have varying degrees of results in terms of student academic improvements with the learning experience, based on pre- and post-test scores or student satisfaction (Bush et al., 2017; Faulconer et al., 2018, Bernard et al., 2004; Prince, 2004). Second, while instructional methods may feature a range of technology and multimedia resources in their implementation, technology and media are not the source of the possible active learning (Clark, 1994). For example, some research projects view active teaching with *clicker questions* for in-class question and answer sessions (Martyn, 2007). The physical clicker response feature is not what identifies the process as an example of active learning. The increased participation from students (e.g., exit tickets, jigsaw reading, round robin), separation of a class into discussion groups (randomly or based on academic performance), ability for change in the instructor's lesson based on the formative assessment results (such as those with real-time updates), and additional factors such are repetition and collaboration make an activity noted in the syllabus classify as an active teaching method.

The more diverse the activities and assessments featuring possible active learning, the higher within Bloom's taxonomy the thinking, creating, and processing skills can be. Thus, more points were assigned to those types of courses following an analysis of the syllabus. This connection of taxonomy tasks to increased active learning was supported by previous studies. Smith, Vinson, Smith, Lewin, and Stetzer (2014) focused on the STEM instructors' use of a range of *active-engagement* teaching methods and how students behaved and instructors perceived these methods. Repetition or a required nature of different class activities (ex.

homework assignments or multiple tests) were also included in the point system as they were likewise included in previous research (Haak et al., 2011).

Defining Education Background Groups

Instructors were divided into three categories representing individual education backgrounds. The formal (F) education group had experience as a student in education courses. It is possible that instructors studied education methods as a student within their own college and graduate courses regardless of the current classes they teach. A Master of Arts or Master of Science in education or education-based undergraduate majors or minors may supplement the instructors STEM-focused academic backgrounds.

Participation in professional development, the reading of education research, and teaching-based faculty assignments and/or projects defined the instructors included in the informal (I) group. Loucks-Horsely and Matusmoto (1999) included the instructors' experience of instructional techniques, materials, and activities influencing adoptions of new strategies. Due to the potential modifications of the same strategies by different instructors, personal experience using different methods and manipulating various resources as they are used becomes especially important. Consideration of a difference between learning about a new method and learning how to implement the method with the content-specific demands of a course was noted by inclusion of the I group instead of simply separating instructors with and without formal education backgrounds.

Loucks-Horsley, Stiles, and Hewson (1996) identified principles of professional development geared toward maximizing learning outcomes for STEM educators. These included an emphasis on active learning methods such as student investigations, inquiry-based learning, and problem solving with application of content. Understanding how students learn and working collaboratively with peers to practice the newly learned or expanded methods were likewise included in effective professional development practices. Geret, Porter, Desimone, Birman, and Yoon (2001) additionally focused on aspects leading to successful professional development for educators identifying the importance of reform activities involving mentoring, coaching utilized within the classroom contexts. These features of professional development are included in the Kaneb Center's workshops, collaborative communities, and individual consultations (University of Notre Dame, 2020) thus the participation in such events aspects may be a common informal education background option.

The no formal or informal training (N) education background instructor group included faculty that did not have experiences as a student in education courses, do not participate in education-based professional development, and read more professional literature tied to STEM than education research.

Complications of Research on and Use of Active Teaching

Despite multiple, original studies finding improvements in student achievement following the use of some type of active learning strategy, some research suggested that student achievement was not positively impacted by these strategies. Andrews, Leonard, Colgrove, and Kalinowski (2011) noted that average college biology professors using practices defined, as active learning did not improve learning gains. Data was collected from course design analyses and pre- and post-test scores in undergraduate Biology courses conducted by professors with and without science education backgrounds. Student learning was not positively related to the amount of active learning employed by the instructor when reviewed using average normalized gain, raw change, percent change, and Cohen's *d* analysis. This result implied the presence of a disparity between the record of a particular teaching method being used in the classroom and the effective implementation of that teaching method. This was probative because studies focusing on the effects of active learning on student achievement need to specifically quantify what constituted the active learning in question. Similar strategies defined as active learning may be executed differently and could produce conflicting data.

The importance of clear definitions of instructional designs and potential variability of how an instructor performs a specific method was evident in Kirschner, Sweller, and Clark's (2006) case of the major disadvantages of "minimally guided" instruction. They concluded that there was a missing component related to how minimal guidance instruction was actually being conducted, as well as a disparity with what was considered minimal or unguided instruction. Kirschner et al. (2006) indicated a problem with the implementation of the approach involving the distinction between teaching as inquiry and teaching by inquiry as well as the frustrations with implementing the strategies in classrooms. The indicated problem with too little guidance with high cognitive load content was addressed by Hmelo-Silver et al. (2007) focusing on the need for instructors to sufficiently scaffold inquiry-based instruction.

By connecting different instructional methods to a scaled system of active teaching using Bloom's taxonomy and the addition of features such as collaboration and repetition (Appendix C), a more definitive system of comparison between courses can be established and then connected to potential differences in the instructors. Additionally, dividing instructors into three categories rather than only separating those with and without science education backgrounds should have highlighted an additional source of variety in course design elements featuring active teaching methods.

Research Questions

My primary research goal was to conduct an investigation of a potential link between course design choices and educational backgrounds of in-person, STEM instructors at the University of Notre Dame. This goal was guided by one primary question and one secondary question:

- In terms of course design for STEM courses, do instructors with different education-based backgrounds select different types of active teaching methods?
- If a difference exists between instructor groups (F, I, and N) with respect to incorporation of active teaching methods in his or her course designs, is the difference statistically significant from the other instructor groups?

Investigation to support the design details and literature review of this study yielded little to no reports on answering these questions. Instructional design choice has been connected to professional development intervention (Garet, Yoon, & Birman, 2002), but the connection between more extensive educational backgrounds appears to be less studied.

Methods and Design

Participants

Participants in the study included 48 instructors at the University of Notre Dame (UND) in Notre Dame, Indiana who teach an in-person STEM course. UND is a private, Catholic university with extensive research programs in STEM fields based on the number and professional reputations of labs, as well as the amount of money brought into the university through research. UND features the Kaneb Center for Continuing Education with services available to faculty and staff which increased the likely number of instructors who have informal education backgrounds (such as education seminar or conference attendance, regular or semi-regular reading of education journals, etc.).

My target population for this research study included STEM instructors at the University of Notre Dame with varying levels of education backgrounds (no formal or informal training in education backgrounds [content-based only], informal education background, and formal education course backgrounds). The instructors taught at least one class with a face-to-face, physical classroom component. I also had the availability to gather some faculty data from online, openly available curriculum vitae and class webpages.

Syllabus Access

The deans of the colleges of Science and Engineering as well as the heads of the various STEM departments were contacted to request copies of course syllabi/course descriptions. I hold an undergraduate degree from UND and act as a faculty member with the university's Alliance for Catholic Education which allowed emails to be sent from an internal UND address as well as an external Indiana University address. Some syllabi were freely available to the public through department websites (ex. UND Introductory Biology), class webpages, and wikipages. This allowed for a preliminary syllabus/course description analysis to be possible without administrative assistance or approval. If any personally identifying information was on the syllabi, those details were redacted before further analysis. The syllabus point distinction system (Appendix C) was applied and the total scores for each class were recorded in an online spreadsheet.

Instructor Recruitment

An emailed letter of introduction was sent 408 STEM faculty members at UND. This included some research faculty who may not regularly teach in-person STEM courses. This boarder identification of potential participants decreased the potential response rate, while remaining inclusive to those who do teach occasional courses. This letter described the purpose of the research project, the role of the survey, a link to the survey (Appendix D), and the IRB consent form (Appendix E) for digital signatures. Faculty email addresses were available online so the potential participants can be contacted directly.

Response details such as information requests and number of contacts made were recorded in a secure online spreadsheet. One week after the initial letters were sent, a follow up email with requests to participate were sent. The survey requests identified this research as independent of UND and included specification as to the voluntary nature of responses. To incentivize an increased participation rate, gift cards (two $25 codes to Amazon.com) were provided to two selected responses. All survey responses, regardless of content and completion amount, were eligible.

Anonymity

Individuals were assigned identification numbers before connections between course designs, material and method choices, and the instructors' educational backgrounds were made. While survey response percentages are included in the research results, no specification of which individuals completed surveys is included in this final report or other future publications to maintain respondent anonymity. Responses were only directly connected to specific courses within an online spreadsheet stored through the IU secure online drives. Published or presented data analysis documentation use the assigned identification numbers to pair courses with instructors.

Hypothesis

I hypothesized that there would be similarities between the type and quantity of methods promoting active learning in courses from individuals in the formal (F) and informal (I) instructor groups. This was primarily supported by literature focused on the impacts and types of professional development on instructor teaching changes (Loucks-Horsely & Matusmoto, 1999; Loucks-Horsely et al., 1996; Geret et al., 2001).

I expected to find a difference, with the potential of a significant difference, in the use of active learning methods between the F and N instructor groups. N faculty with only content background training likely taught using the methods in which they were taught, with potential emphasis on lecture-based instruction. This connects to the need to have initial knowledge of a wider variety of teaching methods, especially those focused on promoting active learning, to be more likely integrated into course designs. The historical nature of STEM instruction (Brockliss, 1996) also projects a disparity in use of methods promoting more or less active learning.

Data Sources and Types

Data was collected through a review of course syllabi and an instructor survey regarding past and present education experiences and decisions. The independent variable of study was the instructors' educational backgrounds (F, I, or N) and the dependent variable was be the use and frequency of use of various instructional design methods, especially focusing on those classified as active learning techniques.

Syllabus Analysis

A syllabus/course description analysis was conducted based on a proprietary scoring system for active learning methodology implementation (Appendix C). To make an objective assessment of the instructors' intentions to use strategies and methods promoting active learning, specific techniques or assessments that illustrate active teaching strategies were assigned different numbers of points. Higher values were awarded to strategies that judged to be comparatively more student-centered and/or constructivist representing authentic tasks. A final score was assigned to each course before associations were made to the instructor's education background category.

Process for Assigning Point Values

Specific terms and descriptors were selected to identify various instructional techniques to group common instructional methods, which may be named differently, together. For example, one course may include practice problems itemized as "clicker questions," while another course has similar practice problems or exit ticket strategies done in class simply listed as "classwork." Both are active learning techniques characterized by independent work and instant or short-term feedback. The majority of this categorization was done before the data was collected to reduce bias in grouping methods and point assignment.

The basis for assigning more points for each instructional method or strategy followed the rankings of Bloom's taxonomy (Adams, 2015; Bloom, 1956) so that strategies presumed to call for higher levels of learning, and thus instruction, were given more points. The higher tiered aspects involving creation, analysis, and evaluation align more strongly with active learning while remembering and understanding align more strongly with passive learning where content is repeated rather than reinterpreted and connected by the student. For example, if a syllabus indicated items such as required study groups or collaborative homework assignments, that course would have points assigned to it since these have increased opportunities for student participation. Based on this rubric system it was possible to have two courses with the same total score, but different methods used. This plan should have allowed for complex, student-center strategies that are more time consuming in one course to numerically match multiple strategies with less individual activity in another course.

The majority of the relevant course descriptors tied to assessment. At UND, the details for how a numerical course score is earned is required to be outlined in the syllabus, making the evaluation portion of a class highly visible. The presence of more or more varied assessments could point to the integration of more active learning strategies in a course. For example, if students have two standardized assessments, there is less individual creation and application of content possible than with multiple, performance-based evaluation sets involving performance or portfolio elements (DeMara et al., 2016; Newhouse, 2017).

To further clarify the point system used for the syllabi, a sample (Appendix F) and scoring assignment (Figure 1) was provided and explained. The syllabus (Sheridan, 2011) is from a face-to-face course offered at UND. It is not a STEM course and will not be included in this study beyond the sample of scoring system use. The total for the course was sixteen points. The individual research of articles, two student presentations, and subsequent discussions fit into two different categories. Points were thus awarded for the student tasks in both categories.

Syllabus/Course Description Terms	**Value**	**Assigned Points**
Test(s)	1	1
Daily or weekly quizzes	2	
Daily or weekly exit ticket (ex: clicker questions, Form, Poll Everywhere, etc.)	2	2
Voluntary office hour attendance by students	1	1
Mandatory office hour attendance by students	2	
Weekly assignments	2	2
Weekly assignments completed in groups	3	
Weekly assignments with answers discussed in class	4	
Questions imbedded into readings or videos	2	
Individual presentation	1	

Group presentation	4	
Multiple individual presentations – includes article research	5	5
Multiple group presentations	5	
Class Discussions – formal and informal	2	2
Portfolio-based evaluation	5	
Grade based on 1 category	1	
Grade based on 2 categories	2	
Grade based on 3 categories	3	3
Grade based on 4+ categories	4	

Table 1. Score breakdown and points awarded based on sample Biological Anthropology syllabus. The syllabus is from an in person, or face-to-face course offered at the University of Notre Dame in the Fall 2011 semester.

The application of the point system rubric for assigning a numerical value to each class based on varied course elements connected to more active teaching techniques was independently applied to duplicate syllabi by a current Instructional Systems Technology faculty member at Indiana University, Bloomington. This secondary analysis helped to support the validity of the syllabus rubric as an assessment of active teaching methods tied to specific courses and thus faculty.

Survey Analysis

An instructor survey/questionnaire included items requesting qualitative and quantitative data (Appendix D). The analysis of the instructor survey responses provided guidance to course design decisions of variety and use of active teaching methods in STEM course designs at UND. Akin to the described range of active learning methods, personal involvement in course designs, participation in college-wide course design elements, and individual commitment to professional development and continuing education can be varied. These professor activities were Likert scaled to avoid simple yes or no responses and focus on increased or decreased frequencies of the specific activities such as reading of STEM or education-based professional literature.

The unit of analysis was the individual instructors, each of whom will be included in one of the three following education background groupings:

1. F - formal education background (regular education seminar or conference attendance and/or presentations, regular reading and/or subscriptions to education journals, college courses in education
2. I – no formal education background, only informal educational experiences such as less than yearly education seminar or conference attendance or semi-regular reading of education journal articles, identification as teaching faculty on the university or department webpages
3. N - no formal or informal training or education background (only STEM content training/backgrounds)

The instructor survey responses divided the professors into one of the three categories for education background (F, I, or N) following the division described above. The instructors were then connected to the courses that they taught or currently teach and the total points from the course syllabus were tied to each instructor.

Some faculty present for my own undergraduate work still teach at UND, so personal knowledge of the professors and experience in their classrooms were minimized with a delayed connection to background categories to increase anonymity and decrease unconscious bias during the analysis phase.

Results

Of the 48 participants in the survey portion of the research, six participants were excluded from the final analysis based on the inability to access a course syllabus for those individuals following multiple attempts, through email, to the department heads, college deans, and the individual professors in addition to varying online searches for the course materials. The finalized sample size was 42 STEM instructors from UND teaching an in-person course. Six additional potential participants responded through email that they were declining participation based on time availability, lack of in-person course teaching, or other reasons.

Primary research question: difference between groups

Descriptive statistics were calculated to view variance within education group before possible variance between groups was identified. While the total sample size for the study was 42, only six instructors fell within the formal education category ($N_F = 6$, $N_N = 17$, $N_I = 19$). Because of this small subgroup, less power and statistical confidence could be associated with values within this specific group as additionally evident by the largest standard error value of the data set ($SEM_F = 1.14$, $SEM_N = 0.69$, $SEM_I=0.63$).

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	Between-Component Variance
						Lower Bound	Upper Bound			
No Formal		17	8.65	2.827	.686	7.19	10.10	5	15	
Informal		19	10.95	2.758	.633	9.62	12.28	6	18	
Formal		6	11.83	2.787	1.138	8.91	14.76	7	14	
Total		42	10.14	3.009	.464	9.21	11.08	5	18	
Model	Fixed Effects			2.790	.431	9.27	11.01			
	Random Effects				.986	5.90	14.38			2.022

Table 2. Descriptive statistics of course syllabi scores and instructor backgrounds. Sample means, standard deviation, and standard errors STEM instructors' use of active teaching methods as derived by the application of the syllabus analysis rubric.

A Pearson correlation coefficient was computed to assess the relationship between instructor education category (Formal, Informal, or No Formal or Informal) and syllabus scores calculating potential active teaching method use. There was a statistically significant linear relationship ($r = 0.41$, $p < 0.01$) between the two variables. The direction of the relationship was positive meaning that these variables tend to increase together. The magnitude, or strength, of the association was calculated to be moderate.

Secondary research question: significant difference between groups

The syllabus score mean was determined to be significantly different for at least one of the groups ($F_{2, 39} = 9.21$, $p < 0.05$). To determine which means were different from one another, multiple comparisons/post-hoc tests were conducted. The mean difference of course scores between I and N ($M = -2.30$, $SD = 0.93$) education background instructors was significant ($p < 0.05$) while the mean difference of course scores between F and I education background individuals was not significant ($p > 0.05$). These findings supported the hypothesis of variation between the education groups and are illustrated in Figure 1.

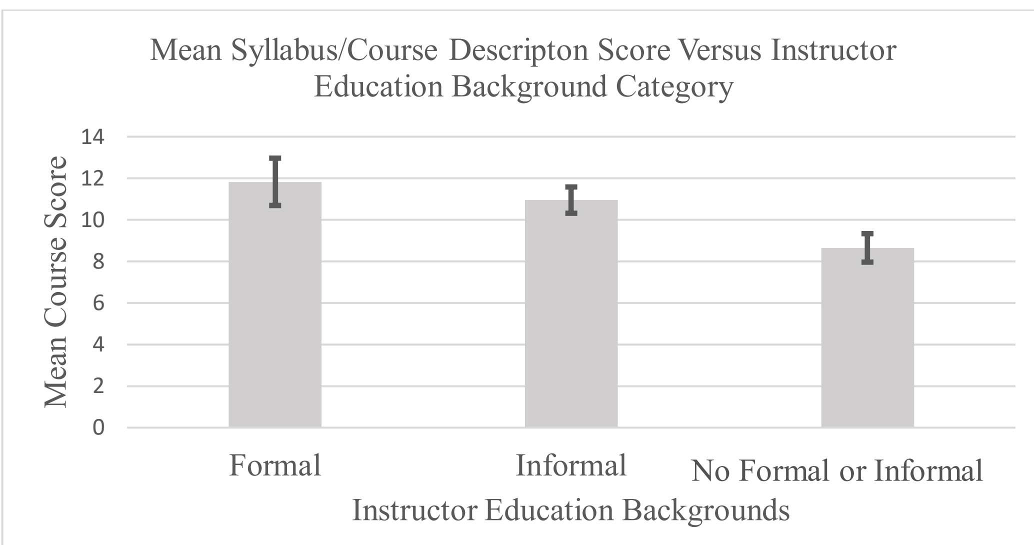


Figure 1. Mean syllabus/course description score versus instructor background categories. The mean difference of course scores between informal and no formal or informal training education

background instructors was statistically significant while the mean difference of course scores between formal and informal education background individuals was not statistically significant.

Instructors with formal education instruction including undergraduate or graduate education courses designed syllabi featuring active teaching methods as calculated using the point system rubric developed for this study with an average score of 11.83 (N = 6, SEM = 1.14). Instructors with informal education instruction such as less than yearly education seminar or conference attendance or semi-regular reading of education journal articles, identification as teaching faculty on the university or department webpages as reading of education-based journals, running of undergraduate or graduate education courses designed syllabi featuring active teaching methods with an average score of 10.95 (N = 19, SEM = 0.63). Instructors with no formal or informal training education backgrounds and only content-based education and training designed syllabi featuring active teaching methods with an average score of 8.65 (N = 17, SEM = 0.69).

Active teaching method frequency of use grouped by instructor education background was calculated and compared for further identification of variation between the instructor groups. Results are shown in Figure 2. The four most commonly used methods by all three instructor groups were tests/formal assessments, voluntary office hours, weekly assignments, and utilizing at least three categories for the development of the semester score. Those with informal education backgrounds utilized the greatest variety of measured teaching methods. Individual method comparisons show a decreased use of repetitive and collaborative assignment and assessment methods by instructors with no formal or informal education backgrounds.

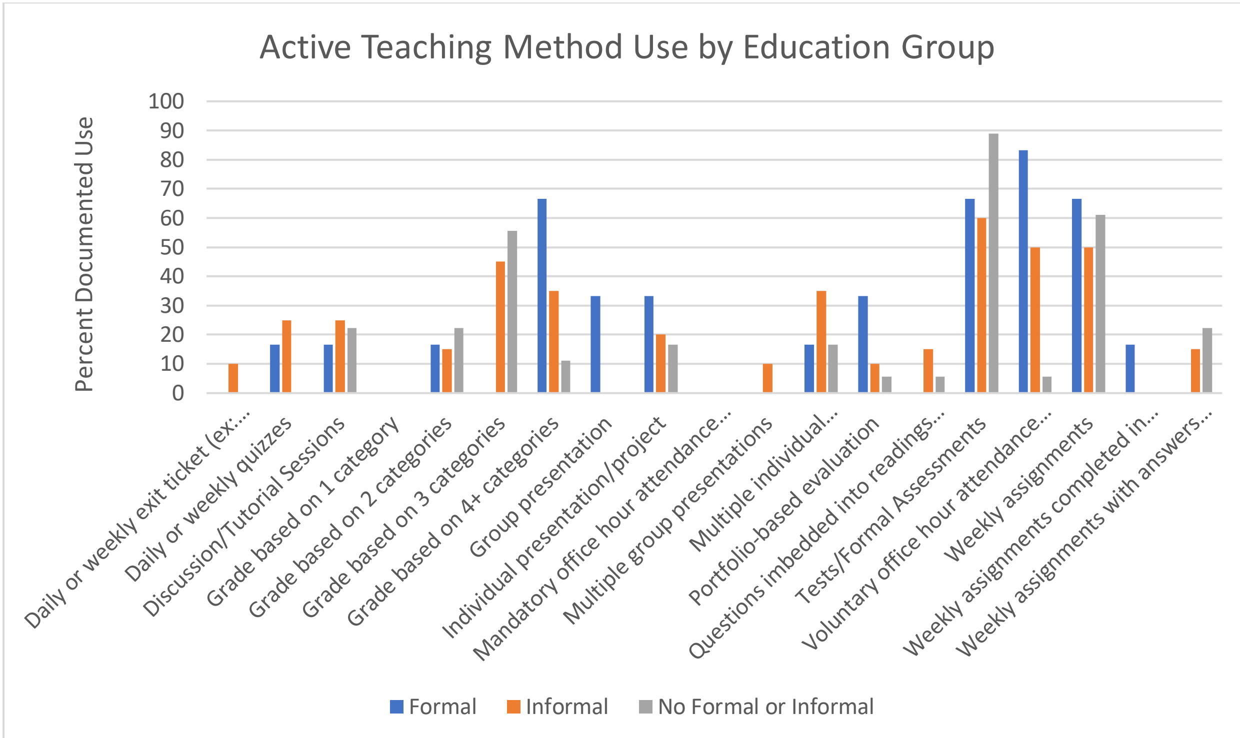
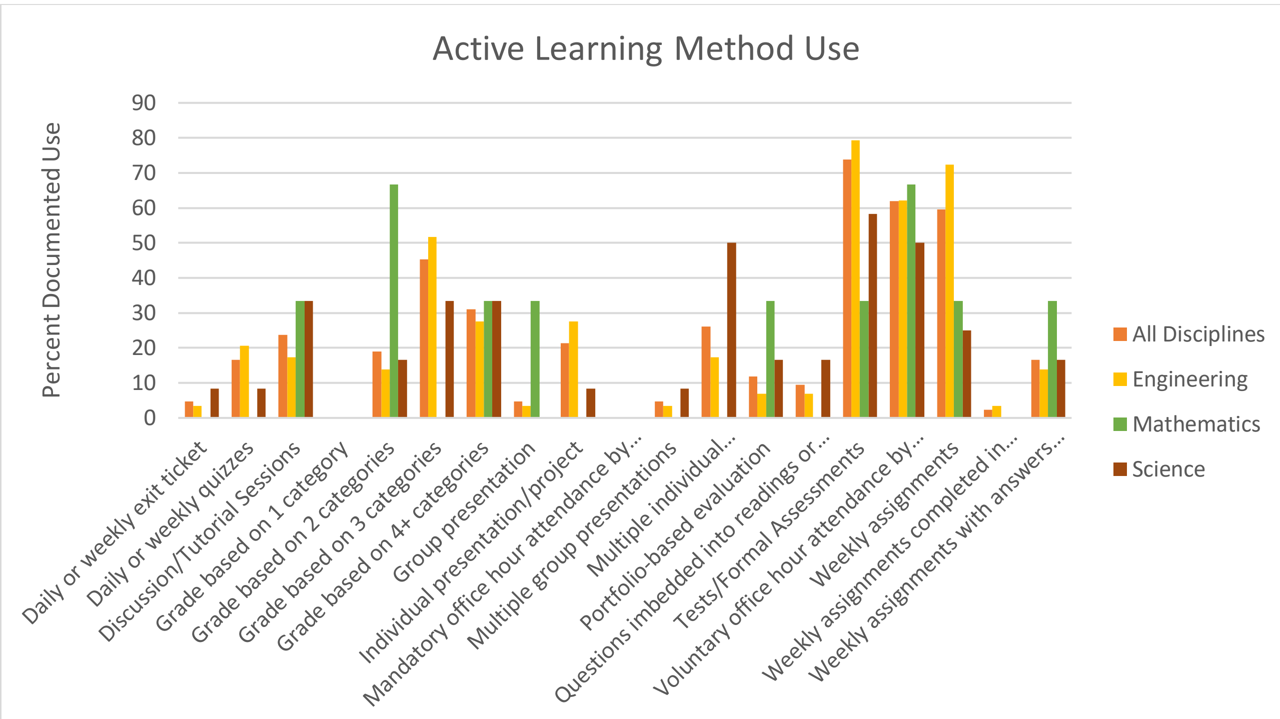
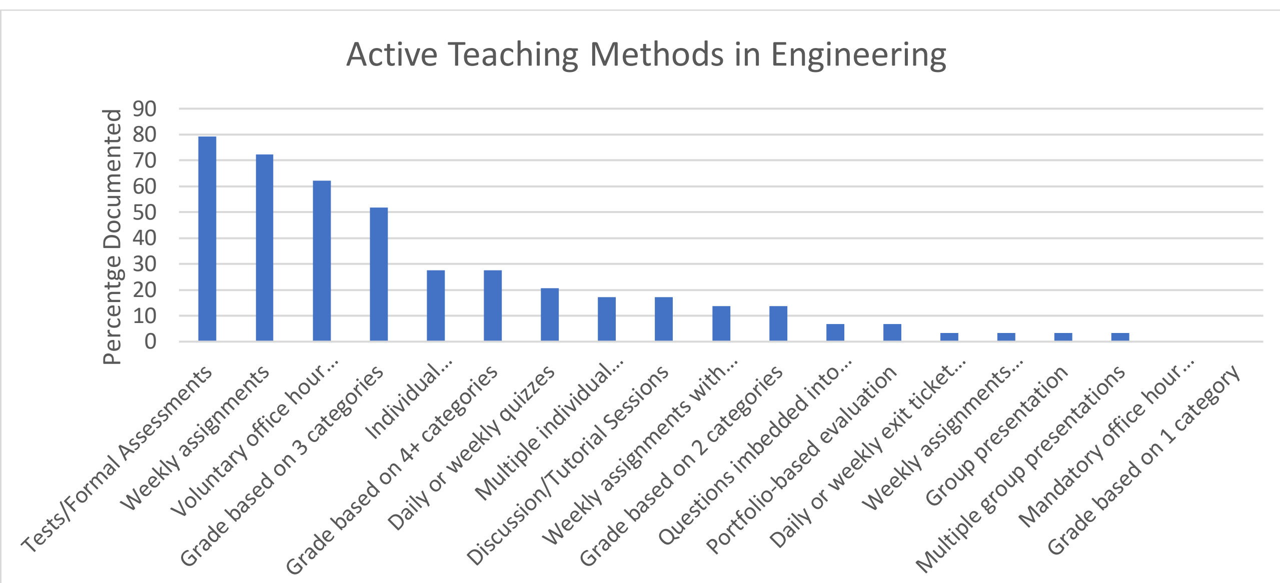


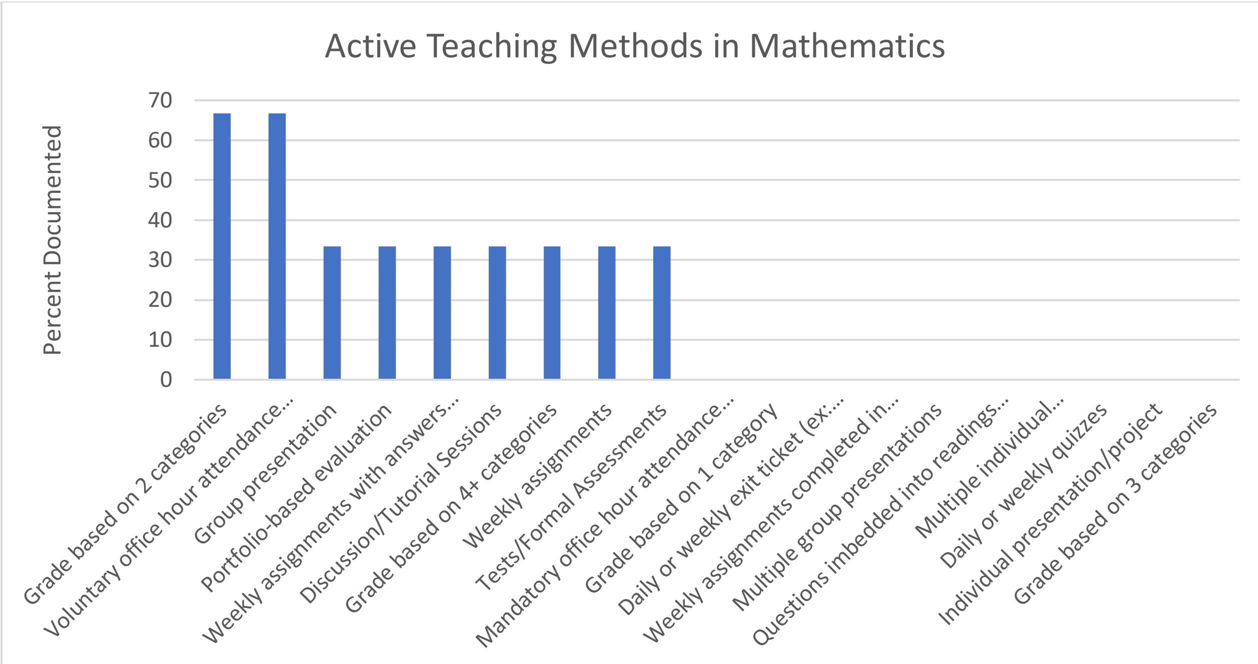
Figure 2. Active teaching method frequency of use grouped by instructor education background. The four most commonly used methods by all three instructor groups were tests/formal assessments, voluntary office hours, weekly assignments, and utilizing at least three categories for the development of the semester score. Those with informal education backgrounds utilized the greatest variety of measured teaching methods.

Additional analysis

In addition to the breakdown of active learning method use by instructor education backgrounds, an ancillary question regarding the use of different active teaching methods was developed and calculated. Trends within STEM disciplines appeared to develop. Figure 2 shows the comparison of use for the specified active teaching methods between the three major disciplines of STEM courses, Engineering, Mathematics, and Science. Tests and other formalized assessments, voluntary office hours, and weekly assignments were noted in the highest percentages in all analyzed disciplines. Engineering courses noted a heavier reliance on individual work (portfolios, presentations, assignments). Mathematics and science courses featured tutorial sessions and discussion more than engineering courses. While a small sample size of mathematics compared to the other two groups ($n_{engineering} = 29$, $n_{mathematics} = 3$, $n_{science} = 12$) reduces the confidence in statistical comparisons, general trends could be further noted and discussed for additional considerations to be made to the Kaneb Center.







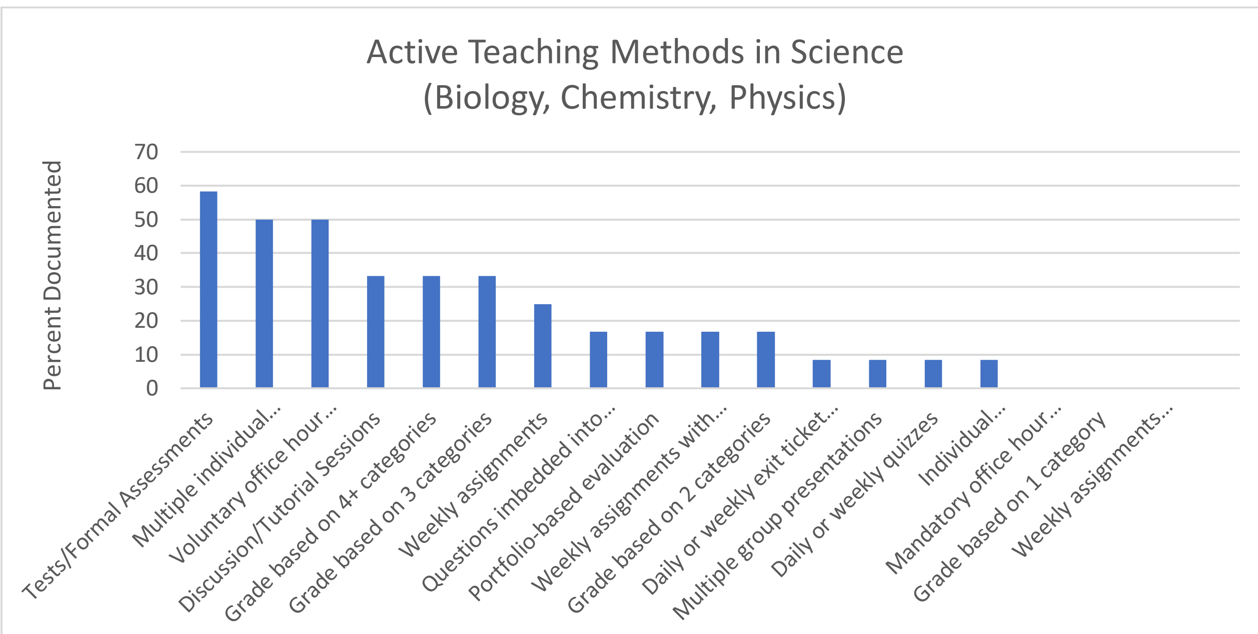


Figure 3. Active learning method use documented in course syllabi/descriptions as a whole and broken down by STEM discipline. Tests and other formalized assessments, voluntary office hours, and weekly assignments were noted in the highest percentages in all analyzed disciplines. Engineering and science showed the most amount of commonality in method use when

compared to the mathematics available data. Mathematics shows the least variety of method use and has the smallest sample size ($n_{engineering} = 29$, $n_{mathematics} = 3$, $n_{science} = 12$).

Conclusions

This research project focused around one primary question and one secondary question to conduct an investigation of a potential link between course design choices and educational backgrounds of in-person, STEM instructors at the University of Notre Dame. In terms of course design for STEM courses, do instructors with different education-based backgrounds select different types of active teaching methods? If a difference exists between instructor groups (F, I, and N) with respect to incorporation of active teaching methods in his or her course designs, is the difference statistically significant from the other instructor groups?

I hypothesized that there would be similarities between the type and quantity of active teaching methods promoting active learning in students in courses from individuals in the formal (F) and informal (I) instructor groups. This was primarily supported by literature focused on the impacts and types of professional development on instructor teaching changes (Loucks-Horsely & Matusmoto, 1999; Loucks-Horsely et al., 1996; Geret et al., 2001). I expected to find a difference, with the potential of a significant difference, in the use of active teaching methods between the F and N instructor groups. N faculty with only content background training likely teach and design courses using the methods in which they were originally taught, with potential emphasis on lecture-based instruction. Such a difference was determined to exist based on the syllabus analysis and categorization of instructors. Multiple comparisons/post-hoc tests were conducted to determine that the mean difference of course scores between I and N instructors was significant ($M = -2.30$, $SD = 0.93$, $p < 0.05$), while the mean difference of course scores between F and I education background individuals was not significant ($p > 0.05$). These calculations supported my hypothesis and answered my focus questions. In terms of course design for STEM courses, instructors with different education-based backgrounds selected different types of active teaching methods and in the comparison of I and N instructors, the difference was statistically significant.

Application and Significance

This study and its findings provide quantitative evidence supporting the professional development of STEM instructors with education-based philosophies, teaching methods, and course development innovations. Faculty do not need a formalized background in education through graduate or undergraduate courses to design STEM classes featuring strategies taught in those courses. There is a lower, personal investment in teaching developments that can have similar outcomes as higher, more timely ones. The no formal or informal training and education background group do not represent a deficit group. Instead, the research shows that is it likely more modifications and expansions on current practices that could lead to more use of active teaching methods which have extensive support with improving student outcomes.

The data collected through this study could be useful to instructor teaching and innovation centers such as the Kaneb Center at UND. In addition to explaining what workshops and tutorials are offered, specific accompanying data could be shared with the faculty when promoting such events. This may provide a greater incentive for instructors to work with the Kaneb Center's resources and develop a more continued education in instructional strategies and developments. Emphasis on active teaching methods and active learning practices are already a part of the curriculum available through the Kaneb Center. Further emphasis on such educational practices with the addition of organization into the ten high-impact educational practices centered around collaborative learning, and authentic intellectual experiences (Kuh, 2008) may promote the shift of more instructors at UND from the N to I groups.

Future Directions for Research

This applied study focused on a sampling of STEM instructors at UND with the potential to provide supportive research for the Kaneb Center. The Kaneb Center, however, does not work exclusively with STEM instructors, but is open to all faculty and staff within the University. It is possible that connections between instructor background and course design choices are not common across different fields of study. Further research could look into the same question of course design selections and educational backgrounds in other instructor groups such as those in liberal and fine arts faculty.

It is possible that the syllabus analysis rubric is not sensitive enough to capture what is happening in the classroom when the course is run. Since this study focused on the design of courses, additional studies and expansions could include documentation from classroom recordings and notes from observations throughout a semester of the course being taught.

This study focused on STEM courses taught in a physical, face-to-face classroom at the University of Notre Dame. It was not limited to undergraduate or graduate courses, nor was it restricted to courses taught for students within that discipline major or for general education purposes. Further focus and subsequent data breakdown along these lines could be completed and allow more resulting trends and detailed recommendations to be provided to the Kaneb Center. Focus on course type, level, class size, and other classroom factors may highlight more specific active teaching method use tendencies than when considering the method use as a whole or within STEM disciplines in general.

Additionally, given the timely shift to emphasize and utilize more digital resources, assessments, and assignments reducing transfer and direct contact/association between individuals prompted by Covid-19 precautions, expanding instructor repertoire and familiarity with more teaching methods is imperative.

Limitations

A limitation of this study related to the potential variation between course design and application. What is done in class may differ from what is planned regarding more or less active teaching methods. Since the focus of this research lies in course designs, connections can still be drawn between the syllabi and faculty background information.

Just as the education-based backgrounds will vary between faculty, so too, will other personality factors and personal backgrounds. While a focus on teaching practices through professional development can increase the use of those practices (Garet et al., 2002), the implementation of such practices may not lead to student success. The final presentation of different instructional methods can have different engagement factors from the viewpoint of entertainment, which may influence student investment or student engagement. Because of this, the implementation of the instructional methods will be outside the bounds of this research.

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Appendix A

Syllabi/Course Descriptions Access Protocol

1. Email Deans, Administrative Assistants to Deans, and Assistant Deans (if appropriate) requesting access to copies of syllabi/course descriptions of undergraduate STEM courses
2. Access syllabi available online if access through the colleges is limited
3. If any personally identifying information is on the syllabi, redact those details prior to further analysis
4. Apply syllabus point distinction (Appendix C)
5. Tabulate total course score

Appendix B

Survey Protocol

1. Gather University of Notre Dame STEM faculty email addresses from individual college websites.
2. Email letter describing the purpose of the research project and the role of the survey within it in addition to the IRB consent form for digital signatures and survey link.
3. Send one reminder email to unresponsive faculty members with same information as the first email.
4. Email the two randomly selected responses to send gift card incentive for participation
    a. All survey responses, regardless of content are eligible for drawing
5. Organize survey data
    a. Assign faculty with new ID numbers to be used in place of names for data analysis
    b. Identify faculty as having formal (F), informal (I), or no formal or informal training (N) education backgrounds
        i. F - formal education background (regular education seminar or conference attendance and/or presentations, regular reading and/or subscriptions to education journals, college courses in education
        ii. I – no formal education background, only informal educational experiences such as less than yearly education seminar or conference attendance or semi-regular reading of education journal articles

iii. N - no education background (only STEM content training/backgrounds)

c. Connect faculty with specific STEM courses to analyze potential correlations between course and faculty data

Appendix C

Syllabus/Course Description Point Distinction for Varying Levels of Active Teaching Methods

Syllabus/Course Description Terms	Point Value	Likely Bloom's Taxonomy Level	Additional Rationale for Value	Assorted Examples from Collected Syllabi
Tests/Formal Assessments	1	Varying levels possible – specific question analysis would be necessary for determination of level	No points as this is a standard assessment with greatly varying taxonomy levels	Exam dates: This is an upper-division biochemistry course with 3 Exams and one semi-cumulative final exam (i.e. I will draw on early material in formulating some questions). Exam 1-3 will be held in class. Final exam scheduled by University. [CHEM 30342]
Daily or weekly quizzes	2	Knowledge, Comprehension	Repetition of assessment	Quizzes and Exams Examinations will be the primary means for student assessment. The knowledge and skills you develop in this course are keys to your success in subsequent courses and your engineering career. Therefore, there will be a strong emphasis on testing for knowledge and skill development. 1. Exams and quizzes will be closed book unless stated otherwise. The instructor will provide reference sheets including conversion factors and the periodic table. 2. There will be seven quizzes and a final exam. Makeup quizzes will be permitted for excused university absences…[CBE 20255]
Daily or weekly exit ticket (ex: clicker questions, Form, Poll Everywhere)	2	Knowledge, Comprehension	Repetition of assessment	"Minute" Quiz questions and answers [CBE 20255]

Voluntary office hour attendance by students	1	Varying levels in discussion likely	Collaboration, may be unlikely utilized as it is voluntary	office hours are Wednesdays from 11-12 in A128 [CHEM 30342]
Mandatory office hour attendance by students	2	Varying levels in discussion likely	Required, collaboration	None
Weekly assignments	2	Comprehension, Application	Repetition of practice	There will 5-6 homeworks assigned roughly bi-weekly. They will be a combination of theory and programming exercises. Throughout the course, you will systematically build a finite element code in MATLAB, aided by the homework prompts and a minimal amount of starter code. Some homework assignments will also include a problem to solve using COMSOL. [AME 40541]
Weekly assignments completed in groups	3	Comprehension, Application	Repetition of practice, collaboration	Homework Policies: Students may turn in homework independently or in teams of two or three, in which case both/all team members receive the same grade. The teams are allowed to vary each assignment. If an individual or team receives help from classmates for an assignment, give credit acknowledging this. [ACMS 30440]
Weekly assignments with answers discussed in class	4	Analysis of content, evaluation of peer contributions and responses	Repetition of practice, collaboration, discussion, formative assessment within discussion	Recitation session: An optional recitation session will be held every 1-2 weeks in --- on Wednesdays 11:30a-12:30p. These sessions will be used to dive deeper into material rarely covered in a traditional lecture: background on MATLAB coding, implementational aspects of FEM, interactive office hours, review sessions for examinations, final project assistance, etc. [AME 40541]

Questions imbedded into readings or videos	2	Knowledge, Comprehension	Increased time of attention with readings or videos	There will be daily quizzes. The material for the quiz will be based on the reading assigned for that day as well as the material covered in the previous class period. [AME 44590]
Individual presentation	3	Analysis, Application	Performance-based assessment	Presentations: You will be responsible for presenting one “Biochemistry in Real Life” segment throughout the semester. These segments will be a brief (5 minute) presentation focused on some aspect of biochemistry that you’ve encountered in your everyday life. You will explain the chemistry behind the everyday phenomena, and draw connections to --- or other chemistry courses. Dr. --- will present a few as examples prior to the first student presentation… [CHEM 30342]
Group presentation	4	Synthesis, Analysis	Collaborative, performance-based assessment	Project Ideas – Everyone in the class is responsible for writing up an individual project idea that we will discuss in class. We will then decide as a group which idea/s is/are the most exciting and promising for publication. We will then work in one to two groups to produce papers on the selected projects. [BIOS 60602]
Multiple individual presentations	5	Synthesis, Analysis	Repeated, performance-based assessment	Plots are of particular importance in this course, for both their esthetics and substance. A portion of your grade will depend on how efficiently and effectively graphical results are presented. Some rules follow. All plots must be computer-generated. All plots must have axes labeled with units when appropriate. The size of the fonts on the plots should be similar to those elsewhere on the page. Much smaller or much larger fonts 2 are unacceptable. Large plots taking up a single page are unacceptable. Whenever possible, combine

				several curves onto one set of axes, especially when making direct comparisons of results. Use different line styles where appropriate. Use color sparingly, but effectively. Reference to all plots must be made in the body of your homework. Grades will be assigned based on students' performance on examinations and homework. [AME 20214]
Multiple group presentations	5	Evaluation, Synthesis, Analysis	Repeated, collaborative, performance-based assessment	Many laboratory assignments will be executed in pairs. It is expected that both team members will contribute equally, turn in one assignment and receive the same grade for that assignment. Teams may discuss the assignment with other teams, but again should conduct and hand in their own work. [CE 70250]
Discussion	2	Evaluate	Collaboration, formative assessment within discussion	There are 14 tutorials. There will be a tutorial on Thursday January 16 during which new material will be covered. Additionally, new material will be covered in tutorials on February 20 and March 19. The remaining tutorials will be used for worksheets and addressing issues with assigned homework. More or less you get a point (up to 10 points) for each tutorial you attend. Lack of success with a worksheet will not affect your tutorial grade but it does indicate that further work on your part is necessary to master that material. Excused absences from tutorials will not count against you. It is our experience that the failure to regularly attend tutorial radically lowers your course grade. [MATH 20550]

Portfolio- or Performance-based evaluation	5	Evaluation Analysis Synthesis,	Multiple elements within assignment, increased likelihood of project-based or problem-based assignments, summative assessment-based work	The course consists of five components: Weekly algorithm assignments and projects (cumulative), a concluding final project. [CBE 20258]
Grade based on 1 category	1	Varying levels	No variation of assessment	None
Grade based on 2 categories	2	Varying levels	Increased variation of assessment forms	Four pre-lab quizzes (20%), four lab reports (80%) [AME 21241]
Grade based on 3 categories	3	Varying levels	Increased variation of assessment forms	Grades will be based on homework (20%), quizzes (60%), and a cumulative final exam (20%) [CBE 20255]
Grade based on 4+ categories	4	Varying levels	Increased variation of assessment forms	Grading: Exams (3 Exams) 300; Final Exam 100 Problem Sets (3 Problem Sets) bonus points on exams; Brief presentations to class 30; Critique of class presentations 10 [CHEM 30342]

Appendix D

Instructor Survey Questions

- Name (Free Response)
- List the name(s) of all of the courses you teach at the University of Notre Dame. (Free Response)
- How many years have you been teaching a college-level course? (Numerical Response)
- Select the level that best describes your participation in department-level instructional development. (Likert scale 0 = never, 1 = rarely, 2 = once a year, 3 = once a semester, 4 = multiple times a semester)
- Select the level that best describes your participation in college or university-level instructional development. (Likert scale 0 = never, 1 = rarely, 2 = once a year, 3 = once a semester, 4 = multiple times a semester)
- Please list all current degree and the field in which they are in (ex. BS in Biological Sciences) (Free Response)
- How many undergraduate credits do you have in Education courses? (Numerical Response)
- How many graduate credits to you have in Education courses? (Numerical Response)
- Do you hold a teaching license (current or expired)? (Yes or No)
- Do you hold a Ph.D. or Ed.D. in an education-related field? (Yes or No)
- Finish the following statement. I read or skim at least half of the articles from Education-based journals __. (Likert scale 0 = never, 1 = rarely, 2 = once a year, 3 = once a semester, 4 = multiple times a semester)

- Finish the following statement. I read or skim less than half of the articles from Education-based journals __. (Likert scale 0 = never, 1 = rarely, 2 = once a year, 3 = once a semester, 4 = multiple times a semester)
- Finish the following statement. I read or skim at least half of the articles from Science, Mathematics, or Engineering-based journals __. (Likert scale 0 = never, 1 = rarely, 2 = once a year, 3 = once a semester, 4 = multiple times a semester
- Finish the following statement. I read or skim less than half of the articles from Science, Mathematics, or Engineering-based journals __. (Likert scale 0 = never, 1 = rarely, 2 = once a year, 3 = once a semester, 4 = multiple times a semester)
- Describe an example where you believe you have taught in a manner involving more active learning teaching methods. (Free Response)
- List a few classroom items you have found to promote more active teaching? (Free Response)

Appendix E

IRB Consent Form

INDIANA UNIVERSITY INFORMED CONSENT STATEMENT FOR RESEARCH
STEM Instructor Education Survey

ABOUT THIS RESEARCH
You are being asked to participate in a research study. Scientists do research to answer important questions which might help change or improve the way we do things in the future.

This consent form will give you information about the study to help you decide whether you want to participate. Please read this form, and ask any questions you have, before agreeing to be in the study.

TAKING PART IN THIS STUDY IS VOLUNTARY
You may choose not to take part in the study or may choose to leave the study at any time. Deciding not to participate, or deciding to leave the study later, will not result in any penalty or loss of benefits to which you are entitled and will not affect your relationship with the University of Notre Dame.

WHY IS THIS STUDY BEING DONE?
The purpose of this research project is to investigate a potential relationship within STEM instructors at the University of Notre Dame between instructor course design choices and educational backgrounds with the potential to provide supportive research for the Kaneb Center at the University of Notre Dame. Data will be collected primarily through a review of course syllabi and instructor surveys with questions related to the course formats and decisions about the methods used in the course.

You were selected as a possible participant because you teach a STEM-based course at the University of Notre Dame.

The study is being conducted by Sarah Corke as part of a dissertation research project though Indiana University, Bloomington.

HOW MANY PEOPLE WILL TAKE PART?
If you agree to participate, you will be one of approximately 60 instructors taking part in this study.

WHAT WILL HAPPEN DURING THE STUDY?
If you agree to be in the study, you will do the following things:
Respond electronically to questions in a survey centered on individual Education backgrounds and participation in instructional design and formal education seminars and courses. The survey will take approximately 10 minutes to complete.

WHAT ARE THE RISKS OF TAKING PART IN THE STUDY?

While participating in the study, the risks, side effects, and/or discomforts include:

- A risk of completing the survey is being uncomfortable answering the questions.
- There is a risk of possible loss of confidentiality.

While completing the survey, you may skip question that makes you uncomfortable and ones that you do not want to answer by leaving the response blank.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THE STUDY?
We don't expect you to receive any direct benefit from taking part in this study, but we hope to learn things that will help scientists and instructors in the future.

HOW WILL MY INFORMATION BE PROTECTED?
Efforts will be made to keep your personal information confidential. We cannot guarantee absolute confidentiality. Your personal information may be disclosed if required by law. No information which could identify you will be shared in publications about this study. Responses will only be directly connected to specific courses on the researcher's personal computer directly accessible to the researcher only. Data analysis will use identifier numbers to pair courses with instructors.

Organizations that may inspect and/or copy your research records for quality assurance and data analysis include groups such as the study investigator and his/her research associates, the Indiana University Institutional Review Board or its designees, and state or federal agencies who may need to access the research records (as allowed by law).

WILL MY INFORMATION BE USED FOR RESEARCH IN THE FUTURE?
Information or specimens for this study may be used for future research studies or shared with other researchers for future research. If this happens, information which could identify you will be removed before any information is shared. Since identifying information will be removed, we will not ask for your additional consent.

WILL I BE PAID FOR PARTICIPATION?
All participants who submit a survey will be eligible one of two $25 Amazon gift cards. The selected participants will be notified via email before April 1st, 2021.

WILL IT COST ME ANYTHING TO PARTICIPATE?
There is no cost to you for taking part in this study.

WHO SHOULD I CALL WITH QUESTIONS OR PROBLEMS?
For questions about the study contact the researcher, Sarah Corke, at 574-360-8449.

For questions about your rights as a research participant, to discuss problems, complaints, or concerns about a research study, or to obtain information or to offer input, please contact the IU Human Subjects Office at 800-696-2949 or at irb@iu.edu.

CAN I WITHDRAW FROM THE STUDY?

If you decide to participate in this study, you can change your mind and decide to leave the study at any time in the future. The study team will help you withdraw from the study safely. If you decide to withdraw, return the survey without responding to any questions or email Sarah Corke specifying your wish to withdraw from the study. Your request will be processed and a confirmation email will be sent notifying you of the removal of any of your responses.

Your participation may be terminated by the investigator without regard to your consent in the following circumstances: you do not teach an in person STEM course at the University of Notre Dame.

PARTICIPANT'S CONSENT

In consideration of all of the above, I give my consent to participate in this research study. I will be given a copy of this informed consent document to keep for my records. I agree to take part in this study.

Participant's Printed Name:

Participant's Signature (physical or electronic)__________________________ **Date**:

Printed Name of Person Obtaining Consent: Sarah Corke

Signature of Person Obtaining Consent: Sarah Corke **Date**: 01/11/2021

Appendix F

Sample UND Syllabus

FUNDAMENTALS OF BIOLOGICAL ANTHROPOLOGY

Department of Anthropology, University of Notre Dame

COURSE: ANTH 30101 TERM: FALL 2011

This course provides an overview of biological anthropology, using the evolution of *Homo sapiens sapiens* as a model for discussing the myriad of topics within the subdiscipline. We will survey how the field synthesizes the biological & cultural processes at work in shaping human adaptation, past & present.

As part of the University's Green Initiative, all readings for the class are available on Concourse, as are all PowerPoint lectures and handouts. Your grades will likewise appear on Concourse as materials are completed.

The topics below usually cover several class periods. Dates are not specifically assigned per topic, to permit you to guide the depth of discussion. However, exam dates are set and will encompass the material covered up to that point. These dates will not change.

COURSE OBJECTIVES

- **using primate evolution to *Homo sapiens sapiens* as a model to explore the subfields of biological anthropology;**
- **exploration of our evolution by means of natural selection using a form/function/adaptation approach;**
- **learning how to build models to understand our evolution, and our place in the natural world;**
- **review of major hominin fossil finds;**
- **development of a critical approach to the analysis of anthropology in the professional and popular press.**

READINGS

All required readings appear together in Concourse, in a folder using the headings listed below. The articles provide a mix of material from the popular press (*Scientific American, Discover,* etc) and professional literature (*Science, American Journal of Physical Anthropology,* etc.). The "extras" folders are readings with further information for those interested in the topic (historic pieces, recent publications, articles you identify during the semester). You will not be responsible for these 'extras' on your exams.

FACEBOOK

Articles of interest to this class are regularly posted on the **"BioAnthropology News"** facebook group (http://www.facebook.com/group.php?gid=34315136474) Many of the authors of your required readings are members -- it is an excellent resource for keeping up with recent work across the broad range of topics in biological anthropology, with commentary from researchers active in the field. Information on this page will not be on your exams, but you will be responsible to keep up with the group for you article reviews (see below).

ATTENDANCE

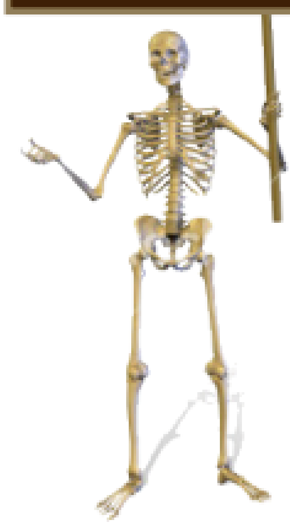
Attendance is strongly advised and excessive absence for discussions, movies, and assignments will prove very detrimental to your final grade. Attendance will be taken randomly during the semester, as well as monitored by completion of In-Class Activities. You will fail the course after if you miss 5 classes, regardless of your grade in the class to that point.

The 3 accepted reasons for a University-sanctioned absence are (as per your Student Handbook): *"personal illness, death in the immediate family, and duties performed for the University. Under the three special circumstances noted, the assistant vice-president for residence life is responsible for verification of the reason for the absence. When an absence is approved, an official form is forwarded to the professor(s) and deans involved."*

If you miss an assignment ***you must present official documentation provided by the appropriate office on campus.*** ONLY documentation from Residential Life and/or Academic Services for Student Athletes and/or a Dean's Office will be accepted.

This **does not** include:

- job interviews
- Med/Law/Grad school interviews
- school-related exams
- early departures for Fall or Thanksgiving Break
- family reunions, weddings, birthdays, etc.



IN-CLASS ACTIVITIES

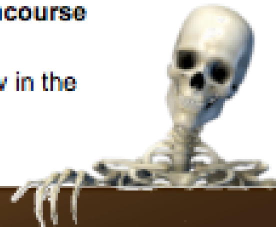
"In-class" activities will be completed during the course period. There will be several during the semester that you **will not be allowed to make-up** if you miss class; however, the assignments will be on Concourse so you can get the information for exams (ask a friend in class for the answers) – but you can not turn in the assignment after the class period for credit.

For clarity (at the risk of being redundant) – *only University accepted excused absences will be accepted.* These activities and the weekly article reviews (below) will make up 20% of your grade. In-class assignments are designed to facilitate discussion & class interaction. **No extra-credit is available to compensate for missed work.**

BI-WEEKLY ARTICLE REVIEWS

Every other Friday (beginning September 2nd) you will be responsible for an article published in the popular press or scientific literature dealing with some aspect of the topics covered in class. The article must be of substantial detail and must be current (published during the **previous month**). In addition, approximately 5 people will be asked to discuss their articles - each student must participate at least twice during the semester. **Late articles will not be accepted.**
You will be expected to post a summary for each article via Concourse *before* coming to class on Friday(s).

Also, there is a handout with the required information for each review in the "Introduction" folder on Concourse – **please use this form for each assignment.**



The articles must be:

1. of sufficient length (at least 2 pages long, WITHOUT large print, ads, large spaces between paragraphs, etc.),
2. from reliable sources (not blogs -- although there are several excellent blogs in anthropology, this assignment does not include these sources),
3. published in the past month. "Early View" versions of journal articles are acceptable.
4. well summarized by you, with clear biases outlined (there are always biases). Also, be sure to summarize in your own words, **do not plagiarize** (your reviews will be checked on Turnitin.com on occasion). More on plagiarism below.
5. clearly applicable to the topics on your syllabus. Don't stretch the bounds, there's plenty to choose from already.

** You may use posts (of sufficient quality/detail and within the allotted time frame) found on the BioAnthropology News page – however, if you summarize an article that has not yet appeared there, you will get 1 point extra credit (per assignment) for searching out an original source.

Full reference: Be sure to provide complete bibliographic information and URL (if applicable) for your article.

Direct link: Make sure the URL links ***directly*** to your article. If I cannot read the article (incomplete URL, re-directed URL, etc), I will not grade your summary and you'll lose **all 10 pts**.

Substance: If the article is too short, you lose 3 pts. There needs to be enough information in the article you select to properly answer the questions required.

Main points: Regarding the main points of the work, do not lift them verbatim from the article (even if you use quotation marks).

Synthesize: Put the information in your own words; utilize information from class and readings.

Bias: Consider aspects such as sample size, composition, social/religious implications of the questions being asked, length of study, equipment used, assumptions, etc.

Language: Be sure to use proper Linnaean classification, and avoid 'chattiness' (this isn't an email, write accordingly).

You will be expected to discuss your article at least 2x during the course of the semester. I will initially ask for volunteers, if none rise to the occasion, I will randomly call on students.

Make sure your articles deal with some aspect covered in this course (see list of topics below). Keep it related to the order Primates and within the temporal scheme of the course.

Below you'll find a list of potential sources for your articles. This is only a partial list, there are many many more available through the library and various on-line sources.

Magazines & On-line sources --

- ScienceDaily.com
- ScienceNews.com
- Scientific American
- Discover Magazine
- American Scientist
- National Geographic
- E (the Environmental Magazine)
- New York Times (Tuesdays)
- ScienceNOW.com
- LiveScience.com
- New Scientist

Journals --

- Nature
- Science
- Primates
- Hereditas
- Human Biology
- Current Anthropology
- American Anthropologist
- Evolutionary Anthropology
- Human Evolution
- Journal of Primatology
- Amer. J. of Physical Anthropology

And sometimes --

- BBC News
- Wired.com
- Slate.com
- Internat'l Herald Tribune
- Economist
- Wall Street Journal
- Time
- Newsweek
- Mother Jones

EXAMS

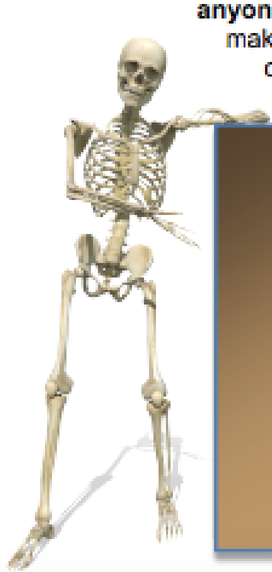
The exams (two hourly and one comprehensive final) count for 20%, 20% and 25% (respectively) of your grade. **There will be *NO* make-up exams.**

Exam 1: Oct 7th
Exam 2: Nov 14th

Final Exam: Mon, Dec 12 (4:15-6:15 pm)

Students with disabilities should contact Disability Services (1-7157) for assistance with the course or any course materials/exams.

Be sure to get to class a bit early on exam day. **Once the first person turns in their exam, anyone entering the classroom will not be allowed to take the test** (or a makeup). So, get a good alarm clock or make a best friend who is wiling to call you before the test ;-)



DATES OF INTEREST

Drop/Add Ends	Aug 30
Quiz 1	Aug 31
Exam 1	Oct 7
Fall Break	Oct 15-23
Exam 2	Nov 14
AAA Meetings	Nov 17-20
Thanksgiving Break	Nov 23-27
Quiz 2	Dec 7
Final Exam	Dec 12 (4:15-6:15 pm)
Article Reviews	alternate Fridays

QUIZES

There will be two quizzes, at the start and end of the semester.

- *Quiz 1* (Aug 31st) -- This will cover the main points of the syllabus to ensure you've read this document and understand the parameters of the course. We will spend the first day of class going over this material, the lecture pdf is available on Concourse (as is this handout). Pay particular attention to the information in bold font. You will also be provided a form to list your final exam schedule and any conflicts with this class's posted final.
- *Quiz 2* (Dec 7th) -- The second quiz will be on the last day of class and will address the course objectives. You will be asked to provide two examples from class that illustrate each objective (yes, I just gave you the quiz questions ;-)

CLASS PARTICIPATION

The exams (2 hourly & 1 comprehensive final will count for 20%, 20% and 25% (respectively) of your grade.

GRADES

Your grade will be composed of the following:

- In-class activities.. 25%
  - Bi-weekly article reviews (10 pts each + 1 pt extra)
  - Article presentations (5 pts each)
  - Movie Questions (10 pts each)
  - Quizes (10 pts each)
- Exams 65%
  - Exams 1 & 2 (20% each)
  - Final (25%)
- Class Participation 10%

I use a standard distribution for all assignments and final grades:

A	92% or more	B-	80%-81.9%	D	60%-69.9%
A-	90%-91.9%	C+	78%-79.9%	F	59.9% or less
B+	88%-89.9%	C	72%-77.9%		
B	832%-87.9%	C-	70%-71.9%		

***** Remember: grades are not given by me, they are earned by you *****

OFFICE HOURS

To help you learn the material, all lectures are posted on Concourse prior to class or immediately following the lecture. In addition, I hold regular office hours twice a week and by appointment – so if something is unclear or if you would like to talk about a topic in more detail than we can cover in class, feel free to stop by my office. I have office hours in my lab (Reyneirs – which is admittedly a bit of a hike), as well as my office (Flanner).

While I will not play "Let's Make a Deal" regarding grades, I am happy to clarify grading issues and/or explain an answer to a test question.

CLASS "RULES"

I will always be early to class so we can begin on time (and so you can ask questions before we begin). I expect that you will contribute to a respectful atmosphere for learning. This includes:

- **No newspapers, no outside reading during class**
- **No texting, no phone calls during class**
- **Get out any food out BEFORE class begins**
- **Get to class on time**
- **Check Concourse to get class assignments** (readings, lectures and handouts)
- **Complete readings BEFORE class begins**
- **Type all assignments**
- **Use common sense when emailing me**
- **"Dr" or "Professor" Sheridan = OK: MRS ≠ OK** ☺

HONOR CODE & PLAGIARISM

Each of you has a copy of the Student Handbook, with a detailed description of the Honor Code. It can also be found at: http://honorcode.nd.edu/docs/handbook.htm. Indeed, you've all taken the pledge below. It will be enforced in this class.

"As a member of the Notre Dame Community, I will not participate in or tolerate academic dishonesty."

Regarding plagiarism, I have a zero tolerance policy. If you are caught doing it, you will get an F for the assignment. If it occurs a second time, I will convene an Honor Code Violation Committee.

The Golden Rule for Avoiding Plagiarism—Give Credit Where Credit is Due
http://wps.prenhall.com/hss_understand_plagiarism_1/0,6622,427073-,00.html

To avoid this problem, give credit to another's ideas or opinions; to facts, stats, images, etc; to spoken quotes from another person; and when you paraphrase another's ideas. If you are at all unclear on whether you are engaging in plagiarism, I suggest the following website:

http://www.indiana.edu/~wts/pamphlets/plagiarism.shtml

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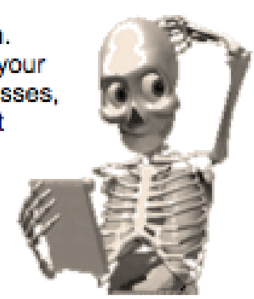
MID-SEMESTER EVALUATION

Around Fall Break, I will give you a **take home course evaluation**. It includes a series of questions pertaining to class design, and is your chance to help effect changes if needed. As the semester progresses, take note of things that work particularly well (so I'm sure to repeat them!), as well as aspects of the class that need 'tweaking.' I give those suggestions careful consideration – and although I can not always implement them (for example, one year a student thought there was too much biology…in a biological anthropology course ;-) – I often do make small changes that help enhance your learning experience.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COURSE CONTENT

Introduction to Biological Anthropology

Introduction: An overview of the course and discussion of the field of biological anthropology.

- Fuentes, A. 2010. The new biological anthropology: bringing Washburn's new physical anthropology into 2010 and beyond – the 2008 AAPA luncheon lecture. Yearbook of Physical Anthropology 143:2-12.

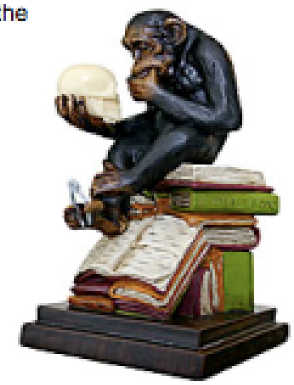
Evolutionary Theory

History of Evolutionary Thought: A discussion of the development of evolutionary theory in Western science.

- Gould, SJ. 1993. Fall of the house of Ussher, in Eight Little Piggies: Reflections in Natural History, WW Norton & Co., p 181-193.
- Sabila, G. 2002. Greek astronomy and the Medieval Arabic tradition. American Scientist 90(4):1-6.

Darwinian Evolution and Natural Selection: An analysis of Darwin's theory, factors influencing its development, and Darwin's dilemma.

- Gould, SJ. 1977 Darwin's delay. In Ever since Darwin. WW Norton & Co, p. 21-27
- Gould, SJ. 2002 Linnaeus's luck? In I have Landed. Harmony books. p. 287-304.
- Armelagos, G. 2004. Evolutionists and creationists at the dinner table. Evolutionary anthropology 13:53-55



The Mechanisms of Evolution: A further discussion of Darwin's dilemma, synthesis of Darwin and Mendel's theories, and molecular genetics.

- Havilad, W. 2003. The study of humankind. In Human Evolution and Prehistory, Thomson Learning, p 74-81.
- Jurmain, R. 2003. Development of evolutionary theory. In Introduction to Physical Anthropology, 9th ed. Thomason learning, p 22-33.
- Quammen, D. 2004. Was Darwin wrong? No evidence for evolution is clear. Nat'l Geo, p 3-19.

For Fun: The Onion. 2006. Kansas outlaws the practice of evolution. http://www.theonion.com/content/node/55807/print/

Anthropological Genetics

Basic Definitions: An overview of basic concepts/terms in anthropological genetics.

- Larsen, CS. 2011. Genetics: reproducing life and producing variation. In Essentials of physical anthropology: discovering our origins. New York: WW Norton & Co., pp 4-54.

Transcription & Translation – How does DNA replicate? How are proteins synthesized?

- Larsen, CS. 2011. Genetics: reproducing life and producing variation. In Essentials of physical anthropology: discovering our origins. New York: WW Norton & Co., pp 55-65.

PRIMATOLOGY

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PRIMATE BEHAVIOR

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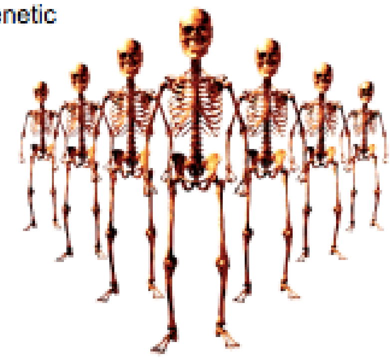

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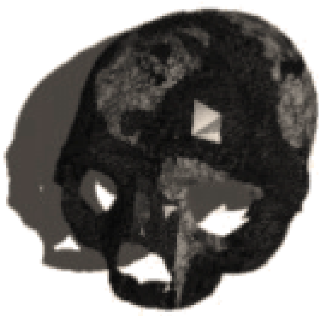

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Fighting Irish skeleton: used with permission from Lesley Gregoricka, MA (Ohio State University)
Hand holding mouse: www.evoluent.com/regular_mouse_in_skeleton.png">www.evoluent.com/regular_mouse_in_skeleton.png
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Skeleton holding a sign: Dreamstime.com #124544
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AAPA logo: www.facebook.com/pages/American-Association-of-Physical-Anthropologists/48926179413
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Appendix G

Syllabus Score Breakdown

Study ID #	Tests/Formal Assessments	Daily or weekly quizzes	Daily or weekly exit ticket (ex: clicker questions, Form, Poll Everywhere, etc.)	Voluntary office hour attendance by students	Mandatory office hour attendance by students	Weekly assignments	Weekly assignments completed in groups	Weekly assignments with answers discussed in class	Questions imbedded into readings or videos	Individual presentation/project	Group presentation	Multiple individual presentations/projects	Multiple group presentations	Discussion/Tutorial Sessions	Portfolio-based evaluation	Grade based on 1 category	Grade based on 2 categories	Grade based on 3 categories	Grade based on 4+ categories	TOTAL	Ed. Level
Possible	**1**	**2**	**2**	**1**	**2**	**2**	**3**	**4**	**2**	**3**	**4**	**5**	**5**	**2**	**5**	**1**	**2**	**3**	**4**		
3	1	2		1		2					4								4	14	F
5	1			1		2				3									4	11	F
12	1			1		2	3			3									4	14	F
30	1					2								2			2			7	F
36				1							4				5				4	14	F
40				1								5			5					11	F
1	1					2														3	I
6	1	2		1		2												3		9	I
8	1			1						3				2					4	11	I
10	1							4	2					2				3		12	I
13		2		1		2											2			7	I
14		2		1								5					2			10	I
17						2							5						4	11	I
19		2		1				4	2								2			11	I

Study ID #	Tests/Formal Assessments	Daily or weekly quizzes	Daily or weekly exit ticket (ex: clicker questions, Form, Poll Everywhere, etc.)	Voluntary office hour attendance by students	Mandatory office hour attendance by students	Weekly assignments	Weekly assignments completed in groups	Weekly assignments with answers discussed in class	Questions imbedded into readings or videos	Individual presentation/ project	Group presentation	Multiple individual presentations/ projects	Multiple group presentations	Discussion/Tutorial Sessions	Portfolio-based evaluation	Grade based on 1 category	Grade based on 2 categories	Grade based on 3 categories	Grade based on 4+ categories	TOTAL	Ed. Level
Possible	**1**	**2**	**2**	**1**	**2**	**2**	**3**	**4**	**2**	**3**	**4**	**5**	**5**	**2**	**5**	**1**	**2**	**3**	**4**		
22	1	2		1		2				3									4	13	I
24	1					2												3		6	I
25	1			1		2				3		5		2					4	18	I
26	1					2						5						3		11	I
27												5						3		8	I
28												5						3		8	I
29	1					2				3					5				4	15	I
34				1					2			5						3		11	I
35	1		2	1											5				4	13	I
42	1											5		2				3		11	I
2	1	2		1					2									3		9	N
4	1	2		1		2						5							4	15	N
7	1			1		2				3								3		10	N
9	1			1		2												3		7	N
11	1			1		2												3		7	N
15	1			1				4										3		9	N
16	1			1		2						5						3		12	N

Study ID #	Tests/Formal Assessments	Daily or weekly quizzes	Daily or weekly exit ticket (ex: clicker questions, Form, Poll Everywhere, etc.)	Voluntary office hour attendance by students	Mandatory office hour attendance by students	Weekly assignments	Weekly assignments completed in groups	Weekly assignments with answers discussed in class	Questions imbedded into readings or videos	Individual presentation/ project	Group presentation	Multiple individual presentations/ projects	Multiple group presentations	Discussion/Tutorial Sessions	Portfolio-based evaluation	Grade based on 1 category	Grade based on 2 categories	Grade based on 3 categories	Grade based on 4+ categories	TOTAL	Ed. Level
Possible	**1**	**2**	**2**	**1**	**2**	**2**	**3**	**4**	**2**	**3**	**4**	**5**	**5**	**2**	**5**	**1**	**2**	**3**	**4**		
31	1			1				4									2			8	N
32	1	2						4											4	11	N
33	1					2											2			5	N
37	1							4												5	N
38	1			1		2											2			6	N
39						2								2			2			6	N
41														2	5					7	N
43	1											5		2				3		11	N
44	1			1		2												3		7	N

Appendix H

SPSS Data Figures Used for Analysis and Conclusion

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum	Between-Component Variance
No Formal		17	8.65	2.827	.686	7.19	10.10	5	15	
Informal		19	10.95	2.758	.633	9.62	12.28	6	18	
Formal		6	11.83	2.787	1.138	8.91	14.76	7	14	
Total		42	10.14	3.009	.464	9.21	11.08	5	18	
Model	Fixed Effects			2.790	.431	9.27	11.01			
	Random Effects				.986	5.90	14.38			2.022

ANOVA

Course

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	67.480	2	33.740	4.333	.020
Within Groups	303.663	39	7.786		
Total	371.143	41			

Correlations

		Education	Course
Education	Pearson Correlation	1	.412**
	Sig. (2-tailed)		.007
	N	42	42
Course	Pearson Correlation	.412**	1
	Sig. (2-tailed)	.007	
	N	42	42

**. Correlation is significant at the 0.01 level (2-tailed).

Sarah C. Corke

padlet.com/sccorke/TheCorkeBoard   www.linkedin.com/in/sarah-corke-9a013b13/

Education

Doctor of Education, Instructional Systems Technology (October 2021)

- Indiana University, Bloomington, IN
- Learning Sciences Minor
- Dissertation Topic: Active teaching methods in collegiate STEM course designs: An analysis of instructor backgrounds in Education and instructional decisions

Master of Arts in Teaching, Secondary Education

- Operation TEACH, Notre Dame of Maryland University, Baltimore, MD (May 2013)

Bachelor of Science, Biological Science

- University of Notre Dame, Notre Dame, IN (May 2011)

Experience

Science Teacher, **Science Department Head** **August 2013 – Present**

Clay High School, South Bend, IN

Leadership

- Established, implemented, and continuously update multimedia professional development and assistance program for faculty/staff evaluation program (Standards for Success) interpretation and completion
- Developed and coordinated a specialized, professional learning community (THAT Group) representing five disciplines focused on the need for increased cross-curricular collaboration of concepts, lesson planning, and technological applications
- Mentored two teachers in Ball State Workplace Specialist I program through extensive observations, evaluations, feedback sessions, and education instruction
- Assisted colleagues with curriculum building, classroom management, laboratory examples, knowledge, and computer technical skills to map student growth
- Maintained science department informational displays
- Designed school-wide instructional framework aligned with faculty evaluation standards

Development

- Co-authored the Exact Path district curriculum plan for SBCSC Biology implemented across the district
- Developed and implemented Integrated Chemistry/Physics, Biology I, and Biology I Honors curriculum content, assessments, and laboratories following Indiana Science Standards through in person, hybrid, and fully online formats
- Developed and implemented Biology II Honors and AP Biology curriculum content, assessments, and laboratories combining Indiana Science Standards and AP Biology Big Four organization through in person, hybrid, and fully online formats
- Continuously updated lesson plans to feature new resources (ex: PCR, electrophoresis, and DNA analysis), incorporate new technology, promote increased student autonomy, and cross-curricular elements

Other

- Expanded the AP Biology course enrollment to continuously double for the past three years while maintaining high scores on the AP exam (highest average class score in CHS science department)

- Successfully wrote and implemented grants allocated for classroom use through South Bend Education Foundation and ACE for Science (over $2,500 total)
- Managed equipment maintenance, inventory, and ordering for class labs within department budgets
- Implemented PBIS (Positive Behavioral Interventions and Supports)
- Established and organized a science club for students, volunteered with National Honor Society blood drives, volunteered with Greenhouse Club activities and annual herb and flower sales
- 2019 Winner of James Morgan Memorial Award for service at CHS

Adjunct Assistant Professional Specialist, Practicum **June 2016 – August 2020**
Clinical Educator, Science Methods I **June 2019**
University of Notre Dame, Alliance for Catholic Education (ACE), Notre Dame, IN

- Developed and implemented practicum graduate-level teaching course at University of Notre Dame
- Supervised and evaluated 80 middle and high school science teachers in field – continuously managed the largest group each year
- Maintained accurate grades and feedback while completing formal and informal on-site observations of teaching technique and content based on the four domains of the M.Ed. program
- Delivered specific and timely critiques for support and reflection including personal anecdotes, lesson plans, teaching resources, and newly researched materials for the students
- Provided extended classroom scenarios for students to work more extensively through the practical applications rather than just theoretical foundations and fundamentals of instruction
- Worked collaboratively with other summer content supervisors and clinical faculty reworking lesson plans to accommodate instruction of laboratory safety to switch between courses

Clinical Educator **October 2017 – June 2019**
Saint Mary's College, Notre Dame, IN

- Mentored Saint Mary's and Notre Dame undergraduate students working toward a minor and major in Secondary Education through Saint Mary's Department of Education
- Co-taught with Saint Mary's senior teacher candidate through dual instruction, shared lesson planning, and supervised student-teacher led instruction
- Provided teacher candidates with extensive resources and training to be successful with classroom and laboratory resources
- Evaluated in both formal and informal formats while providing continuous support throughout the lesson planning and implementation processes
- Reformatted, revised, and technologically expanded a new, multimedia approach to the statistical work needed and highly recommended for the SMC Assessment Cycle assignment

Science Teacher **August 2011 – June 2013**
Archbishop Spalding High School, Severn, MD

- Co-authored and implemented College Preparatory and Honors levels of Biology in content, assessment, and laboratories following Maryland Science Standards
- Developed and implemented Marine Science curriculum of content, assessments, and laboratories used by other teachers. This course was specifically selected by the principal for him to teach upon my move back to Indiana following the completion of Operation TEACH.
- Assisted in science and additional departments as in-house substitute and exam proctor

Technical Skills

- Multi-media design programs including Adobe Illustrator, Word, Excel, PowerPoint, and Publisher
- Proficiency in SPSS and Google Certified Educator with extensive knowledge and training capabilities with Google Applications including Drive, Calendar, Sheets, Classroom, and Docs
- Extensive LMS use and management skills – PowerSchool, Sakai, Canvas, Blackboard, and TaskStream
- Experience with HTML and CSS programming

Additional Items

- Member of Saint Mary's College Partners in Education Council – Biyearly discussion group of local stakeholders of the Saint Mary's Education program focused on guiding improvements in the mentorship and advancement of the undergraduate teaching program
- Member of Teacher Leadership Team 2020-21 and 2021-2022 school years
- Member of Flinn Scientific Research Council – Academic-based group utilized for feedback regarding classroom and laboratory resources, equipment, and company perceptions periodically throughout the year
- Publication through Association of American Educators - Making the Most of Your Classes After the Exam (www.aaeteachers.org/index.php/blog/1875-making-the-most-of-your-classes-after-the-exam)
- Teaching Licenses – IN (Life Science and Chemistry, Grades 5-12), MI and MD (Biology, Grades 6-12)
- Certifications – Advanced Placement Biology, Flinn Laboratory Safety, CPR/AED/First Aid

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