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Mixed-major biology courses are often utilized by kinesiology programs to provide essential foundational material to prepare students for higher-level courses within kinesiology. There has been an increase in overall kinesiology students in these mixed-major biology courses. Despite this significant shift in student demographics, faculty in mixed-major biology courses have not adjusted their instruction, missing vital opportunities to engage students from academic majors outside of the biological sciences with course content that prepares them for their academic majors. Faculty must utilize instructional models that allow students to succeed across various academic disciplines, especially students from kinesiology-related majors. The purpose of this study was to understand the current approaches of biology faculty in their mixed-major courses through classroom observations and course artifacts. Semi-structured interviews were used to identify faculty needs and attitudes toward an adapted differentiated instructional (DI) approach based on career pathway. Analysis provided insight into current faculty practices and their perceptions of teaching students from kinesiology-related majors. Eight themes emerged across the two specific aims of this study. Results indicated a disconnect between actual teaching practice and perceived practice as well as a lack of understanding of the diverse majors that make-up their mixed-major biology courses, specifically kinesiology majors. Recommendations for action items included the need for interdepartmental collaboration between biology and kinesiology faculty and led to the creation of the Interdisciplinary Taskforce for STEM Success (ITSS) to provide a relationship between the science and kinesiology programs. Further development and expansion of this taskforce will address faculty needs as it relates to the incorporation of DI based on career-pathway in mixed-major biology courses.

IMPROVING KINESIOLOGY STUDENT SUCCESS IN MIXED-MAJOR BIOLOGY COURSES: A CASE STUDY EXPLORING FACULTY PERSPECTIVES OF DIFFERENTIATING INSTRUCTION BASED ON CAREER PATHWAY

by

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Approved by

Dr. Pam K. Brown

Committee Chair

DEDICATION

To my loving husband, Shaun. You are my best friend, my biggest comfort, my strongest motivation, and my deepest love. Thank you for believing in me and my dreams, even long after I lost belief in myself and for loving me even if I had not been able to achieve it. You are and will always be 'my person'. I know that whatever door we come upon, we will also open it together.

To my wonderful son, Noah. Your light shines through everything you do. Your support of me through this process has meant the world to me. I am so blessed and thankful that I get to call you my son. I hope that any sacrifice you have endured throughout the pursuit of my dreams will be repaid to you as you work your way through law school and through life.

To my mom, Charlotte. Thank you for loving me and serving as a constant light of goodness in this world. You are the best mother that a child could ask for. You have always been a shining example of how to do everything in life with poise and grace. You are forever my mother and friend.

To my dad, Johnny, and to my brother, John. Although you each left this world way too early, your presence has always been with me every step of the way. I love and miss both of you dearly.

APPROVAL PAGE

This dissertation written by Patricia J. Williams has been approved by the following committee of the Faculty of The Graduate School at The University of North Carolina at Greensboro.

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CHAPTER I: PROJECT OVERVIEW

Growth in kinesiology-related majors has been steadily increasing for several years. This overall growth has been attributed to the kinesiology major's value in allied-health professional programs (Thomas, 2014). While this growth in student enrollment is essential for higher education, it also means that dynamic shifts in instructional approaches used in allied-health related biology courses are needed. At some institutions, more than half of students enrolled in these biology courses are from a major other than biology (Johnson, 2019). In addition, student success rates in these courses are low. Almost half of students enrolled in these courses fail earn a C or better (Gonzalez, 2014). Current mixed-major science courses are generally taught with a one-size-fits-all instructional approach. This approach often leaves out the differing needs of students from different academic majors who are taking these courses. One pedagogical approach that has been shown to be effective and successful is differentiated instruction (Altintas & Ozdemir, 2015; Bal, 2016, Little et al., 2014; Mastropieri et al., 2006; Mitee & Obaitan, 2015; Richards & Omdal, 2007).

Differentiated instruction (DI) is a pedagogical approach that allows students to use their unique skills, experiences, and backgrounds to master course materials based on instruction and assessments intentionally designed for them by their instructors. It is based on the idea that students learn better when their interests, individual needs, experiences, and learner profiles are used to design instruction and assessment (Ozbal, et al., 2019; Thomas, 2014; Thomlinson 2005). The use of instruction and assessments that relate to student interests and career pathway "promote[s] engagement, motivation, and helps [the students] connect what is being taught with things they already value" (Santangelo & Tomlinson 2009, p. 308). This is especially true for students taking mixed-major biology courses which are preparing them for allied health or

kinesiology-related professional programs. If postsecondary faculty provide differentiated instruction and assessment in their mixed-major science courses, students from differing majors will be provided with the tools necessary to connect biological concepts to their individual major and personal interests (de Graaf et al., 2019).

To utilize differentiated instruction in classes, we must first gain an understanding of faculty perspectives relating to offering differentiated instruction and assessment. Therefore, it is necessary to explore postsecondary faculty attitudes and perspectives relating to differentiated instruction and assessment to address faculty needs as they work to improve instruction for kinesiology majors in these courses.

Background Literature

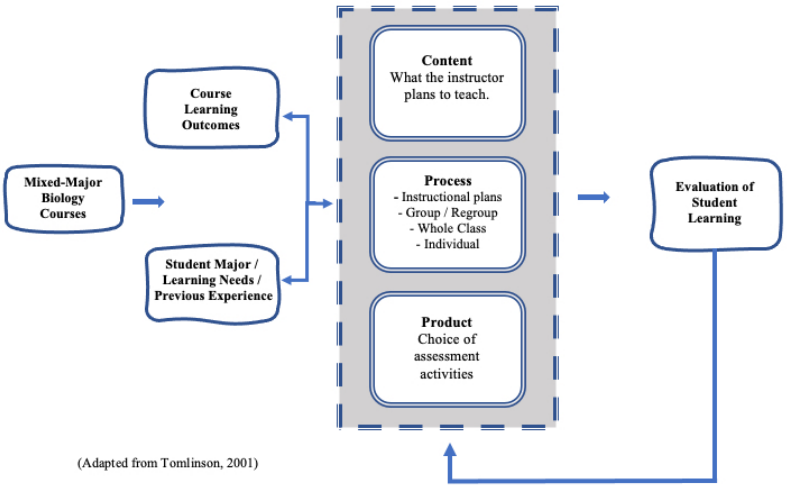
Differentiated instruction (DI) is an educational approach where instructors recognize the differences in educational background, course readiness, preferences in learning, and individual interests of students. In the primary and secondary setting, DI is utilized to improve student success and student growth by meeting each student where they are in the learning process. In higher education, DI is designed around the unique needs of adult learners, including their personal background knowledge, differing interests and abilities, as well as individualizing learning experiences to align course materials with the academic majors of the individual students.

Features and Components of Differentiated Instruction

There are several key elements, according to Tomlinson (2001, 2003, & 2005), that inform differentiation: DI based on *Content, Process*, or *Product* (Figure 1). An instructor can adapt the learning environment to provide instruction, resources, or activities to help students gain the concepts and knowledge they need in the classroom. In the mixed-major biology

classroom, this could mean that faculty provide unique instructional examples, instructional support content, activities, or assessment choices that are differentiated based on the different majors that make up the mixed-major classroom. Tomlinson (2003) also notes the importance of instruction being concept-focused and principle driven. By providing a variety of examples and assessment opportunities in mixed-major courses directed at different academic interests, students will be able to better connect concepts and learning outcomes from their mixed-major courses and apply those concepts directly to their individual academic interests.

Figure 1. Model of Differentiated Instruction in Mixed-Major Biology Courses.



Note. This figure demonstrates how differentiated instruction can be incorporated through *content, process*, and *product* into mixed-major biology courses. Each of these factors come together to influence how students learn and apply their knowledge to their lives.

Theoretical Evidence Supporting Differentiated Instruction

There is profound theoretical relevance for the use of DI in the classroom. DI is centered around two main theoretical frameworks: Piaget's constructivist theory (Thakur, 2014) and Tomlinson's theory of differentiated instruction (Thakur, 2014). Piaget suggested that individuals construct their understandings through interaction with instructors and peers (Piaget, 1974;

Woolfolk, 2010). This learner-centered approach allows individuals to use their unique experiences and backgrounds to understand new content and information. While the constructivist framework can help us understand the role of instructors in the classroom to create individualized instruction, the Theory of Differentiated Instruction blends a variety of educational frameworks to centralize the need for instruction that is inclusive of differing academic majors. The theory is designed to take full advantage of the student's ability to learn in a social and collaborative way (Tomlinson et al., 2003; Subban, 2006; Tomlinson, 2010).

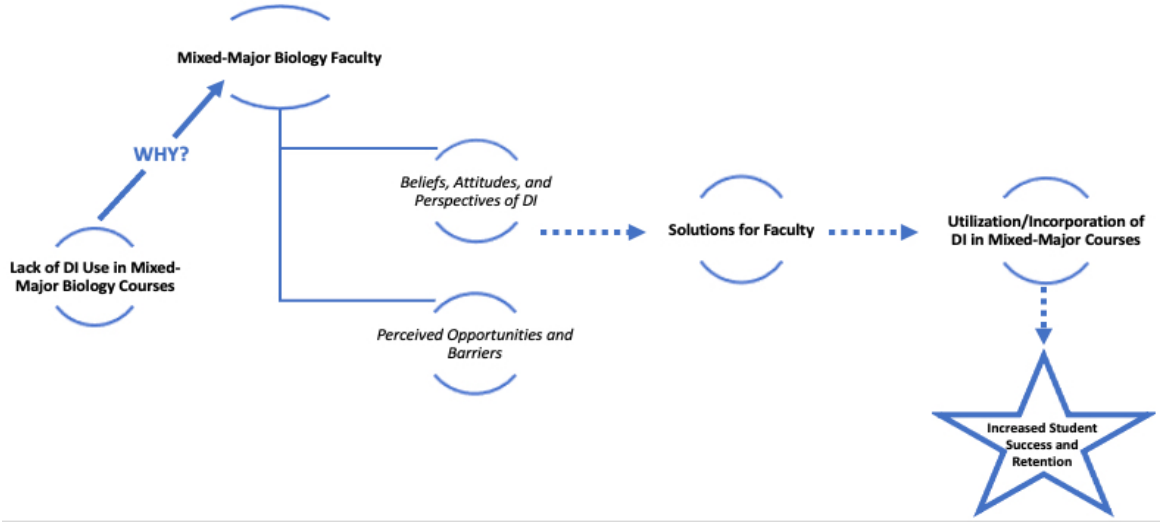
Use of Differentiated Instruction and Assessment in Postsecondary Settings

Despite the success of DI in the primary and secondary educational settings (Altintas & Ozdemir, 2015; Bal, 2016; Little et al., 2014; Mastropieri et al., 2006; Mitee & Obaitan, 2015; Richards & Omdal, 2007), faculty in higher education have been slow to adopt DI as an instructional approach, especially in mixed-major biology courses. Additionally, there are large gaps that still exist in the literature regarding DI in higher education, especially in mixed-major college courses and based on career-pathway. This is especially true regarding DI based on Career Pathway. Research on DI in higher education has consistently demonstrated significant improvement in student's understanding of course content, higher course attendance, and improvement in overall course grades (Freeman et al., 2007; Sturges et al., 2009; Maurer et al., 2012; Sturges & Maurer, 2013; Graaf, Westbroek, & Janssen, 2019). Regardless of the approach to DI, the research clearly indicates that instructors must work to meet students' needs in these mixed major biology courses. In a survey of the literature relating to DI in mixed-major or interdisciplinary courses, Schary and Cardinal (2015) suggested instructors need to include more cross-disciplinary activities and assessment to enhance undergraduate success in kinesiology and other allied health majors.

Barriers to Differentiated Instruction

Faculty face many barriers to the implementation of differentiated instruction (DI). Some institutions experience time and financial constraints and a lack of professional development while others face a lack of resources and large class sizes that limit the use of DI (Tomlinson et al., 2003; Rodriguez, 2012; Smit & Humpert, 2012; Dosch and Zidon, 2014; Subban, 2006; Tulbure, 2011; Suprayogi, 2017; Wan 2017; AlHashmi & Elyas, 2018; De Graaf et al., 2019). Differentiation, according to Dosch and Zidon (2014), is "challenging at all levels, but perhaps more so at the college level" (p. 352). Ideally, faculty in the higher education setting would have professional development opportunities and resources to help them incorporate DI into their mixed-major biology courses. Each college and university are faced with their own unique set of challenges. They must face those challenges in a way that is supportive of their faculty, student body, and the campus community.

Figure 2. Conceptual Model Toward Incorporation of DI in Mixed-Major Courses.



Note: This figure demonstrates that the lack of the use of differentiated instruction (DI) in mixed-major biology courses can be addressed by identifying faculty perspectives on the use of differentiated instruction in mixed-major biology courses.

Rationale and The Missing Piece for Kinesiology-Related Majors

DI is a teaching and learning tool that is challenging to implement in any educational setting but is incredibly difficult to integrate into college courses. Large class sizes in mixed-major biology courses, limited time with students, and many non-teaching responsibilities pose a challenge for college faculty. While instructors in mixed-major biology courses cannot control all these factors, faculty can help students by ensuring resources keep pace with their diverse enrollments and taking steps to improve engagement in these early STEM courses.

Kinesiology is a STEM field that has a foundation in biological sciences. Kinesiology is the study of human movement, performance, and function that integrates a variety of studies from cell and molecular biology, anatomy and physiology, nutrition, neuroscience, and biochemistry. The American Kinesiology Association (AKA) defines kinesiology as the multidimensional study and application of the biological, allied health, psychological, and humanistic perspectives as it relates to physical activity (American Kinesiology Association, 2018). The AKA has provided a series of core elements and key learning outcomes to ensure the success of kinesiology students in their respective programs (Appendix A). These key learning outcomes and core elements demonstrate the clearly evident and deep connections between the study of kinesiology and other STEM fields.

Unfortunately, studies have demonstrated a lack of kinesiology programs being viewed as a STEM field. There are several reasons for this such as kinesiology programs not being housed in the same college or school as other STEM programs as well as the vast difference in kinesiology curriculum from university to university (Kutz et al., 2020; Bassett et al., 2018; Thomas, 2014). The result of this is that many biology faculty may not even realize they need to provide resources for kinesiology related majors in these early introductory courses. In fact,

kinesiology students have reported that one of hardest hurdles for them to be successful is getting past the timing of the prerequisite courses, repeated coursework (both inside and outside their kinesiology program), and engagement in kinesiology as an 1st and 2nd year student (Kutz et al., 2020). Students struggling with early introductory science courses are delayed in taking many of the kinesiology courses due to prerequisite issues or course timing. If mixed-major biology faculty can create content using techniques such as DI centered on the career pathway, students will have opportunities to be more engaged not only in the biology courses but also in how biology informs their kinesiology major and future career. This can lead to greater student success in these courses and less delay in getting to their major course requirements.

Utilizing DI in these mixed-major courses through career pathways can also provide early STEM- and kinesiology identity forming experiences. Overall, if faculty identify the needs of differing majors early (especially in kinesiology) then this early exposure of kinesiology as a STEM field as well as the early connections of kinesiology concepts to foundational biology content can help improve student success earlier in their academic career (Kutz et al., 2020).

Purpose and Specific Aims

The purpose of this exploratory case study (Yin, 2012) was to explore and identify current practices and perspectives of faculty concerning the use of differentiated instructional techniques based on career pathways to improve the success of kinesiology students in mixed-major biology courses. Current teaching practices as well as the needs and perspectives of faculty were explored to provide a foundation for encouraging faculty to adapt their courses to improve success for students from kinesiology-related majors.

Aim #1: To explore the current teaching practices and perspectives of faculty regarding differentiating instruction toward the improvement of kinesiology student success in mixed-major biology courses.

Aim #2: Identify the needs and resources faculty deem necessary to successfully implement differentiated instructional practices based on career pathway in mixed-major biology courses.

Methods

A qualitative, exploratory, case study was utilized to explore the perspectives, attitudes, and beliefs of biology instructors regarding their knowledge and use of differentiated instruction (DI) in mixed-major biology courses. Multiple sources of data collection were employed throughout the study to gain a robust understanding of faculty experiences and perspectives on differentiated techniques based upon career pathway. The case study approach is a research approach that explores specific research questions to better understand a problem in a real-world setting (Merriam & Tisdell, 2015; Yin, 2012). Specifically, case studies allow a researcher the flexibility to incorporate multiple perspectives (Marshall & Rossman, 2016). The exploratory nature of the case study approach will provide a detailed understanding of the "how", "why", and "what" of the phenomenon being studied (Yin, 2014; Creswell, 2013). In addition, the case study approach allows for the researcher to explore a "real life", bounded system to solve a problem in a local context (Creswell, 2013). This case study provided a robust understanding of the experiences in which biology professors utilize, understand, and perceive differentiated instruction as an approach to reach the variety of majors in their biology courses.

Constructivism and the Theory of Differentiated Instruction provided the theoretical frameworks for observing and interviewing faculty on their current approaches and perspectives of DI in mixed-major courses. This study was designed to identify faculty perspectives, attitudes,

and beliefs concerning differentiated instruction in mixed-major biology courses. Faculty, like students, construct their knowledge based on previous experiences. Many instructors continue to teach the way they have been taught. According to Oleson and Hora (2013), the primary source of an instructor's approach to teaching in higher education is observing other instructors' behaviors and their own previous educational experiences. Ultimately this means that faculty pedagogical techniques are primarily shaped by their previous knowledge and experiences (Schoenfeld, 2000). Therefore, it is essential to understand faculty perspectives and approaches to provide pedagogical tools and training to faculty in these mixed-major courses.

Researcher Positionality / Researcher Role

My diverse background makes me uniquely suited to undertake this interdisciplinary study. I am a biology instructor in a higher education institution and a kinesiologist with a strong interest in exercise physiology. As a biologist, I have a strong understanding of the key goals and learning outcomes required in these mixed-major courses. As a kinesiologist, I have a strong understanding of the core elements that kinesiology majors need to be successful in kinesiology programs (Appendix A). My unique experience, as both a biologist and kinesiologist, served as a strength in my role as the researcher of this case study. In addition, being a faculty member in the department in which this case study took place and my collegial relationship with the faculty members allowed for a more open and authentic experience from the participants. I have a deep understanding of the needs and issues that faculty and students face within this department and that provided a strong foundation for this study. My close work-relationship with the participants allowed for an insider view that other researchers would not appreciate. I am also responsible for teaching a wide variety of mixed-major biology courses, so I have a personal understanding of the importance of reaching the diverse population these courses serve. Additionally, I have

advanced degrees in online teaching and instructional design and value the role course design and instruction has on student success. I have a strong positive opinion on the importance of DI and active learning in science courses and I am aware of the bias I have concerning this research. Full positionality and researcher role can be found in Appendix B.

Defining the Case and Research Setting

The single case in which this study was focused is a biology department from a public 2-year, coeducational institution with approximately 10,000 full-time and part-time students located in the Southern Piedmont region of North Carolina. The biology department at this college is unique in that is has a strong undergraduate research program which is uncommon within the community college system. This college partners with the Community College Undergraduate Research Initiative (CCURI) and is one of the first community colleges in the nation to receive Partnership for Undergraduate Life Science Education (PULSE) certification for undergraduate research. The biology department serves a wide variety of students across a wide range of disciplines. With over 170 programs of study across its 3 campus locations, faculty work to prepare students not only for transfer to other institutions, but to prepare students directly for careers. This diverse method of preparation means that faculty in this department have students not only who major in biology, but also who are preparing for degrees from a boarder range of academic majors and degree programs and makes this department a prime candidate for the use of D.I. based on career pathway.

Participants

Participants were recruited using convenience sampling (Appendix C) within the college's biology department. Six of the fifteen biology faculty members consented to participate in this study (Appendix D). These faculty participants provided the researcher with course

artifacts, participated in a classroom observation, and a semi-structured interview to discuss their knowledge, perspectives, and use of differentiated instruction in courses with a diverse range of majors.

Data Collection Measures and Analysis

Since there is a complex combination of cognitive, sociocultural, and even institutional factors that influence how a college instructor designs their educational approaches, it is crucial to gather information relating to their previous experience as learners (how they learn), their previous experience in the classroom (how they were taught), their professional development experience, and their reflection on student feedback from previously taught courses. The goal of this analysis will be to find relationships between the participants and their observations, course documents, and semi-structured interviews.

Three Point Classroom Observation

Participants identified a session of a mixed-major biology course of their choosing that they felt was a "typical classroom session." One full class session was observed using an *observer-as-non-participant*, *explore-to-discover* approach using a modified systematic observation instrument for each participant. There were three main stages to each classroom observation: 1) The Classroom Observation Protocol for Undergraduate STEM (COPUS), 2) recorded lecture observations, and 3) post observation reflections.

The COPUS observation tool is a STEM research tool that is both valid, reliable, and reduces researcher bias using a defined set of parameters (Smith et al., 2013). COPUS was utilized to gain a baseline perspective of the class session being observed (Appendix E). The total number of observations was six. Each class observation lasted approximately 50-minutes and each observation session was recorded to allow the researcher to take post-observation notes

and jottings as well as to review the accuracy of the codes assigned during the observation. Since the COPUS instrument is generally a quantitative tool, this researcher utilized the general trend data for each observation to gain a picture of the data that emerged from each observation to form a baseline representation of the general classroom instructional approaches and faculty/student interaction (Appendix E).

In addition, each classroom observation was recorded, transcribed, and analyzed to recognize any patterns and themes that emerged through the class session. The recorded lecture was compared to the COPUS baseline data to evaluate instructional approaches and techniques and the use of differentiation or other learning strategies during the classroom session. Following each observation, post-observation reflections were completed by the researcher. This reflection was used to gauge how the classroom activities were perceived by the research and to compare them to the recorded data (COPUS and Observation Transcripts). Each post observation reflection was prepared in narrative form using a researcher developed reflection guide (Appendix F).

Departmental Document Analysis

To gain insight into key instructional approaches, the researcher collected course documents (course syllabi, course specific handouts, summary of student major, etc.) from each participant. These documents were obtained (where applicable) from each participant to incorporate constant comparative analysis. Documents were analyzed and categorized into conceptual categories and themes to recognize patterns within each course being observed. This information provided insight into current teaching practices which were analyzed for comparison of teaching practice among the other sources of data collected.

Semi-Structured Interview

Each participant completed a semi-structured interview to reflect on differentiated instruction in terms of their understanding of the concept, perspectives, beliefs, and attitudes on the use of DI in mixed-major biology courses after their classroom observation. The interview guide (Appendix G) was researcher developed and contained 15 open-ended questions that were divided into 3 main dimensions: 1) Learning Experiences, 2) Teaching Experiences, and 3) Differentiated Instruction. The interview guide was developed based on research findings from previous studies (Tomlinson et al., 2003; Rodriguez, 2012; Smit & Humpert, 2012; Dosch and Zidon, 2014; Subban, 2006; Tulbure, 2011; Suprayogi, 2017; Wan 2017; AlHashmi & Elyas, 2018; De Graaf et al., 2019) and was tailored to the higher education environment.

Data from the individual interviews were analyzed through open and axial coding to explicate patterns and critical ideas within the data using the Atlas.ti software (Version 9 MAC; Atlas.ti., 2020). Codes were then evaluated by listening to the interview recording to ensure accuracy of the coding scheme. Each theme was provided with a detailed description to define conceptual categories and analyzed using clustering and member checking (Appendix H & I) (Marshall & Rossman, 2015). Each participant was provided with the transcript of their interview and emerging codes collected from the data to ensure that the researcher made the appropriate and accurate interpretation of the participants' views and perspectives. In addition, intercoder reliability was also addressed by providing researcher defined codes to two independent reviewers to establish consistency in the meanings of the codes and accuracy among the interpretation of the data (Marshall & Rossman, 2015).

Threats to Trustworthiness

The researcher took care to limit threats to trustworthiness using bracketing, constant comparative analysis, and peer-debriefing (Appendix B). Despite the comprehensive attempts to limit threats to trustworthiness, this researcher understands that we live in a social world shaped by our own personal interpretations.

Findings and Results

Observational and interview data provided insight into the first aim of this research. Data (Appendix H) suggest that there are two main themes relating to a disconnect between current and perceived teaching practice as well as a disconnect between the makeup of student majors within their mixed-major biology courses.

Current versus Perceived Teaching Practice

All six participants indicated that their previous educational experiences (primary, secondary, and post-secondary) were solely lecture-based and faculty-centered. According to Oleson and Hora (2013), the primary source of an instructor's approach to teaching in higher education is observing other instructors' behaviors and previous educational experiences, so the expectation is that these six participants courses would be lecture-based and faculty-centered. When asked how faculty perceived their current teaching style, three out of six faculty participants indicated that they perceived their class to include DI. However, classroom observations (via class recordings and COPUS analysis) and document analysis indicated that only one participant utilized at least one DI supported approach in their mixed-major biology course. One participant noted:

> I find myself using anecdotes my previous instructors told me from way back when and I have told those to my students. I even tell my students; this is what and how my teacher taught me when I was your age. And so, I am literally falling back on what I know

This observation of current classroom practices supports the previous research and indicates that an instructor's pedagogical approaches are primarily shaped by their previous knowledge and experiences (Schoenfeld, 2000).

Actual versus Perceived Student Enrollment by Major

Interview data and document analysis provided insight into the actual and perceived enrollment by academic major and revealed an interesting dynamic between the actual enrollment by major and the majors the participants perceived make up their mixed-major biology courses (Appendix H). According to enrollment data for each of the observed courses, more than 80% of the student enrollment in these observed courses were made up of majors in an area other than traditional STEM (Biology, Chemistry, Math, and Physics). These majors included a variety of disciplines in allied health related professions (e.g., nursing, EMT, dental hygiene) and other majors such as exercise science and education-related professions. In fact, approximately 50% of the students enrolled in the courses observed were from an area relating to kinesiology. This aligns with the current research, which shows at some institutions, more than half of students enrolled in these biology courses are from a major other than biology (Johnson, 2019).

Despite this actual enrollment distribution, participants did not realize they had majors from a kinesiology related major even though they make up about 40% of their actual student population. One participant stated:

> I've been teaching mostly students far from my field. So, they are taking this course as a pre-requisite for nursing because it is a requirement for their major and I am not a nursing professor. They are in an area that is far afield from my own professional area.

While there are only a few references in the literature relating to faculty perception of student enrollment by major in biology courses, there are some indications that this is a problem. Unfortunately, many biology faculty members fail to recognize this diversity of academic majors in their courses and teach using a one-size-fits-all instructional approach (Thomas, 2014). When participants were asked probing questions specifically about kinesiology majors and enrollment of exercise science students in their mixed-major courses, all participants stated they did not consider the potential of having students from kinesiology-related majors. Further probing indicated that 4 of the 6 participants did not consider kinesiology/exercise science a STEM field. One participant stated:

> uh, exercise science? That is a different department. We don't have students from that area. I don't know… uh… I guess there could be some just taking a biology course for fun or to fulfill a transfer requirement. These are not students we serve.

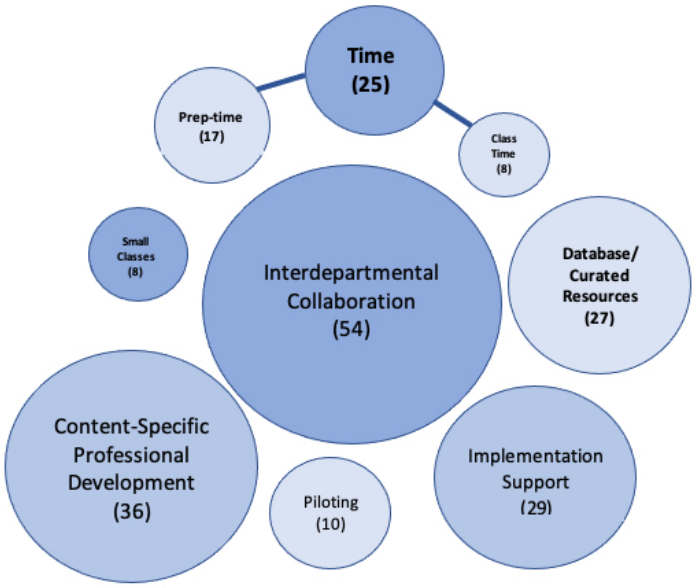
This disconnect in student population is concerning. The growth in kinesiology-related majors in these courses requires faculty to address the needs of this growth and student needs must be acknowledged and addressed.

Faculty Perspectives of Needs and Required Resources for DI Implementation Based on Career-Pathway

The second aim of this research study was to identify the needs and resources faculty deem necessary to successfully implement differentiated instructional practices based on career pathway in mixed-major biology courses. Several key themes emerged (Appendix H) regarding

the resources and needs of faculty utilizing DI techniques in their mixed-major biology courses. Understanding these needs will be instrumental in developing the tools and resources at the department level to help improve student success in biology courses with a variety of academic majors.

Figure 3. Packed Frequency Bubbles of Themes



Note: This figure illustrates the frequency of each theme that emerged from the participant interviews. These are not percentages and only the top 8 top emerging themes are shown here.

Interdepartmental Collaboration

While faculty indicated that DI based on career-pathway or major would significantly improve student success in these biology courses, they feel unprepared to utilize examples from other areas effectively. Faculty indicated that interdepartmental collaboration could help them make connections with key concepts that will link mixed-major biology courses to concepts students can use in their future majors and careers. One participant indicated…

> Having interdepartmental collaboration between biology faculty and faculty from other academic majors commonly enrolled in by students in mixed-major biology courses

would be needed to implement DI that focuses on a wide range of topics outside of the standard biology examples.

Content-Specific Professional Development

Another key need faculty discussed was the need for content-specific professional development. Faculty indicated that too often, professional development opportunities consist of only the theory or concept while very rarely providing tools to instructors on how to incorporate these concepts in specific courses. One participant stated…

> [Faculty] need professional development. We need to know how to do it … I need someone who specializes in this sort of technique or that has the knowledge base to help translate that into the classroom.

This consensus on content-specific professional develop can help improve kinesiology student success. It shows that implementation of DI inside the classroom can only take place if the faculty can develop content and resources relating to kinesiology topics and how to incorporate that content into their courses.

Instructional Support

Participants also indicated a need for implementation support from administration or their specific department. This type of support covers financial, technological continued learning experiences, supplies, and tools. Faculty noted that sometimes they receive specific support in the form of professional development, but that the support ends there. One participant stated:

> We have too much professional development on the big ideas, but no one is willing, to you know, actually give us the support we need to use these things they tell us. It's like [the leadership] just checks some box that they told us about something and move on.

> They don't provide the support to make these techniques a real, um, possibility in courses.

Time and Class Size

Another issue that was elaborated on by each participant was time and class size. Each participant noted that time and class size were huge factors in how they choose to structure their courses. Regarding class size and time, one participant noted:

> It's not just an issue with class time and the size of the class, you know. I am sure you experienced this. We don't have the class time because there is just too much to get through. Think about cellular respiration. I barely have time to get through that just spouting out facts. Now factor in the activity. Um… not just the time in class, you know, the time I would have to use up to create these things, um, activities. With all they want us to do, when will I be able to do it.

Successful Piloting of DI Techniques

Piloting of DI within other mixed-major courses was seen as essential as well. Participants felt that they needed to see a technique successfully work in another class before they were asked to try it. According to one participant:

> I need to see it done first. Why am I gonna try something that I don't know will work with our student population. It is… um… too big of a risk for me. I need to see faculty with more experience with DI use it successfully before I, like, take a swing at it. Too much of a risk for maybe not a big payoff. My students need to know things and I don't think I want to use them as Guinea pigs to see if it works or not.

Databases and Curated Resources

A need for a collection of activities and resources was a common need suggested by participants. Faculty deem it imperative to have resources and activities organized in a database or a digital collection to successfully implement DI in their mixed major courses. One participant stated:

> For me, in terms of tools, I think there's something to be said for creating sort of a stock, a stock of how different concepts from different field interrelate. Because when you're talking about differentiating a topic, you need to know how that topic can be related to other fields. Almost like a database of cross-referencing.

Discussion and Implications for Practice

This study aimed to identify current and perceived teaching practices and the tools or resources faculty deem necessary to implement DI in mixed-major biology courses to improve kinesiology student success. The results of the study aligned with the literature at a variety of points, but some emerging data addressed a gap in the research in two main areas: 1) participants perceived dissociation of kinesiology from the STEM fields and 2) recommendation of specific resources to implement DI in mixed-major courses.

Dissociation of Kinesiology as a STEM Field

A potential barrier to the implementation of DI and the success of kinesiology students in this departments mixed-major science courses was revealed in this study. The data indicated a complete dissociation of kinesiology from the STEM field on the part of the participants. This is concerning considering kinesiology student success in these mixed-major biology courses is key to help them succeed in their chosen field, kinesiology. These courses are designed to provide students from a wide variety of majors (including kinesiology students) the foundational

knowledge necessary to help them succeed in their academic major. While the literature does indicate that many biology faculty fail to recognize this diversity of academic majors in their courses and teach using a one-size-fits-all instructional approach (Thomas, 2014), there is a gap in the literature as to why biology faculty are missing this key piece about their student population. The literature does provide several hypotheses for this disconnection such as kinesiology programs not being housed in the same college or school as other STEM programs or the vast differences in kinesiology curriculum from university to university (Kutz et al., 2020; Bassett et al., 2018; Thomas, 2014). These hypotheses align with this study's data which showed that faculty did not know they had kinesiology students in their courses, and therefore, made no attempt to provide resources for kinesiology majors in these early introductory courses.

Essential Needs and Resources for the Implementation of Differentiated Instruction

While each participant in the study indicated that support for differentiated instruction based on career pathway would help increase student success and learning, they also noted that this approach is only feasible if appropriate resources are provided and faculty needs are addressed. Seven themes (Appendix H & I) emerged from the data regarding the needs and resources faculty perceived as essential to implementing DI in their course based on career-pathway. Common themes expressed by faculty in this study, which are also supported by the literature, were professional development, implementation resources such as funding, departmental support, technology, class size, and time (Tomlinson et al., 2003; Rodriguez, 2012; Smit & Humpert, 2012; Dosch and Zidon, 2014; Subban, 2006; Tulbure, 2011; Suprayogi, 2017; Wan 2017; AlHashmi & Elyas, 2018; De Graaf et al., 2019).

Three of the themes from this research study were novel and revealed a uniqueness among science faculty needs in mixed-major science courses in higher education. The first novel

theme emerging related to the need for interdepartmental collaboration. While there is literature relating to interdepartmental collaboration relating to a variety of issues such as curricular alignment within departments (Witham & Ellis, 2021) and student service alignment (Alsheyadi & Albalushi, 2020), faculty from individual departments tend to be siloed and are largely separate from one another. Faculty discussed the need to better understand the various academic majors that they serve and how to best reach each of these students from a wide variety of majors. Faculty participants indicated that their expertise and training is as a subject-matter expert in the biological sciences therefore they would feel their knowledge is not adequate to use interdisciplinary examples. A connection to experts in other fields would help them better understand what is needed for students from diverse majors. This theme also aligns well with the issue presented in Aim 1 where faculty are not aware of the majors they serve, and this could be a bridge to help biology faculty better understand the students they serve.

Another novel theme that emerged is the need for successful piloting. While piloting is common in the literature (Aljawarneh, 2020; Brewer et al., 2019; Tzanni, 2018), no literature exists relating to piloting DI in the higher education classroom based on career pathway. Faculty do not want to risk a failed or unsuccessful DI activity in an already challenging teaching environment. Faculty would be more willing to support DI based on career pathways after a successful piloting of DI based on career pathway within their department. This would require a departmental commitment at the research institution to both pilot and train faculty within the department.

The last novel theme emerging from the data is the creation of a database of curated resources. Faculty reported the need for a database of stored materials and curated kits that could be searched and used in their classroom based on topic. While there are examples of some

databases in the literature (Liu et al., 2012), these are largely general resources that are neither STEM specific, DI specific, nor are they cross-listed based on career pathway or specific major. This need is highly specialized and would need to be tailored to the specific needs of STEM departments so that it can serve the specific variety of academic majors within those departments.

Future Research

This study offers important insight on the teaching environment at one institution and provides key perspectives and needs of biology faculty in a medium-sized community college. Although not generalizable, it is hoped that this research can inform future research directions on the implementation of DI based on career-pathway in higher education can be established. Tomlinson's theory (Tomlinson, 2005; Tomlinson, 2003; Tomlinson, 2001) was largely founded on differentiation in primary and secondary education and is commonly used to differentiate based on issues faced in these educational settings (e.g., reading level, placement, skill set). Because of this, Tomlinson's theory is not commonly used in higher education to differentiate based on students' career-pathways. It is recommended that this novel approach to Tomlinson's theory of DI be further researched in higher education departments with mixed-major courses.

CHAPTER II: DISSEMINATION PLAN

Faculty work hard to ensure the success of their students. But as student demographics change, sometimes faculty miss key events or changes in enrollment that necessitate moving beyond one-size fits all approaches. This case study revealed some key barriers for the implementation of DI based on career pathway in mixed-major biology courses. Important but unexpected findings were identified, and a plan developed to help faculty better serve their students. After all the analysis, the results of this work were disseminated by sharing the findings of this case study with the biology department, especially with those who participated in this research study. Additionally, it was recommended to the biology department that an interdepartmental taskforce be established to help improve student success in courses which serve a diverse set of majors.

Presentation of Findings and Next Steps

On January 7th 2022, findings of the study were discussed with the chair of the department. An open and positive discussion about the change in the distribution of student majors and perceived faculty needs were discussed. A handout (Appendix J) created to inform various stakeholders was provided to the department chair to discuss the various needs and concerns raised from this study. An open discussion about enrollment distribution from this study's document analysis was presented. Data pertaining to the enrollment based on course section of each observed course was provided during the meeting. Data was also presented and discussed relating to the enrollment breakdown of students in courses that highlighted the significant enrollment of more than 80% of the students in these mixed-major courses who were not majoring in the traditional STEM fields (Biology, Chemistry, Physics, and Math). This data led to a frank discussion about how the department should define the meaning of STEM within

this academic department. The discussion with the chair was also instrumental in the next steps of dissemination because it provided insight into the importance of understanding student needs from an interdepartmental perspective. Given that approximately 40% of the students enrolled in courses observed were from an area relating to exercise science (i.e., kinesiology, health and PE education, physical therapy), the department chair agreed there is a significant need to help faculty bridge the knowledge gaps between these biology and the other STEM related department on our campuses.

On January 8th, the department chair and I presented these findings to the faculty during the departmental faculty meeting. Each faculty member was provided the same handout (Appendix J) to disseminate the information gained on the needs of the department as related to DI needs based on career pathway. Faculty, in general agreed, with the overall data presented and they each indicated a general lack of knowledge related to the diverse range of majors enrolled in our mixed-major biology courses. The meeting included discussion designed to gain insight into the next steps for the department. Despite the need for resources determined by this study, the lack of knowledge relating to the distribution of majors and student demographic was deemed the most significant barrier to student success in these mixed major courses. Based on the study data and faculty feedback during the information session, it was determined that an interdepartmental / interdisciplinary taskforce would need to be created to ensure curricular alignment as well as to better understand the needs of faculty from multiple departments. The department determined the best plan of action was to create this taskforce and establish its first interdisciplinary focus to look at the connection between exercise science and biology, because of the data gathered from this study. Further departments will be included upon the successful implementation of this first collaboration.

Interdisciplinary Taskforce for STEM Success (ITSS)

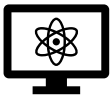
The Interdisciplinary Taskforce for STEM Success (ITSS) was created to align curricular standards among the different programs and to focus on the needs of students from an interdisciplinary and collaborative perspective using the expertise and from the different professions and fields. The goal of this taskforce is to collaborate with departments whose majors have prerequisite STEM courses within their academic major. The ITSS seeks to work in collaboration with these departments to ensure students have the tools they need in these mixed-major courses so that the courses actively support the students' career development as well as their overall success. As the lead of the ITSS, I invited the chair of exercise science, the faculty course leads for mixed-major biology, and faculty of introductory level exercise science courses to form the first ITSS team. Initially, this taskforce will meet monthly with the eventual frequency to be determined by the taskforce as it continues to get established. The first ITSS taskforce meeting was held on January 14th, 2022. This meeting was held on zoom due to the ongoing pandemic and ease of attendance for each member across our three campus locations. Future meetings will be held in person to build a closer collaboration.

My role in this meeting was to facilitate conversation between the two departments and to present the results of this research to the exercise science department and data relating to the importance of interdepartmental collaboration. I provided each member of the taskforce with the meeting agenda (Appendix K) the handout with the results from this study (Appendix H and I), information on the key aspects of successful interdepartmental collaboration from the literature (Appendix L), and benefits of interdepartmental collaboration for students (Figure 4) for student success in mixed-major courses from a variety of disciplines.

Figure 4. Benefits of Interdepartmental Collaborations on Student Success

Course Content More Closely Aligns with Career
Interdepartmental collaboration provides students insight and connection into their future career goals earlier in courses. Curriculum alignment helps students build greater connections to their course material.

Promotes Higher-Level Critical Thinking
When faculty can provide connections of their course material to different academic areas that hold significance to their students, students are able to develop their critical thinking skills due to established connections between their academic experiences.



Enhance Learning Experiences
Students are engaged in course material at an earlier stage when students see clear connections to their pre-requisite courses and their future career goals. This provides students an earlier look into the interdisciplinary aspect of their learning experiences.

Promotes Innovative Solutions in their Careers
Students can visualize more innovative solutions in their majors and careers if they are provided stronger connections early in their academic journey. Early connection with the concepts helps student relate material in a more innovative way.

Adapted from Wilson & Zamberlan, 2012

Note: This figure illustrates some key features that interdepartmental collaboration can have on student success in their courses. This figure summarizes four key ideas as noted in Wilson & Zamberlan, 2012.

The first meeting on the ITSS was productive and successful. The minutes of the meeting have been included in this dissertation with the approval of the ITSS committee (Appendix M). In addition to the topic mentioned previously, there was a discussion on the results of the departmental study and the resulting need for the formation of the taskforce. I provided insight into the need for the interdepartmental collaboration and key reasons these collaborations are beneficial to departments and students. During this discussion I emphasized the fact that interdepartmental collaboration has a multitude of benefits relating to student success. In addition to the value of sharing knowledge and resources among faculty from different areas, students see improvement in making greater career connections, enhance their critical thinking skills and learning experiences, and students learn ways to create innovative solutions and

alternative approaches to problems in their career field (Wilson & Zamberlan, 2012). These improvements and connections in mixed major courses is another reason the ITSS is essential for student success in mixed-major courses from a variety of disciplines.

The meeting also included a lengthy yet beneficial discussion on what STEM is and what courses / departments make up the STEM field. This discussion allowed members to better understand STEM viewpoints from the two departments and members began to better understand the need for collaboration between exercise science and biology. Members from each department were excited to share insight into each of their programs and courses. Members from Exercise Science provided biology faculty with details about their degree program (A.A.S in Health and Fitness Science) as well as provided further insight into exercise science students who are enrolled in A.S. (Associate of Science) degree programs that have expressed interest in transferring into kinesiology-related programs. Further information was provided on concepts from exercise science courses that relate to the biology courses to provide faculty insight into the connection between kinesiology and STEM education.

The meeting also addressed initial steps to develop interdisciplinary course alignments between the core biology courses and the exercise science courses that are required for Exercise Science students during their first year in the A.A.S or A.S. programs (Table 1) and their respective course descriptions (Appendix N).

Table 1. First Year Course Alignment

Fall Semester – 1st Year		**Spring Semester – 1st year**	
BIO	**HFS**	**BIO**	**HFS**
BIO-168 – Anatomy and Physiology I	HFS-110 – Exercise Science	BIO-168 – Anatomy and Physiology II	HFS-116 – Prevention & Care of Exercise Injuries

Note: The courses in the table are first year courses the ITSS deemed most appropriate for initial course standard alignment. BIO is the prefix for the mixed-major biology courses and HFS is the prefix for exercise science courses.

Plans to align specific learning outcomes between these courses will occur throughout the Spring 2022 and Fall 2022 semesters. Continued collaboration between departments through the ITSS will seek to bridge gaps between the departments and will be expanded to other areas. Significant progress was made toward a better understanding of exercise science as a STEM field and initial discussions to have exercise science present their needs at a future biology faculty meeting began. During the next meeting, each department was tasked to bring specific course learning outcomes for each course. Members have been tasked with identifying which concepts show student weaknesses to build collaborations to support student learning.

This successful initial meeting of the ITSS taskforce reinforced the needs identified in Aim 1 and 2 of this research study. Further development of the ITSS taskforce will help faculty from across multiple departments build greater connections to a wide variety of disciplines. This initial meeting also demonstrated the need for not only a better definition of what STEM is by including a wider range of majors, but also to start building a community to address the needs and resources of faculty as it pertains to DI based on career-pathway.

CHAPTER III: ACTION PLAN

The results of this study provide insight into faculty needs and expectations in mixed-major biology courses toward the incorporation of DI based on career pathway. A clear need was established for a better understanding of the diverse majors that enroll in mixed-major biology courses as well as the resources that faculty need to allow for the more seamless integration of DI in these courses. The research informs various campus stakeholders at the departmental and college level of the need for creating mixed-major biology courses that are more inclusive and representative of the diverse major that make them up. While the implications of this research affect a wide range of students across a wide variety of majors, it very specifically affects students from kinesiology-related programs. The long-term goal of this project is to ensure faculty are trained and have the resources to incorporate DI or other active learning strategies based on career pathways within each of their courses. Helping faculty meet the needs of each of their students is of utmost importance. While the creation of the ITSS outlined in chapter II goes a long way toward helping faculty understand the diverse representation of STEM majors within the college, there is still more that can be done to help faculty gain the tools and resources they need to put this newfound understanding into practice. In fact, Aim 2 of this research study revealed unique needs of faculty toward the implementation of DI based on the career pathway in their courses. These needs will be further addressed through the following action plan (Figure 5).

Figure 5. Four-Stage Action Plan Timeline

Note: This is a 4-stage timeline of the next stages of the dissemination and action plan for future research. These stages are described in detail in the following text of Chapter III.

Expansion of the ITSS

One of the biggest results of this study was the need for the creation of the ITSS between the traditional science programs and exercise science to better understand the needs of our students through interdisciplinary collaboration. The initial formation of the ITSS primarily focused on the results from Aim 1 of the research study due to the overwhelming need for faculty to have a better understanding of kinesiology's role as a STEM field. Despite this intense need, it placed the results of Aim 2 on the backburner regarding implementation. Without understanding the needs of kinesiology students in mixed-major courses, it is impossible to

implement DI based on career-pathway. Now that this first foundational piece has been laid, the long-term goal of this project needs to be the expansion of the ITSS in two capacities.

ITSS Expansion Based on Faculty Need

First, ITSS will be expanded to incorporate the needs and resources that faculty identified in this study. The goal of the ITSS will be to research and begin the implementation of the resources identified by the faculty participants. Faculty identified interdepartmental collaboration to be successful implementing DI based on career pathway. Steps have already been taken by the formation of the ITSS, which is a collaboration of biology faculty with faculty from other departments whose students are required to take mixed-major biology courses. This collaboration was identified as one of the largest needs by faculty in Aim 2. The collaboration will be increased to work on a wider and wider range of topics within these mixed-major biology courses.

Other needs identified in Aim 2 included content-specific professional development, lack of time, implementation support, piloting, and the formation of a database of DI activities specific for STEM courses that relate to a variety of career pathways. The ITSS and I will act as advocates for these much-needed resources for faculty. The ITSS will consult with departmental deans and vice-presidents to identify key resources that can be provided / implemented in the short-term as well to create plans for those resources that have a more long-term implementation timeline. This taskforce will also continue to work with faculty to further refine their needs as they evolve and to make requests to department chairs and deans to help improve DI and active learning based on career-pathway in these biology courses as well as courses in other academic areas.

ITSS Expansion Based on Collaboration

Second, the ITSS will be expanded to include faculty from a wider range of departments for increased collaboration. Biology and Kinesiology will continue to work in a collaborative way, but the need for other departments' input on what their students need is also highly valuable. Other programs across campus, including allied health related programs, will greatly benefit from this collaboration. As participating academic departments identify key resources and collaboration needed, the ITSS will help bridge the various departments together to improve mixed-major courses in both the sciences as well as other programs. The ITSS will continue to be a STEM taskforce, but the long-term plan is to encourage other departments and divisions across campus to collaborate in a similar way to improve student success in all courses across campus.

Online Repository of Differentiated Instruction

To provide faculty tools for implementing DI in their mixed-major biology courses, I hope to create a framework for developing an online repository of differentiated instructional techniques that is geared toward traditionally mixed-major biology courses. This repository needs to include several pieces. The repository needs to provide users with detailed information on the use of DI in the classroom. It also needs to maintain records of current and past research of DI in higher education. One of the major pieces that the repository needs to house are course/unit activities that can be utilized in mixed-major biology courses. The repository's focus would center on previously designed activities that mixed-major biology faculty can access so that DI can easily be integrated into their courses. I plan on first developing this repository at my local institution and then expanding regionally and perhaps nationally (as a consortium) depending on its local success. I will seek my local institutions' support in creating this

repository. As a member of the online technology team for the institution, I have the skills and support necessary for the creation of this repository. I will seek institutional funding to get started on the process while looking for grant funding opportunities to continue its growth and development.

Further Research and Dissemination

Interdisciplinary/interdepartmental collaborations and the use of DI based on career pathway are important avenues to student success in biology courses. It is my intention to present the findings uncovered in this study (both the need for DI based on career-pathway as well as the dire need for collaborative efforts in mixed-major courses). To promote this research at the local and regional level, I plan to present at the annual professional development conference hosted every spring semester by my academic institution. This local conference has developed from a National Science Foundation Grant awarded to our college and our department. This conference highlights inquiry-based learning techniques, active student engagement, and undergraduate research techniques in a one-day professional development conference. This conference will allow me to provide background and tools to my campus community as well as the regional academic community. I also plan to present this research and findings at the North Carolina Community College Association of Biology Instructors (NC^3ABI), held each Spring, to help promote the need for DI and to provide resources to the academic community at this conference that attracts attendees from across the state. At the national level, I plan to submit this research for publication in the College of Undergraduate Research Education (CURE). CURE is a national conference that reaches a wide variety of academic programs across the country. I believe this research is a perfect fit for each of these conferences. Each of these conferences deal

with pedagogical approaches to improve educational experiences in the higher education setting, and I have a track record of presenting at these conferences in the past.

Further Academic Research

In the long-term, I plan to continue my research with DI and other possible instructional techniques to better meet the needs of students in mixed-major courses. In addition to identifying faculty perspectives, it will be essential to look at student perspectives regarding DI based on career-pathway in higher education. It is hoped that this leads to future academic publications in my academic area. Some journals on which I plan to submit papers include The Journal of Microbiology and Biology Education, CBE – Life Science Education, The Journal of Chemical Education, and Advances in Physiology Education. Future studies in this area can promote positive experiences for students enrolled in these mixed-major biology courses.

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APPENDIX A: AMERICAN KINESIOLOGY ASSOCIATION (AKA) CORE ELEMENTS

AND LEARNING OUTCOMES

Core Curriculum that Aligns the Kinesiology Curriculum with Biology

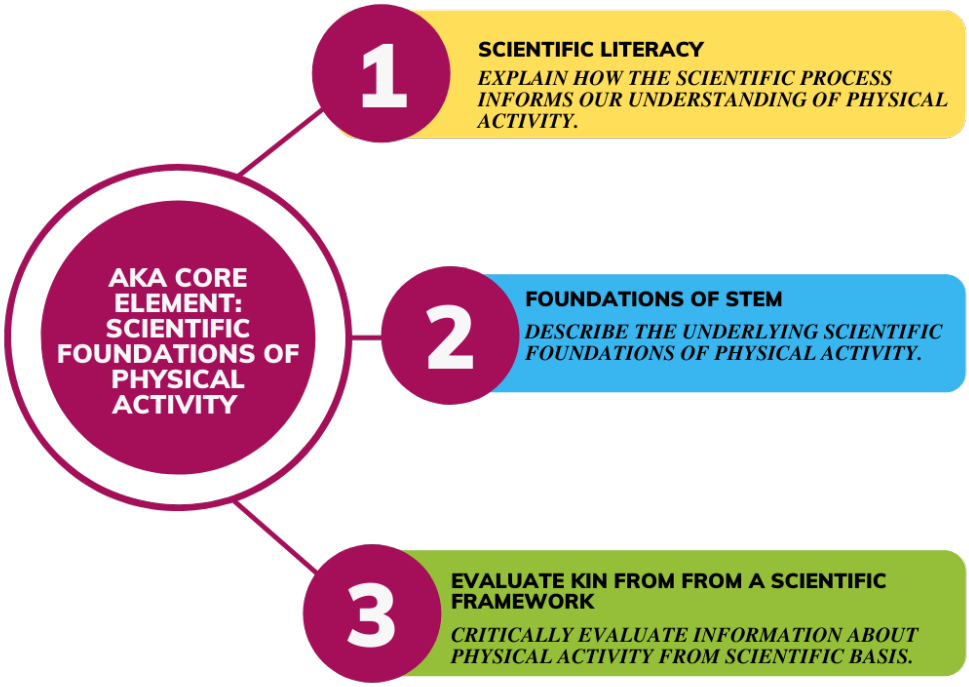
Excerpt taken directly from AKA Website Section on "*AKA statement regarding the Undergraduate Core Curriculum in Kinesiology"*
https://americankinesiology.org/SubPages/Pages/Statement%20on%20Undergraduate%20Core

"The American Kinesiology Association (AKA) defines kinesiology as the academic discipline that involves the study of physical activity and its impact on health, society, and quality of life. Kinesiology draws on several sources of knowledge including knowledge gained through scholarly study and research, knowledge gained from professional practices centered on physical activity, and knowledge gained from personal physical activity experiences."

"The AKA believes that one of the defining features of the academic discipline of Kinesiology is its embrace and integration of the multi-dimensional study and application of physical activity. Kinesiology explores not only biological, medical, and health-related aspects of human movement, but also psychological, social-humanistic, and professional perspectives."

Learning Outcomes that Align the Kinesiology Curriculum with Biology

Kinesiology Core Element - Scientific Foundations of Physical Activity



APPENDIX B: RESEARCHER POSITIONALITY AND THREATS TO TRUSTWORTHINESS

Researcher Positionality

I am a biology instructor in a higher education institution and have a strong passion for work in the field of kinesiology. In addition to advanced degrees in biology and microbiology, this researcher also has advanced degrees in online teaching and instructional design and higher education administration. My views have further been shaped over the last four years as a doctoral student in kinesiology. These educational experiences have made me passionate about inclusive instruction in biology courses and the support of students from kinesiology-related majors. As a biologist, I have a strong understanding of the key goals and learning outcomes required in these mixed-major courses. As a kinesiologist, I have a strong understanding of the core elements that kinesiology majors need to be successful in kinesiology programs. My diverse background makes me uniquely suited to undertake a study with mixed-major biology students. My unique experience, as both a biologist and kinesiologist, served as a strength in my role as the researcher of this case study. In addition, being a faculty member in the department in which this case study took place and my collegial relationship with the faculty members allowed for a more open and authentic experience from the participants. I have a deep understanding of the needs and issues that faculty and students face within this department and that provided a strong foundation for this study. My close work-relationship with the participants allowed for an insider view that other researchers would not appreciate. I have a strong positive opinion on the importance of DI and active learning in science courses and I am aware of the bias I have concerning DI research. I am also responsible for teaching a wide variety of mixed-major

biology courses and personally understand the importance of reaching the variety of majors in these courses (such as kinesiology majors). Before beginning the study, I utilized reflexivity (via peer discussion) to distinguish between my personal and professional experiences relating to DI to bracket these experiences thereby separating them from data collection process. Also, member checking and peer debriefing were utilized to ensure greater credibility and trustworthiness throughout this study and to ensure researcher bias was not reflected in this study's findings.

Threats to Trustworthiness

I took care to limit threats to trustworthiness. Researcher bias is a significant threat to trustworthiness and the researcher worked to set aside preconceived notions about DI in mixed-major biology courses using constant comparative analysis to bracket the research regarding data interpretation (Creswell and Poth, 2016). Researcher bias was also addressed through peer-debriefing to limit potential bias and ensure the legitimacy of the data (Guba & Lincoln, 1994). Copies of the data and codes that the researcher identified were provided to fellow academic colleagues to check for potential implicit bias. Member-checking was also conducted through a post interview review to ensure accuracy of participant transcripts and their emerging themes. Furthermore, researcher bias was limited through triangulation of the data via separate data collection points (observation, course documents, and interview) and further minimized through this convergence of data (Creswell & Poth, 2016). Despite the comprehensive attempts to limit threats to trustworthiness, I understand that we live in a social world shaped by our own personal interpretations.

APPENDIX C: SAMPLE PARTICIPANT RECRUITMENT EMAIL

Hello to all my fellow biology faculty! I am conducting a research study through the Kinesiology program at the University of North Carolina at Greensboro. I am in search of participants here at Gaston College who teach mixed-major biology courses (e.g., anatomy and physiology, nutrition, biology, microbiology, genetics) to learn more about instructional styles and potential use of differentiated instruction in your mixed-major courses.

What is the study about?

The purpose of this study will be to identify current practices and perspectives of faculty concerning the use of differentiated instructional techniques based on career pathway to improve the success of kinesiology students in mixed-major biology courses. By understanding the needs and perspectives of faculty, recommendations can be made to help faculty incorporate resources or to provide professional development to improve course success for students from kinesiology-related majors. This study is being conducted to fulfill dissertation requirements for the Doctor of Education in Kinesiology at the University of North Carolina at Greensboro. Any data collected in this interview will be used for formal research-based purposes toward the completion of a doctoral degree as well as potential future publications. You were invited to participate in this interview because you are a faculty member (full-time, visiting, part-time, or adjunct) and teach mixed-major science courses (either online, hybrid, web-based, or face-to-face) as a part of your professional responsibilities. The interview questions are related to your personal experiences as an educator, as well as your perspectives, attitudes, and beliefs on the use of differentiated instruction in your mixed-major science courses. The interview questions are intended to identify your unique experiences in the mixed-major science classroom. Don't use DI or don't know what it is? No worries. I still want you to participate. Knowledge or use of DI is not essential. What matters is that you actively teach mixed-major biology courses. This project's time commitment will be 2-3 hours spread over two data collection events (classroom observation and interview). In addition, you will be asked to provide a syllabus of the mixed-major biology courses and sample course activity (if applicable). All identifying information will be removed and coded for your protection. Individual data or information gathered through this study will not be shared with anyone and your participation is voluntary.

What are the potential benefits and risks of participation?

Your participation in this interview is voluntary. You may choose not to participate at any time. If you decide not to participate in this study or if you withdraw from participating in the interview, you will not be penalized in any way. The results of this interview will be used for scholarly purposes for the completion of my doctoral research at The University of North Carolina at Greensboro. There are no known risks, discomforts, or inconveniences anticipated from your participation in this interview. The interview will take approximately 45 minutes. Your responses will be confidential, and I will not collect or record any identifying information such as your name, email address, work location, etc. You receive no direct benefits from participating in this research study; however, your responses will help me identify faculty experiences, perspectives, and potential needs toward the use of differentiated instruction in mixed-major science courses.

If you are interested in participating, please respond to this email or email at williams.patricia@[redacted]edu. I will provide information about the projects specific IRB approval and informed consent at that time. This project is approved by the [redacted] College IRB (IRB00010300 [redacted] College IRB #1) and through UNC Greensboro IRB (IRB-FY21_264). This research is classified as exempt according to 45 CFR 46.101(b).

Trisha

APPENDIX D: INFORMED CONSENT

Project Title: Improving Kinesiology Student Success in Mixed-Major Biology Courses: A Case Study Exploring Faculty Perspectives of Differentiating Instruction Based on Career Pathway.

My name is Patricia Williams, and I am a graduate student in the Department of Kinesiology at the University of North Carolina at Greensboro. Thank you for taking the time to meet with me for this study.

What is the study about?

The purpose of this study will be to identify current practices and perspectives of faculty concerning the use of differentiated instructional techniques based on career pathway to improve the success of kinesiology students in mixed-major biology courses. In order to best understand the needs of faculty, this study will include a classroom observation (class session chosen by you, the participant), document analysis (examples of syllabi and/or classroom activity id available), and an informal interview. Both the interview and classroom observation will be recorded for ease of transcription. The single interview will take approximately 45 minutes and the single classroom observation will take approximately 1 hour (or the duration of one classroom session). Your responses will be confidential, and I will not collect or record any identifying information such as your name, email address, work location, etc. The data collected in this study will help better understand the needs and perspectives of faculty so recommendations can be made to help faculty incorporate resources or to provide professional development to improve course success for students from kinesiology-related majors.

This study is being conducted to fulfill dissertation requirements for the Doctor of Education in Kinesiology at the University of North Carolina at Greensboro. Any data collected in this study will be used for formal research-based purposes toward the completion of a doctoral degree as well as potential future publications.

You were invited to participate in this study because you are a faculty member (full-time, visiting, part-time, or adjunct) and teach mixed-major science courses (either online, hybrid, web-based, or face-to-face) as a part of your professional responsibilities. All data collected in this study are related to your personal experiences as an educator, as well as your perspectives, attitudes, and beliefs on the use of differentiated instruction in your mixed-major science courses. This study is intended to identify your unique experiences in the mixed-major science classroom and to provide insight into any needs faculty may have in their mixed-major courses.

What are the potential benefits and risks of participation?

Your participation in this study is voluntary. You may choose not to participate at any time. If you decide not to participate in this study or if you withdraw from participating in the study, you will not be penalized in any way. The results of this study will be used for scholarly purposes for the completion of my doctoral research at The University of North Carolina at Greensboro. There are no known risks, discomforts, or inconveniences anticipated from your participation in this study. The single interview will take approximately 45 minutes and the single classroom observation will take approximately 1 hour (or the duration of one classroom session).

"All information obtained in this study is strictly confidential unless disclosure is required by law."

Your responses will be confidential, and I will not collect or record any identifying information such as your name, email address, work location, etc. You receive no direct benefits from participating in this research study; however, your responses will help me identify faculty experiences, perspectives, and potential needs toward the use of differentiated instruction in mixed-major science courses.

If you have questions about this study, you can contact the researcher by email at pjwilli3@uncg.edu or her dissertation chair, Dr. Pam Brown, at plkocher@uncg.edu. In addition, "If you have any questions about your rights as a research participant or concerns or complaints about the study, please email the UNCG Office of Research Integrity at ori@uncg.edu.

If you agree to continue in this study, please circle "Agree". If you do not agree or want to withdraw from the study, please circle "Disagree".

You, the participant, _____ to take part in this study.

Agree **Disagree**

APPENDIX E: COPUS OBSERVTION DOCUMENT AND OBSERVATION CODES

The COPUS Observation was completed using an online tool, Generalized Observation and Reflection Platform (GORP) ("GORP", 2021) by the University of California at Davis. This COPUS Observation Guide (Smith et al., 2013) is an example of the published guide found at https://cwsei.ubc.ca/sites/default/files/cwsei/resources/tools/COPUS_protocol.pdf)

Date: _____ **Class:** _____ **Instructor:** _____ **No. students** _____ **Observer Name:** _____

Classroom arranged how? _____

1. **L**-Listening; **Ind**-Individual thinking; **CG**-Clicker Q discussion; **WG**-Worksheet group work; **OG**-Other group work; **AnQ**-Answer Q; **SQ**-Student Q; **WC**-Whole class discuss; **Prd**-Predicting; **SP**-Student present; **TQ**-Test/quiz; **W**-Waiting; **O**-Other

2. **Lec**-Lecturing; **RtW**-Writing; **FUp**-Follow-up; **PQ**-Pose Q; **CQ**-Clicker Q; **AnQ**-Answer Q; **MG**-Moving/Guiding; **1o1**-One-on-one; **D/V**-Demo+; **Adm**-Admin; **W**-Waiting; **O**-Other

For each 2 minute interval, check columns to show what's happening in each category (or draw vertical line to indicate continuation of activity). OK to check multiple columns.

COPUS

	1. Students doing													2. Instructor doing												3. Engagement			Comments: EG: explain difficult coding choices, flag key points for feedback for the instructor, identify good analogies, etc.
min	L	Ind	CG	WG	OG	AnQ	SQ	WC	Prd	SP	T/Q	W	O	Lec	RtW	Fup	PQ	CQ	AnQ	MG	1o1	D/V	Adm	W	O	L	M	H	
0 - 2																													
2																													
4																													
6																													
8 - 10																													
	L	Ind	CG	WG	OG	AnQ	SQ	WC	Prd	SP	T/Q	W	O	Lec	RtW	Fup	PQ	CQ	AnQ	MG	1o1	D/V	Adm	W	O	L	M	H	
10 - 12																													
12																													
14																													
16																													
18 - 20																													
	L	Ind	CG	WG	OG	AnQ	SQ	WC	Prd	SP	T/Q	W	O	Lec	RtW	Fup	PQ	CQ	AnQ	MG	1o1	D/V	Adm	W	O	L	M	H	
20 - 22																													
22																													
24																													
26																													
28 - 30																													

1. **L**-Listening; **Ind**-Individual thinking; **CG**-Clicker Q discussion; **WG**-Worksheet group work; **OG**-Other group work; **AnQ**-Answer Q; **SQ**-Student Q; **WC**-Whole class discuss; **Prd**-Predicting; **SP**-Student present; **TQ**-Test/quiz; **W**-Waiting; **O**-Other

2. **Lec**-Lecturing; **RtW**-Writing; **FUp**-Follow-up; **PQ**-Pose Q; **CQ**-Clicker Q; **AnQ**-Answer Q; **MG**-Moving/Guiding; **1o1**-One-on-one; **D/V**-Demo+; **Adm**-Admin; **W**-Waiting; **O**-Other

For each 2 minute interval, check columns to show what's happening in each category (or draw vertical line to indicate continuation of activity). OK to check multiple columns.

page 2

	1. Students doing													2. Instructor doing												3. Engagement			Comments: EG: explain difficult coding choices, flag key points for feedback for the instructor, identify good analogies, etc.
min	L	Ind	CG	WG	OG	AnQ	SQ	WC	Prd	SP	T/Q	W	O	Lec	RtW	Fup	PQ	CQ	AnQ	MG	1o1	D/V	Adm	W	O	L	M	H	
30 - 32																													
32																													
34																													
36																													
38 - 40																													
	L	Ind	CG	WG	OG	AnQ	SQ	WC	Prd	SP	T/Q	W	O	Lec	RtW	Fup	PQ	CQ	AnQ	MG	1o1	D/V	Adm	W	O	L	M	H	
40 - 42																													
42																													
44																													
46																													
48 - 50																													

Further comments:

Use of COPUS in this Case Study

The COPUS Observation tool is a tool that is designed to evaluate what is happening in the classroom during a particular classroom session. It is quantitative, reflective tool to inform instructors of their classroom teaching habits and approaches. For this case study, the COPUS data collected served to create a reflective impression of the instructional approaches occurring the classrooms of the participants of this study. The COPUS observation tool was utilized in this study due to its design as a validated STEM instrument.

Observational data was collected in 2-minute increments throughout each observed class session. Within these two-minute increments, specific instructor and student "actions" were marked using a predetermined set of codes established by the COPUS instrument. There are 25 codes that relate to specific actions that may occur during the observation. Twelve of the codes relate to a potential action performed by an instructor and thirteen codes that relate to a potential action performed by a student. To streamline the data coding, the researcher utilized the General Observation and Reflection Platform, GORP ("GORP", 2021), created by the University of California at Davis, to allow for the collection of data in an online setting that is compatible with the COPUS instrument while also automatically saving data as it is recorded.

The GORP data collection process allows for the data recorded to be visualized into representative pie charts that allow for a representative picture of the class observation to emerge from the data. This data was utilized to combine the transcribed lecture and the post-observation reflection to check is the researcher perceptions of what is happening in the classroom matches the qualitative data that was emerging in the study. This profile was used to provide the researcher insight into the predominant instructional practices that occurred during a "traditional" classroom session.

Table E2. COPUS Observation Codes Relating to Instructional Activity of the Participant

Code	Description	Updated Description
LEC	*Lecturing (presenting content)*	Same
RtW	*Real-time writing, doc. projector, etc (usually checked off with Lec)*	Same
Fup	*Follow-up/Feedback to entire class*	Same
PQ	*Posing a non-rhetorical question to students*	Same
CQ	*Asking a clicker question to the class (mark the entire time the instructor is engaged)*	Engaging (asking students a question) using electronic response systems of any kind. (e.g., iClicker questions, Poll Everywhere, SMART board response technology, iPAD response systems, etc). *** this updated definition was just to include other electronic response systems developed over the past decade since the creation of the COPUS instrument ***
AnQ	*Listening to and answering student questions with entire class listening*	Same
MG	*Moving through class guiding ongoing student work during learning tasks*	Same
1o1	*One-on-One extended discussion with one or a few students, not paying attention to the rest of the class (sometime marked along with MG or AnQ)*	Same
D/V	*Showing or conducting a demo, experiment, simulation, video, or animation.*	Same
Adm	*Administration (assign homework, return tests, etc.)*	Same
W	*Waiting when there is an opportunity for an instructor to be interacting with or observing/listening to student or group activities and the instructor not doing so.*	Same
O	*Other – explain in comments.*	Same

Modification of the "CQ code" for Instructional Research

This research study investigated the perspectives of mixed-major biology faculty and their potential use of differentiated instruction based on career pathways. In addition, the use of

this COPUS tool was to provide a baseline of instructional practices of each participant to help frame faculty responses during interviews and throughout the data analysis process (Table 2). To account for the updated clicker technology over the past decade, one code was expanded to reflect the modern classroom (Table 2). The "CQ – Clicker Question" code was expanded to include other real-time, response-based instructional technology used in addition to standard "iClickers". While faculty have access to "iClicker" technology, this research modified "CQ" to include questions posed using any type of response-based instructional technology (Table 2).

Limitations of COPUS in this Study

While the use of COPUS in this study was used as a baseline to gain insight into the participant's classroom approaches and STEM teaching practice, it is important to note the limitations of COPUS regarding this study. The COPUS is a tool that was designed to provide faculty a way to reflect upon their STEM teaching practice (Smith, et al., 2013). The protocol recommends that observers use multiple (2 or more) observations if using COPUS to evaluate faculty in the work setting. Since this study just wanted to get a general understanding of what a lecture may look like, only one observation was conducted. This observation was not used as an evaluative tool for participants. It served as an additional viewpoint of the recorded observation to help better frame the interview sessions and the overall picture of the approach of the faculty member in their mixed-major biology course.

One other limitation of the use of COPUS was the dated nature of one of the coding categories. The "CQ - *Asking a clicker question to the class (mark the entire time the instructor is engaged)",* has not been updated to reflect that there is more instructional technology that has been developed that serve as alternative tools to "iClicker questions". For the purposes of this study, the "CQ" category was updated to include questions that may have been asked using an

alternative electronic response system outside of the standard “iClicker” software (e.g., Poll Everywhere, Kahoot, Pollmaker). While this update was included for this study, it is important to notes that no participant was observed using the “CQ” code in the study and that update in the code did not have an impact in the results of this study.

APPENDIX F: POST OBSERVATION REFLECTION GUIDE

Observation ID: _____

Observer: _____

Date and Time: _____

Course: _____

Course Description:

Jottings:

Observation Comments:

APPENDIX G: INTERVIEW GUIDE

Introductions:
Please introduce yourself and describe your professional role in higher education.

- *Probing Question*: How long have you been an instructor of mixed-major science courses?
- *Probing Question:* What events or experiences drove you to teach postsecondary mixed-major science courses

Learning Experiences:
Tell me about your experience as a learner (from primary, secondary, postsecondary education)?

- *Probing Question*: How has your previous experience as a student impacted how you teach your students today? If so, how?
- *Probing Question*: What were some learning/class activities you responded to (either positively or negatively) as a student? Explain.

Teaching Experiences:
Briefly describe your "typical" student population in your mixed-major biology courses.

- *Probing Question*: What are the diverse majors that are typically enrolled in your mixed-major science courses?
- *Probing Question*: What is the relationship of Exercise Science / Kinesiology students to mixed-major biology courses?
- *Probing Question*: Does this affect how you structure your lessons or course content?
- Describe a typical day in your mixed-major science course.
- *Probing Question*: How would you describe your overall teaching methodology?

Describe how your experiences as a student have influenced how you approach teaching your students today.

- *Probing Question*: Has that caused you to adapt your current learning environment for your students?

Describe how you believe your teaching practice match the needs of students in your mixed-major science courses. Please explain.

Describe how you help students make connections with the course content to their majors or interests.

- *Probing Question*: What are these strategies?
- *Probing Question*: Where did you learn these strategies?

Describe, to the best of your knowledge, how students in your class "prefer" to learn.

- *Probing Question*: How do you know? What do you look for from each of your students?

Differentiated Instruction:
Describe what differentiated instruction means to you.

- *Probing Question*: If you are not sure what differentiated instruction… provide what you believe is based on the name "differentiated instruction".

Describe your experience with differentiated instruction.

- Helpful Statement: Provide a summary of differentiated instruction if the participant is not aware of the terminology
- *Probing Question*: Was your experience with differentiated instruction based on previous educational experiences? Professional Development? Self-Learning?

Describe your most pressing needs as a mixed-major science instructor. Describe the tools, material, professional, or peer development that could help you differentiate your classroom or provide diverse educational experiences for your students.

- *Probing Question*: What do you need to help teach your students?
- *Probing Question*: How would you use (or increase use) of differentiated instruction in your mixed-major biology course if provided resources or professional development.

Describe your perspectives of the most helpful resources or professional development that could benefit you in incorporating differentiated instruction.

- *Probing Question:* Are there other tools that would benefit you?

Describe your ideal professional development or resource tool.

- *Probing Question*: Do you believe this would increase or decrease the likelihood of using differentiated instruction in your mixed-major courses?

Wrap-Up – I appreciate your time and thoughtful reflection on your experiences as a mixed-major science instructor.

Is there anything you thought of during the interview that you did not get to say that you feel will provide insight into your experiences and perspectives of differentiated instruction in mixed-major biology courses?

- *Probing Question*: Any other information that you wish to share?

Describe what you would ask fellow instructors if you were a researcher in this study.

- *Probing Question*: Is there something I did not ask but should have?

APPENDIX H: THEMES AND EVIDENCE

Table of Themes, Definitions, and Evidence

Aim #1: To explore the current teaching practices and perspectives of faculty regarding differentiating instruction toward the improvement of kinesiology student success in mixed-major biology courses.

Category	Theme	Definition	Data
Previous Learning Experiences			
Learning Experiences	Lecture-Based Instruction / Faculty Centered	The lecture-based instructional approach is an educational approach where instructors are the primary source of the lecture. The student's focus is mostly on the instructor. ***6/6 participants reported Lecture only instruction Primary through Post-Doc.***	- Interviews
Faculty Perspectives on Previous Learning Experiences	- Teaching How They Were Taught (Comfort)	Faculty tend to teach the way they were taught. It is part of their comfort zone and aligns with their previous learning experiences from their primary, secondary, and postsecondary education. ***6/6 participants reported they instruct today based on previous learning experiences***	- Interviews
Actual and Perceived Teaching Practice			
Current Teaching Practice (Actual)	Faculty-Centered, Lecture-Based Instruction	The faculty-centered approach is a passive learning approach where the students primary focus is on the instructor and lecture is the primary source of delivery of course content. ***1/6 participants had DI related activity***	- Interviews - Observations - COPUS - Document Analysis
Teaching Practice (Participant Perceived)	Mix between Faculty-Centered and Student-Centered	The faculty-centered approach is a passive learning approach where the students primary focus is on the instructor and lecture is the primary source of delivery of course content. The student-centered approach is an active learning approach where the students and the instructor are partners in the learning environment and the students take a more active role in their learning. ***3/6 participants perceived their classroom as a DI supported class.***	- Interviews

Actual and Perceived Student Enrollment Based on Academic Major		
Actual Enrollment Distribution	> 80% of student enrollment is in an area other than traditional STEM (BIO/CHM/MAT/PHY) ~ 50% of student enrollment is in an area relating to EXE	- Document Analysis
Faculty Perspectives of Student Enrollment Distribution	- 4/6 faculty did not consider KIN a STEM Field - 6/6 faculty did not realize they had enrollment from EXE potential majors	- Interviews

Aim #2: Identify the needs and resources faculty deem necessary to successfully implement differentiated instructional practices based on career pathway in mixed-major biology courses.

Category	Theme	Definition	Data
Needs (Informational/ Interpersonal support)	Interdepartmental Collaboration	Interdepartmental collaboration is a need where faculty suggest working with members of other departments to create a more inclusive learning environment. Mixed-major biology faculty reported the need for more collaboration to incorporate DI based on career pathway. *54 mentions*	Interviews
	Content-Specific Professional Development	Content-specific professional development is a need where faculty report the need for PD that focuses on specific content or concepts within their course. STEM faculty reported they need PD related to content that connects other majors to biology specific topics. *36 mentions*	Interviews
	Implementation Support	Implementation support is a need reported by faculty where they are provided administrative or departmental support to help integrate DI or other active learning strategies into existing courses. This can be technology support, funding, collaboration, continued learning experiences, continued purchase of supplies and tools, etc. *29 mentions*	Interviews
	Time:	Time is reported as an issue for faculty on two fronts. Overall, there is not enough time to implement.	Interviews

	• Not enough class time • Not enough prep. time	*25 mentions* Not enough class time to incorporate into an already content heavy subject. *8 mentions* Not enough prep time (course load and responsibilities too heavy to dedicate time to the creation of resources). *17 mentions*	
	Smaller Class Size	Faculty reported the need for smaller class sizes to be able to provide DI in their courses *8 mentions*	Interviews
	Successful Piloting	Faculty reported the need for an already developed and successful DI resources piloted in the current department. *10 mentions*	Interviews
Resources (Tangible support)	Database / Repository	Faculty reported the need for a database of stored materials that could be searched and used in their classroom based on topic. *21mentions*	Interviews
	Curated Resources / Kits	Faculty reported the need for kits or curated resources that require materials to be used. *6 mentions*	Interviews

Representative Quotes by Theme:

Theme	Key Quotes from Interviews
Previous Learning Experiences and Teaching Practice	*"I find myself using anecdotes my previous instructors told me from way back when and I have told those to my students. I even tell my students; this is what and how my teacher taught me when I was your age. And so, I am literally falling back on what I know."* *"In a class of 40 students, well, what do you do when half of it wants a lecture and half wants to do an activity? There is a dichotomy of two things, and they are diametrically opposed in this*

	one class. I can't do both at the same time, I'm either going to lecture or not lecture. And so, I fall back on what I, what I've always fall back on, hey, I'm just gonna stand up here and lecture."
Perceived Student Enrollment	*"I've been teaching mostly students far from my field. So, they are taking this course as a pre-requisite for nursing because it is a requirement for their major and I am not a nursing professor. They are in an area that is far afield from my own professional area."* *"Most of my students are somewhere on the periphery of science, they may not be close in, like nursing. But I have started seeing more student with an interest in veterinary science or those that want to go into PA school."* *"uh, exercise science? That is a different department. We don't have students from that area. I don't know… uh… I guess there could be some just taking a biology course for fun or to fulfill a transfer requirement. These are not students we serve."* *"Honestly, the area did not cross my mind. I guess it is just outside of science and math. I guess, um, I have not had a student inform me they, um, are interested in that area. Um…Is it…um… bad that I never considered that"*
Interdepartmental Collaboration	*"Many of my students are on the periphery of science, like exercise physiology or nursing, and you do the best you can to try to make connections to examples that are relevant to them, but those fields are still outside my expertise."* *"Having interdepartmental collaboration between biology faculty and faculty from other academic majors commonly enrolled in by students in mixed-major biology courses would be needed to implement DI that focuses on a wide range of topics outside of the standard biology examples."* *"I think just being able to talk with other faculty across campus and just kind of, like, a think-tank group were, you know. Then someone from biology can talk to, you know, faculty from another major and ask how I can get my student further knowledge on topics in your program…"*
Content-Specific Professional Development	*"It's one thing for us to have the theory in our head, but it is a whole different thing to try and put some foundation underneath it to actually get to implement it. Implementation is hard.*

	That's the problem. Professional development is needed to give us more than the theory. We need professional development with actual practice or key takeaways for implementation." *"When you learn a science topic, you get to the theory and then you go to the lab and you implement the theory, you play with it and see how it works. That's the missing piece of professional development. Usually, it's just the presentation of the theory with little on implementation."* *"We have all these educational terms for [differentiated instruction] but there is never training on how to actually take one of your courses and actually pushing it out to that course."*
Implementation Support	*"You now, if I had the technology, if I had the little buzzers or, you know clickers, I might incorporate teaching techniques that would help students. But we don't have that support, do we?"* *"We have too much professional development on the big ideas, but no one is willing, to you know, actually give us the support we need to use these things they tell us. It's like [the leadership] just checks some box that they told us about something and move on. They don't provide the support to make these techniques a real, um, possibility in courses."* *"So I would love to do some of these things, but I think a lot of things would have to fall into place with a lot of support systems, that not only the time, the, you know, um, the community to give those examples, you know, the administration actually give us the tools we need with actual takeaways and examples."*
Time and Class Size	*"How can I utilize some of these tools and techniques? I have um… like... 60 students in my classes and they are packed in a small auditorium. I can't even walk around. It would be crazy to attempt any activity outside of lecturing. They get the hands on in lab anyway."* *"Do I do it? No, I don't because I don't have time. Honestly, it's a big issue… it is great, would be great to do [DI], of course. You're literally addressing the needs of each student in the class. Um… but is there time? No. That level of content just cannot be done in such short time."* *"It's not just an issue with class time, you know. I am sure you experienced this. We don't have the class time because there is just too much to get through. Think about cellular respiration. I*

	barely have time to get through that just spouting out facts. Now factor in the activity. Um… not just the time in class, you know, the time I would have to use up to create these things, um, activities. With all they want us to do, when will I be able to do it."
Successful Piloting	*"I need to see it done first. Why am I gonna try something that I don't know will work with our student population. It is… um… too big of a risk for me. I need to see faculty with more experience with DI use it successfully before I, like, take a swing at it. Too much of a risk for maybe not a big payoff. My students need to know things and I don't think I want to use them as Guinea pigs to see if it works or not."* *"I would rather see the department leadership bring a group or something, like a team, to try it. That group can work out how to do it and get it done. They can work out the bugs and roll it out. I am… um…I'm not going to do that until I see it works with other courses here at the college."*
Database / Repository / Curated Kits	*"For me, in terms of tools, I think there's something to be said for creating sort of a stock, a stock of how different concepts from different field interrelate. Because when you're talking about differentiating a topic, you need to know how that topic can be related to other fields. Almost like a database of cross-referencing."* *"But do I have time to go look for all these connections and ideas for my class? No. But, having a collection of resources that I can search and go, hey, I want to introduce this topic next week, I want to know how it relates to exercise science or nursing. I can't dig through the literature but… um… a curation of resources would be more manageable."*

APPENDIX I: THEMES AND DEFINITIONS

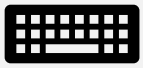
Emerging Themes and Definitions

Interdepartmental Collaboration

Interdepartmental collaboration is a need where faculty suggest working with members of other departments to create a more inclusive learning environment. Mixed-major biology faculty reported the need for more collaboration to incorporate DI based on career pathway. College faculty are trained as subject-matter experts and report limited knowledge of other academic areas and feel collaboration would support DI based on career pathways.

Content-Specific Professional Development

Faculty reported the need for content-specific professional development which focuses on specific content or concepts within their course. STEM faculty reported they need PD related to content that connects other majors to biology specific topics (such as kinesiology or other academic major outside of biology).



Instructional Support

Implementation support is a need reported by faculty where they are provided administrative or departmental support to help integrate DI or other active learning strategies into existing courses. Subthemes include technology support, funding, collaboration, continued learning experiences, continued purchase of supplies and tools, etc.

Time

Time is reported as an issue for faculty on two fronts: 1) Not enough class time to incorporate into an already content heavy subject and 2) Not enough prep time (course load and responsibilities too heavy) to dedicate time to the creation of resources that support DI implementation in mixed major courses.

Smaller Class Size

Faculty reported the need for smaller class sizes to be able to provide DI in their courses. Faculty reported enrollment in classes as large as 90 students and do not see DI implementation as a viable option as long as course enrollments are large.

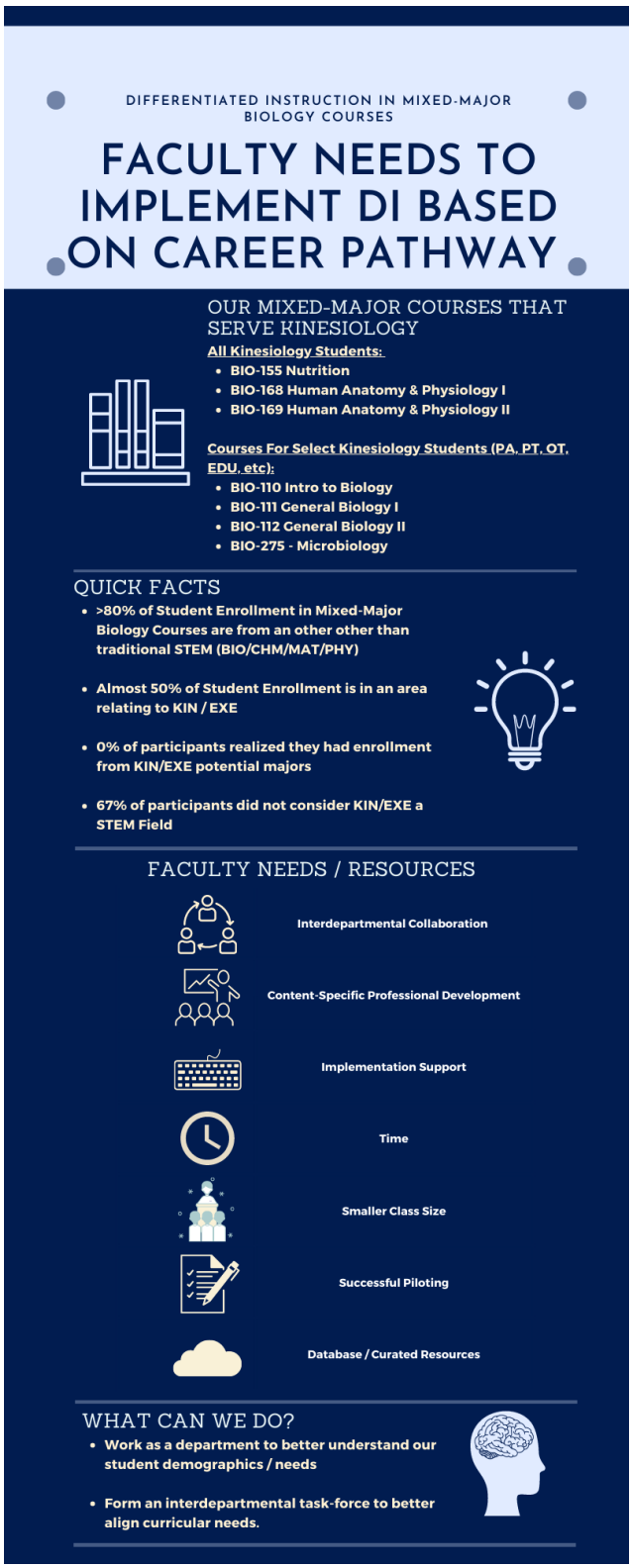
Successful Piloting

Faculty reported the need for an already developed and successful DI resources piloted in the current department. Faculty do not want to risk a failed or unsuccessful DI activity in an already challenging teaching environment. Faculty would be more willing to support DI based on career pathways after successful piloting in the department.

Database / Curated Resources

Faculty reported the need for a database of stored materials that could be searched and used in their classroom based on topic. In addition, faculty reported the need for kits or curated resources of required materials to be used so that it could be easily accessed for specific class sessions without the need for planning and prep work.

APPENDIX J: DI HANDOUT / INFORGRAPHIC



APPENDIX K: ITSS MEETING AGENDA

ITSS Planning Meeting
January 14, 2022
Agenda

1. **Welcome and Thanks**

2. **Formation of Taskforce**

    a. Data from Study (Infographic Handout)

    b. Discussion on STEM profession.
        i. What is STEM to each of you?
        ii. Creating Change

    c. Needs of a Successful Collaboration

3. **Building Curriculum around HFS and BIO**

    a. Discussion on the needs and benefits for our students.

    b. Courses for Alignment

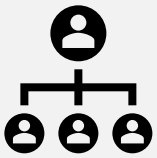
    c. Goals? Needs?

    d. Student representation?

4. **Next Steps / Next Meeting?**

APPENDIX L: KEYS TO SUCCESSFUL INTERDISCIPLINARY COLLABORATION

Aspects of Successful Interdisciplinary Collaboration in Higher Education



Administrative Support

One common feature of successful interdisciplinary collaboration is the support from college administration. In addition to support, individuals in administrative roles can provide insight into key collaborations as well as helping to identify key partnerships between divisions / departments.

Established Working Relationships / Communities

Working communities and relationships are essential for collaborative success. Maintaining an open mind and willingness to accept ideas from outside sources is critical to collaborative success. These communities help expose departments to new experiences and perspectives.

Shared Goals

Collaboration in higher education requires members of each division/ department to share goals related to the collaboration. Ensuring there is a varied curriculum while establishing relationships with each department (courses and department in this case) will create the bridges necessary to increase student success.

Adapted from Fulford, 2016

APPENDIX M: ITSS MEETING NOTES/MINUTES

Interdisciplinary Taskforce for STEM Success
January 14, 2022
Meeting Minutes

Members Present: Patricia Williams (Biology faculty), [redacted] (Biology Course Lead), [redacted] (Anatomy and Physiology course lead), [redacted] Exercise Science course lead, [redacted] (Health and Fitness Department Chair)

Absent: [redacted] (Science Department Chair)

Meeting Convened via zoom at 10:10 am.

I. Welcome by Patricia Williams to discuss the need for the ITSS. Data presented from research conducted in the Fall 2021. Immediate need to provide insight into the connection of Exercise Science to the STEM field. Consultation with the Science department chair and departmental faculty recognized the need for better integration of Exercise Science topics using DI in various biology courses in the Science department.
    a. Handout (presented digitally and emailed prior to the meeting) provided quick facts related to key points uncovered in the Fall 2021 study.
        i. 80% of student enrollment in mixed-major biology courses is from an area other than STEM. (Note – used a traditional definition of STEM – biology, chemistry, math, and physics). No study participant realized they had enrollment in KIN potential majors. 67% of participants did not consider KIN a STEM field
        ii. About 40% of biology enrollment is in KIN. (Note – [redacted] noted that the department at [redacted] is called Health and Fitness Science.
    b. A screen share of data showing the benefits of interdepartmental collaboration on student success and key details of successful interdepartmental collaboration was provided.

II. Discussion on STEM fields lead by Patricia Williams
    a. A change in current perceptions of what STEM is to include programs such as Health and Fitness Science (KIN). Questions were raised regarding the best way to achieve this in a positive way [redacted] suggested HFS and BIO faculty to meet and discuss needs between the two departments to show they have similar goals between programs.
    b. HFS course lead and department chair provided a description on the Fitness Science program at [redacted]. A screen share of the

program, its program outcomes, and course map was provided to all members.

c. [redacted] suggesting aligning courses with learning outcomes.

III. Building Curriculum around 1st year courses

a. Members selected 2 courses in Biology and 2 courses in HFS that students take during the first year of their program. Courses selected by members are BIO-168 and HFS-110 (both taken by HFS students during the Fall of their first year) and BIO-169 and HFS-116 (both taken by HFS students during the Spring of their first year).

b. [redacted] (HFS course lead) will provide course learning outcomes and [redacted] (BIO course lead) will provide course learning outcomes at the next meeting to begin aligning the outcomes and curriculum to the needs of students from both departments.

c. Suggestion was raised by [redacted] if this committee needs a student representative from each program to help gain their individual perceptive. Further discussion on this was tabled until the next meeting.

IV. Next meeting tentatively scheduled for Friday, March 4th 2022 at 10:00 am

a. HFS leads will provide learning outcomes of HFS 110 & 116

b. BIO leads will provide learning outcomes of BIO-168 & 169

c. Each member will provide insight into specific concepts that students find challenging with these courses.

Respectfully submitted by [redacted]

*****Edited by Patricia Williams to redact names and identifying information for inclusion in dissertation. *****

APPENDIX N: BIO/HFS COURSE DESCRIPTIONS FOR CURRICULAR ALIGNMENT

BIO-168 Anatomy and Physiology I (4 Credit Hours)
Class Hours: 3
Lab Hours: 3
Prerequisites: NONE
Corequisites: NONE

This course provides a comprehensive study of the anatomy and physiology of the human body. Topics include body organization, homeostasis, cytology, histology, and the integumentary, skeletal, muscular, nervous and special senses. Upon completion, students should be able to demonstrate an in-depth understanding of principles of anatomy and physiology and their interrelationships.

BIO-169 Anatomy and Physiology II (4 Credit Hours)
Class Hours: 3
Lab Hours: 3
Prerequisites: Take BIO-168
Corequisites: NONE

This course provides a continuation of the comprehensive study of the anatomy and physiology of the human body. Topics include the endocrine, cardiovascular, lymphatic, respiratory, digestive, urinary, and reproductive systems as well as metabolism, nutrition, acid-base balance, and fluid and electrolyte balance. Upon completion, students should be able to demonstrate an in-depth understanding of principles of anatomy and physiology and their interrelationships.

HFS-110 Exercise Science (4 Credit Hours)
Class Hours: 4
Lab Hours: 0
Prerequisites: NONE
Corequisites: NONE

This course is a survey of scientific principles, methodologies, and research as applied to exercise and physical adaptations to exercise. Topics include the basic elements of kinesiology, biomechanics, and motor learning. Upon completion, students should be able to identify and describe physiological responses and adaptations to exercise.

HFS-116 Pvnt & Care Exer Injuries (3 Credit Hours)
Class Hours: 4
Lab Hours: 0
Prerequisites: NONE
Corequisites: NONE

This course is a survey of scientific principles, methodologies, and research as applied to exercise and physical adaptations to exercise. Topics include the basic elements of kinesiology, biomechanics, and motor learning. Upon completion, students should be able to identify and describe physiological responses and adaptations to exercise.