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Interdisciplinary Learning and the Effects on Students

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Abstract

In order to be an effective teacher, it is important to prepare students for their future in the 21st century. Students are expected to be able to problem-solve and make connections beyond the silos of single discipline classrooms. The purpose of this literature review was to examine interdisciplinary instruction and how it affects student learning. While researching, multiple themes arose including how interdisciplinary learning improves student engagement as well as efficacy. In addition, studies indicate that interdisciplinary methods help students develop problem-solving and higher-order thinking skills. Last, interdisciplinary learning creates opportunities for students to build relationships with both teachers and classmates and often led to academic success.

Interdisciplinary Learning and the Effects on Students

Although the content of education has changed as society has evolved, the purpose of education has always been to teach students to think and learn. Schooling a hundred years ago focused on teaching citizenship and work habits, which eventually evolved into teaching understanding of social issues (Boix Mansilla & Lenoir, 2010). Another focus that has developed is how content from specific disciplines is used in other areas. The concept of interdisciplinary learning is not something new; documentation of this type of learning was researched throughout the 20th century (Klein, 2015). Both the Iowa Core and the Common Core standards address the need for literacy in all disciplines with their discipline-specific literacy standards (Iowa Core, n.d.). For example, in the English Language Arts (ELA) classroom, students must analyze historical documents in order to make connections to the literary significance. However, it is also the expectation that students will practice and apply the literacy standards learned in ELA, such as identifying the purpose of texts, production of writing, and research skills in other content areas including history, social studies, science, and technical subjects. With these expectations, the Iowa Core has established the need for cross-curricular learning (Iowa Core, n.d.).

Even with these expectations in place, scholars believe the current state of education is not preparing students to be creative, collaborative problem-solvers (Castro & Totah, 2017; You, 2017) and that interdisciplinary learning provides the opportunity for student to see cross-curricular connections that would lead them to a more meaningful learning experience (You, 2017). Interdisciplinary inquiry helps students to understand the world around them because the world is not just made up of separate subjects in isolation (Jolley & Ayala, 2015). Some researchers have suggested the need for a drastic change in the current education system in order

to prepare students for an uncertain and ever-changing future (Pountney & McPhail, 2017). One solution would be to create co-taught interdisciplinary classes that integrate multiple content areas into unique real-world opportunities for learning in one class. In this way, teachers could bring together multiple disciplines in order for students to understand a theme or essential question.

Cross-curricular and interdisciplinary learning are concepts with similar meanings and the words are used interchangeably. Interdisciplinary learning is defined as a project or class that integrates the curriculum, concepts, tools, methods, and knowledge from two different content areas, and this is done in order to fully understand a topic or theme, or solve a problem (Klein, 2015). Cross-curricular learning is learning about a theme or topic across various subjects or disciplines (Esteve-Faubel et al., 2018). The two definitions are similar in that both types of lessons utilize themes or topics as a way to learn. The difference seems to be in the number of disciplines included in that learning. Dennis (2020) explained that all knowledge is created on connections that do not have boundaries. Therefore, learning opportunities for students can transcend the boundaries of single subjects. Students need to have a basic understanding of world issues, and the world does not exist in neatly separated 90-minute classes (Boix Mansilla & Lenoir, 2010).

In order to be an effective teacher, it is important to prepare students for their future in the 21st century. This literature review will focus on the impact of interdisciplinary co-taught classes and lessons on students' engagement, academic success, and problem-solving skills, in addition to how this type of learning can increase enjoyment and build relationships in the classroom. Because learning in the 21st century is about making connections between ideas, fields, and concepts, then schools must teach students how to make those connections (Stanley et

al., 2012). Interdisciplinary learning may create learners that are globally-competent and college and career ready (Boix Mansilla & Lenoir, 2010). Interdisciplinary, cross-curricular classes are one way for teachers to give students the opportunity learn and practice those 21st century skills.

Literature Review

This literature review will summarize the finding of research conducted on the topic of the effectiveness of interdisciplinary learning. The researcher initially set out to gain an understanding of how cross-curricular instruction can help students learn and stay engaged in learning. The topic was revised to focus on how interdisciplinary or cross-curricular instruction can affect students' learning. Research was collected from database searches on Gale and ERIC via EBSCO. The initial search terms used were interdisciplinary learning, cross-curricular learning, and effects. The research expanded to include search terms such as engagement, achievement, 21st century skills, and higher-order thinking.

Interdisciplinary Learning and Engagement

Participating in co-taught interdisciplinary classes can help students improve academically and be ready for 21st century life outside of education. Although creating co-taught interdisciplinary classes can be both challenging and rewarding for teachers, the effect on students is what justifies the work. Students tend to show engagement and interest in cross-curricular projects and classes (Cuervo, 2016; Fletcher-Wood, 2016; Jolley & Ayala, 2015; Ng & Fergusson, 2020). An interesting real-world problem and enthusiastic teachers make it easy for student to be engaged in cross-curricular lessons (Alexander et al., 2008).

When students enjoy what they are doing, they are more likely to participate (Birchinall, 2013). In addition, the collaboration between students and the kinesthetic activities that are part of interdisciplinary learning help create conditions that lead to engagement through real world context, connections, and relevance (Birchinall, 2013). Interdisciplinary co-taught classes create context and connections for the lesson and projects that students complete. Using interdisciplinary learning has been shown to be enjoyable and is therefore likely to improve

engagement at all levels of learning. For example, in Aslan's (2016) study that looked at the benefits of using cross-curricular reading instruction in elementary school, he found that utilizing a thematic cross-curricular approach was enjoyable for students because they found interest in the themes, and therefore were engaged. However, this study was an explanation of practices and literature and not research (Aslan, 2016). Duerr (2008) found similar benefits in middle school in her research. Duerr (2008) does not conduct any evaluations of actual middle schools, but shares research that explains how an interdisciplinary unit in middle school can create opportunities for students to engage with topics in order to create meaning and understanding.

At the high school level, students have stated that they enjoy cross-curricular themes in the classes they take (DiCamillo & Bailey, 2016). In this case, two college education teachers chose to teach an interdisciplinary class at a local urban high school in order to find out how to best instruct their pre-service education students. They co-taught a class of 23 eleventh grade students who were predominantly African American. The content of the class integrated history and English. The researchers gathered qualitative data through surveys and personal reflections of classroom activities. The researchers found that students really appreciated the cross-curricular content and many of them stated they felt more willing to engage with English content because of the historical context (DiCamillo & Bailey, 2016).

This same type of learning can also be helpful at the college level. Ross et al. (2013) researched whether an interdisciplinary, introductory-level college science class was beneficial for students as a way of creating a good basic understanding of science and the scientific method. This study included 21 students from various majors who participated in the class that was used as a pilot study. The researchers collected qualitative data through in-class discussions, assignments, and end of class surveys. The researchers found that in this class, which combined

literacy with science, both science majors and non-science majors stated it was engaging, enjoyable, and furthered their understanding of science (Ross et al., 2013) These examples show that interdisciplinary learning can lead to engagement at all levels of learning.

Engagement in Interdisciplinary Project-Based Instruction

The type of projects completed in interdisciplinary co-taught classes help students build understanding of real-world problems and allows students to care about something, engage with the work, and not just complete classwork as a way to meet a requirement (Castro & Totah, 2017). For example, the University of Manchester in England used a cross-curricular thematic project to teach 292 primary-grade pre-service education students from two different cohorts about cross-curricular themes and inquiry-based learning. The researchers successfully collected qualitative data from open-ended blog posts from 195 of those pre-service education students for their case study. By participating in a cross-curricular thematic project, the education students were able to see how cross-curricular lessons or projects could increase students' engagement and how they could apply cross-curricular lessons in their future career. The researcher concluded from the lack of negative comments and the overwhelming positive reflections in the students' blogs that the participants in the project were highly motivated and engaged (Birchinall, 2013). The same study expressed that the teachers delivering the instruction were highly-engaged and motivated in the project, which might have been a factor in hooking the students as opposed to the type of instruction. However, the researcher concluded that the relevant, real-world challenges presented in the cross-curricular class were a factor in keeping students motivated and engaged (Birchinall, 2013).

A college in New Zealand found similar results. Schaddelee & McConnell (2018) researched the effectiveness of a new program that utilized an interdisciplinary project-based

curriculum for first year students of Bachelor of Applied Management at Otago Polytechnic. The researchers collected data about student perceptions of engagement via student surveys from 45 students in the first year of the program. Their research found that engagement was high during well-designed and implemented interdisciplinary projects. Other researchers also cited the need to create well-planned, theme-based interdisciplinary units in order to meet the needs of the students and to ensure that they are able to reach the desired learning targets. Wang et al. (2020) came to this conclusion during their yearlong case study of six teachers in two different high schools. The researchers stated that students did enjoy and engage with the project even though the lessons did not meet state content standards. Teachers in the Wang et al. (2020) study stated that they felt as though the interdisciplinary hydroponic project they collaborated on did not align to their specific content standards and took time away from content that their students needed to learn for state testing (Wang et al., 2020).

This was also the case in another study. Alexander et al. (2008) researched a high school program that utilized a cross-curricular English and science project in year 10. Researchers collected data from 180 students via questionnaire and from interviews with the instructors who taught the students. The teachers reflected that students were engaged throughout the entire project, and, although the students did not reference engagement specifically, more than three-quarters of them mentioned that they really enjoyed the project, and almost half said it was interesting. The researchers emphasized the fact that many students referenced the engagement with real world problems was the best part of the project.

One study found that while utilizing small group instruction during co-teaching, students were more engaged, and some shy students had the opportunity to participate in discussion in a less intimidating environment whereas they had not previously participated in larger group

discussions (Hurd & Weilbacher, 2017). Although the Hurd and Weilbacher (2017) study evaluated the effectiveness of interdisciplinary co-teaching teams in two Midwestern middle schools, their findings explained the effects on student participation. The researchers collected qualitative data via interviews, focus groups, and field notes. In addition to participating in discussions, students received more individualized instruction because the teachers had the time to assess and re-teach content to those who needed it when working with their cross-curricular co-teaching teams. In a co-taught classroom, students also have the opportunity to experience two different teaching styles and might benefit from one over the other (Hurd & Weilbacher, 2017). Although just the opportunity to experience different teaching styles or small group instruction on its own does not ensure engagement, it does increase the opportunities for some students to find a way to engage in class.

Efficacy of Interdisciplinary Learning

Engagement in interdisciplinary learning does not mean the lesson is always successful. A study conducted by Fletcher-Wood (2016) of year 7 students in Great Britain examined history and math cross-curricular lessons. One history teacher and one math teacher chose to align their daily lessons so when students learned about certain methods or concepts in math class, they also learned in history about the mathematician who created that method or discovered the concept. After the first year of creating and teaching this curriculum, the history teacher asked students to write a paper explaining how the class helped them understand a concept outside of history. The researchers found in student responses that only 45 percent of the students were able to make a connection to learning about math, and 55 percent thought the point of the lessons was solely about learning history (Fletcher-Wood, 2016).

Eronen et al. (2019) found a similar result in a study in Finland. The researchers evaluated 19 eighth-grade students who participated in a problem-based transdisciplinary class where students learned and used interdisciplinary skills in projects-based learning real world projects. The effectiveness of the class was evaluated though questionnaires and interviews with both teachers and students. At the conclusion of the class, researchers found that students were not able to identify the content that was learned (Eronen et al., 2019). If the point of interdisciplinary learning is to integrate multiple disciplines into one lesson or class, then students should come away with an understanding of how the content of both disciplines connect to the topic or theme. However, in both of the examples above, not all students were able to identify what they were learning or how that knowledge was connected. Although students in both studies indicated the lessons were enjoyable, they did not report an increase in learning. Also, in both studies, researchers found that students were excited to share in one class or lesson what they learned in another (Eronen et al., 2019; Fletcher-Wood, 2016).

Interdisciplinary Learning and Problem-Solving Skills

Interdisciplinary co-taught classes can teach students problem-solving skills. Participating in cross-curricular learning may help students understand their place in the world, identify and solve real-world problems, and improve their communication skills (Castro & Totah, 2017; Jolley & Ayala, 2015). Jolley and Ayala (2015) researched the effectiveness of interdisciplinary learning by evaluating a curriculum unit that combined geoscience and archeology. Researchers collected data from four teachers and 30 students via observations of teachers and students, student responses to case study questions, pre- and post- student questionnaires, and post instruction teacher interviews. Teachers stated during the interviews that they felt as though the context created in the interdisciplinary class allowed students to

become creative problem-solvers. For example, the researchers stated that students struggled with one particular hands-on activity, but the students persevered and worked through the problem.

In a study of year 10 students in England, Alexander et al. (2008) collected data from 180 students in a cross-curricular English and science class. The researchers stated that real world problems do not fit into discipline specific categories; therefore, the opportunity to participate in a cross-curricular project helps students see the connections between the knowledge of different disciplines. The researchers found that these opportunities to discover the interdisciplinary connections helped students improve their problem-solving skills.

Eronen et al. (2019) conducted a study with eighth-graders in Finland and found that an interdisciplinary approach to learning was able to improve students' problem-solving skills by requiring them to communicate, collaborate, and self-reflect. The 19 students, who were interviewed both before and after taking the course, stated that they were able to find ways to work together in order to solve issues and sometimes that meant they needed to reflect on what worked, what didn't, and try again (Eronen et al., 2019).

Problem solving can be achieved in interdisciplinary history and math classes also. A study completed by Lim and Chapman (2015) evaluated approximately 100 students split into four 11^{th} grade classes in Singapore with two of the classes as control and two experiencing a cross-curricular history and math approach. Students were asked to reflect on their experience, and although the study did not give students the opportunity to use problem-solving skills, the students stated in their reflections that they were able to see how the interdisciplinary lesson could lead to it.

Secondary science education is another area with opportunities for interdisciplinary connections and problem-solving skills. In a study of trends of interdisciplinary learning You (2017) looked at the history of interdisciplinary teaching in science, the reasons science should use this type of teaching, and the benefits of this type of lesson. The researcher found in his review of published studies that interdisciplinary learning led to higher-order thinking and problem-solving skills (You, 2017).

Science, technology, engineering, arts and mathematics education (STEAM) has also been shown to increase student's problem-solving skills. Ng and Fergusson (2020) used both qualitative and quantitative research to study 89 secondary teachers and 352 female students to evaluate the impact of an interdisciplinary STEAM program. Through surveys and focus groups, the researchers found that students gained skills in working together and problem-solving, and the students noted problem-solving as one of the benefits of the STEAM program (Ng & Fergusson, 2020). In addition, Eronen et al. (2019) showed that the 19 eighth-grade students in Finland who took part in interdisciplinary STEAM class were able to problem-solve. In questionnaires and interviews, students stated that they were motivated to participate, problem-solve, and were thinking and learning to learn. Students reported that they proposed solutions, reflected on what worked and did not work, and tried again when needed. Yet, one shortcoming of this type of lesson is that students might not make the connections expected. For example, Eronen et al. (2019) explained that, although the students thought the interdisciplinary project was fun, they were not able to identify what discipline specific content knowledge was to be learned during the lesson cross-curricular project.

In another study that compared disciplinary, multidisciplinary and interdisciplinary STEM classes, Wang et al. (2020) found that the interdisciplinary classes encouraged authentic

learning and problem-solving skills. Wang et al. (2020) conducted a yearlong case study of six teachers in two different high schools who taught an interdisciplinary science, technology, engineering, and math (STEM) program. Although the researchers were examining teachers' beliefs and instructional practices, the findings reported how the program helped both the teachers collaborating and the students participating in the program to problem-solve through the inquiry process.

However, one downfall of interdisciplinary classes such as those mentioned above, is that students often lack skills needed for lessons. For example, problem-solving skills need to be explicitly taught during thematic units and teaching these skills can take time. DiCamillo and Bailey (2016) researched this topic when they co-taught an 11th grade cross-curricular English and history class. As college professors, they taught this class in order to be able to ensure that the methods they were teaching pre-service teachers were current and relevant. They found that many of the students lacked the skills they assumed that an 11th grader would have. This resulted in changes to their cross-curricular unit that limited the amount of time they could spend on the unit because they had to teach those specific skills. However, it helped the researchers prepare their education students to know how to best plan for an interdisciplinary project.

Higher-Order Thinking

Interdisciplinarity has had a long history in American schools. Boix Mansilla and Lenoir (2010) examined how the concept developed throughout the last century of primary and secondary education. They looked at how the purpose of education has changed, and the integration of knowledge from different disciplines has become more necessary in the current educational landscape. In order to become 21st century learners, Boix Mansilla and Lenoir

(2010) asserted that students need to be able to analyze global issues through an interdisciplinary lens.

Teachers of interdisciplinary classes expect students to learn to think for themselves, not just learn information to repeat back later, and to develop critical awareness in order to decide how to solve a problem (Boix Mansilla & Duraising, 2007). Learning in the 21st century is about making connections between ideas, fields, and concepts. Therefore, school must teach students how to make those connections.

When learning about abstract topics that transcend one content area, interdisciplinary learning can lead to higher-order thinking and show students connections they might not otherwise see (Dyment, et al., 2015). In a case study of schools across Tasmania, Dyment et al. (2015) collected data from principals and curriculum leaders through surveys and meetings in order to research the effectiveness of cross-curricular sustainability education. When analyzing data related to the implementation of cross-curricular classes in these schools, the researchers reported that a number of schools were already using a cross-curricular approach, which allowed students to see connections and solve real world issues. In addition, school leaders reported that by using the cross-curricular approach, students were able to interpret complex information and better understand the environment and sustainability (Dyment, et al., 2015). You (2017) explained that interdisciplinary learning in science can instill higher-order thinking skills, such as deductive reasoning, complex understandings, and critical thinking by requiring them to analyze issues from multiple perspectives and look for connections and patterns across disciplines.

Fields such as engineering do not easily fit into discipline-specific sciences, therefore, interdisciplinary classes and projects allow secondary students to explore these more complicated topics while still in high school. Hardre et al. (2013) completed a yearlong study of

11 high-school math and science teachers as they created and implemented interdisciplinary engineering classes. In this study, math and science teachers participated in professional development through a university and learned how to teach interdisciplinary classes; therefore, much of the findings focus on the teachers and their teaching methods. Data was collected from the teachers via questionnaires, discussion boards, journals, observations and interviews. One finding of the study was that both the teachers and the students engaged in inquiry-based learning which led to higher order thinking and problem solving (Hardre et al., 2013).

Teachers co-teaching a cross-curricular class can model collaboration and help students to make connections between domains that they previously thought to be separate. A case study completed by Shapiro and Dempsey (2008) analyzed how one interdisciplinary co-teaching team was able to work together and effectively teach the integrated content. One specific benefit of the interdisciplinary class cited by the researchers was that students were able to analyze conflict from a variety of perspectives. The researchers showed the combination of the two curriculums led students to a deeper understanding of each content and the ability to establish connections between the disciplines (Shapiro and Dempsey, 2008). Pountney and McPhail (2017) examined the development of interdisciplinary curricula in two high schools and noted that interdisciplinary techniques can result in learning where the concept learned exists in each of the subjects independently, or it can lead to new learning, novel insights, and a deeper understanding of abstract concepts.

The use of essential questions is one way that teachers can lead students to deeper understanding. DiCamillo and Bailey (2016) followed 23 high school students in a cross-curricular English and history class that featured essential questions as a way to explore themes. The essential questions required students to read analytically and write argumentative papers.

The researchers believed that these practices led students to a more thorough understanding of the themes presented. DiCamillo and Bailey (2016) found based on the students' final essays that almost every student thought critically about the essential questions. In this way, interdisciplinary strategies led to more higher-order thinking than a lesson confined to a single discipline.

Achievement – Academic Success

An interdisciplinary approach can have positive effects on student learning. Studies show that interdisciplinary learning leads students' to deeper understanding of topics or concepts (Cuervo, 2018; DiCamillo & Bailey, 2016; Jolley & Ayala, 2015). The integration of knowledge from multiple disciplines provides richness by expanding a students' capacity for understanding, allowing them to see things through multiple perspectives (You, 2017).

In addition to increasing students' ability to see topics from various perspectives, interdisciplinary curriculum can also have a positive influence on student achievement. DiCamillo and Bailey (2016) studied 23 students in a high school English and history cross-curricular class. They found that by the end of the cross-curricular class, some students who could not write a complete paragraph at the beginning of the year were able to write a five to six paragraph essay by the end. The researchers noted that although the instructors had hoped for higher quality final essays, all of the students became stronger readers and writers during that year (DiCamillo & Bailey, 2016).

Cross-curricular team teaching can increase achievement for adult learners, also. A group of educators in Wisconsin created a cross-curricular thematic program for adult learners trying to earn their high school equivalency diploma. In a review of the program, Walker (2019) explained the typical high school curriculum taught in separate subject areas was not effective,

yet when they implemented thematic units and lessons, the adult students were able to learn and progress. Previously, students-some of whom had been in the program for 10 years-worked at their own pace on curriculum divided into traditional subject areas with little success. The new program consisted of five cross-curricular thematic units, each lasting three-weeks. The researcher stated that the changes were successful because the participants were more engaged and motivated, developed time management skills, had less anxiety about learning, and were able to earn a diploma. Unfortunately, the researchers did not include the number of students who completed the program before and after the changes were instituted (Walker, 2019).

A study conducted by Lim and Chapman (2016) looked at how using an interdisciplinary approach in math could affect learning. This study used history as a tool to teach math in an 11th grade classroom and measured students' achievement compared to those students in a traditional course. The researchers found that students in the interdisciplinary classes performed higher in all seven areas on the post-test taken at the completion of the class. The same students were tested four months later and again a year later with the same test and showed similar results, although the effect size grew smaller each time. This same study looked at student perceptions of history in their math classes. Students indicated that by learning about the connections between math and history, they were able to gain a greater understanding of the math concepts (Lim & Chapman, 2016). Interdisciplinary classes create the opportunity for deeper understanding of content. The also allow students to learn about the topics but also their interdependency in more than one subject area (Shapiro & Dempsey, 2008).

Avramides et al. (2015) collected research from a science department in a secondary school in the United Kingdom that was implementing a cross-curricular STEM project. The researchers found that low ability students lacked the skills needed to work effectively in groups

or develop their own ideas during cross-curricular projects. Researchers gathered data from 13 teachers, including the head of the science department, via interviews focused on the effectiveness of the cross-curricular project. The findings stated that lower performing students struggled; however, the opportunity to take part in cross-curricular co-taught classes allowed those students to learn how to express themselves and give more complete answers by the time they got to the end of the project.

Interdisciplinary learning can be effective in various subject areas. Cuervo (2018) researched the differences in achievement between an interdisciplinary music class and a stand-alone music class. He gathered qualitative data from 60 middle school students and four teachers with pre-tests and post-tests, student surveys, and questionnaires. Two instructors taught each class of thirty students. Cuervo (2018) found that the students who experienced the interdisciplinary instruction were more successful at composing music, and they gained more meaningful understanding of music concepts. Fletcher-Wood (2016) reported on the process of integrating history and math classes for year 7 students in Great Britain. In his report, he stated that cross-curricular history and math classes demonstrated historical connections that students may not have made on their own because history helped create context for real-world math problems (Fletcher-Wood, 2016). An article by Isgitt and Donnellan (2014) explain how math can be integrated cross curricularly. Their article summarizes their discussion, planning and integration of English and math skills in each of their classrooms. Their research showed that students can utilize the problem-solving skills they learned in Calculus to analyze difficult a piece of literature. Conversely, students could use discussion techniques from their English class to explain a complex math problem. Although the researchers did not collect any data or share

any specific information about their students, in their reflection on the integration of Calculus and English skills, they noted that critical thinking is universal.

Barriers of Cross-Curricular Learning

Sometimes the integration of two subjects into one lesson or class is not as effective as intended. Some students view interdisciplinary lessons negatively, stating these types of lessons are challenging and time consuming (Jolley & Ayala, 2015). Stanley et al. (2012) collected data about the effectiveness of a cross-curricular program from student surveys and interviews with the director the program at a middle school in England. The researchers found that interdisciplinary lessons are time consuming to create and complete. The also found that these types of collaborative inquiry-based lessons are hard to make up after an absence because often there is not enough time in the regular classroom and the collaborative nature of cross-curricular projects is not conducive to make-up work. The researchers explained that one of the few complaints from the teachers was student behaviors that hindered learning in the double-blocked cross-curricular class environment. They attributed these behaviors to the extended time spent in the classroom.

Araujo et al. (2017) explained the importance of preparation, communication, and flexibility when creating successful interdisciplinary lessons. In this study, Araujo et al. (2017) engaged in action research to collect data about an interdisciplinary unit created by practicum students for a local elementary school. The researchers collected data through observations and field notes, analysis of lesson plans, and written reflections of the practicum students after they had taught their interdisciplinary unit. Although the researchers focused on the teacher candidates, they found that lack of planning or lack of time for implementation resulted in missed learning opportunities for the students. For example, although some lessons included

both math and social studies concepts, connections were not explicitly stated, and the elementary students did not necessarily see how one part of the lesson affected the other (Araujo et al., 2017).

In recent research designed to look at students' perceptions of engagement during interdisciplinary project-based learning classes, the authors explained that students did not know how to collaborate or function as a group; therefore, they did not enjoy and were not able to engage in the learning opportunity (Schaddelee & McConnell, 2018). Being able to work with others is a skill necessary for 21st century learners (Boix Mansilla & Lenoir, 2010; Iowa Core, n.d.), therefore it is a deficiency that would need to be addressed when creating cross-curricular collaborative projects.

Benefits of Cross-Curricular ELA

In a study of cross-curricular reading instruction, Aslan (2016) stated cross-curricular lessons that combine reading and other content areas "provide authentic, ongoing, multidimensional opportunities to assess students' progress, participation, and achievement" (Aslan, 2016, p. 1800). Achievement due to cross-curricular reading is also evident in another study. Chaovanapricha and Chaturongakul (2020) explained how collaboration between English teachers and those in other subject areas could enable students to improve their reading skills and gain more knowledge of the subject. The researchers collected data from three English instructors, three business instructors, and 106 students at a university in Thailand via observations, focus groups, and questionnaires. In the findings, the students stated that they were able to gain knowledge by studying English and other content areas together. In addition, the researchers mentioned that the students showed an increase in academic reading skills, also. This idea of learning language in context is substantiated by experts Shea and Shanahan (2020)

in their work for the National Science Teaching Association. Instead of language acquisition being the focus of one subject area, skills and strategies can be taught in cross-curricular instruction in order to enable students to access information in any setting (Aslan, 2016).

In a paper that analyzed the research and concepts of English Language Arts education in New Zealand, Locke (2015) suggested that English class needs to be redesigned into two separate classes, one for Literature and the other focused on writing and reading texts in other disciplines. After defining the current role of English teachers and current curriculum, the researcher explained the benefits of how learning that integrates English into other content areas would help students better understand the texts they are reading. Locke (2015) summarized the findings and stated, "students will be engaged in an inquiry-based exploration of how and why texts emerge in a range of disciplinary and non-disciplinary contexts"

Building Relationships

Team teaching is another aspect of interdisciplinary classes. Qualitative research collected from interviews, observations, and surveys of co-teaching middle school teams found that because of the opportunity to implement smaller groups when co-teaching, students were able to develop closer relationships with their teachers (Hurd & Weilbacher, 2017). The researchers went on to point out that, students had the opportunity to go to the teachers with whom they were more comfortable when they needed help, which made those students more likely to seek assistance. In another study conducted by Fenwick et al. (2013), teachers cited additional class time as one of the most important benefits of co-taught classes because it gave them the opportunity to meet the needs of more students. Fenwick et al. (2013) conducted a case study of three schools in Scotland, one of which had successfully integrated social studies across the curriculum. One of the main benefits reported by the teachers in the interdisciplinary school

was the added time with students due to the cross-curricular classes. This allowed the teachers to get to know the needs of their students and then address those needs more effectively. In both Hurd and Weilbacher (2017) and Fenwick et al. (2013), the chance to work with smaller groups of students due to being in a co-teaching situation allowed the teachers to build relationships with their students. This then allowed their students to be more comfortable seeking help and gave them more opportunities to learn.

Some cross-curricular classes are double-blocked, and another benefit of that extended time with students is that it may lead to greater bonding among teachers and students (Wallace, 2007). For example, a cross-curricular inquiry-based program in England showed an improvement in student-teacher relationships compared to traditional classes (Stanley et al., 2012). Stanley et al. (2012) collected data from 167 students in typical single discipline classrooms and 195 students in a cross-curricular learning program through pre- and post-questionnaires. This study examined how project-based cross-curricular classes could benefit year 7 students from diverse backgrounds. Because of the amount additional time spent in the cross-curricular class, students shared that they felt a genuine connection to their teachers and they believed the classroom was a place where they could safely participate in the exploration of various topics and problems. In addition, the relationships built in interdisciplinary classes also helped reduce the occurrences of bullying.

Conclusion

Interdisciplinary learning is an expectation of current education as is stated in both the Iowa Core and Common Core. Cross-curricular, or interdisciplinary, classes or lessons impact student engagement, academic achievement, problem-solving skills, higher order thinking skills, and educational relationships. The effects of interdisciplinary learning are positive if the lessons are well-planned and implemented; however, as with any lesson, there can be downfalls. The research found shows the effects of interdisciplinary co-taught classes. Interdisciplinary learning is an expectation of the Common Core, even if interdisciplinary classes are not implemented as often as discipline-specific classes. On the other hand, discipline-specific teachers can implement interdisciplinary lessons in stand-alone classes also. Future research should continue to examine the prevalence and effectiveness of cross-curricular, co-taught classes in the United States, as many researchers stated that additional research is necessary, and they were only able to study a small sample (Cuervo, 2018; Dyment et al., 2015; Jolley & Ayala, 2015; Krammer et al., 2018). Other researchers stated the need for future studies investigating teacher motivation and co-teaching teams (Fenwick et al., 2013; Hardre et al., 2013; Wallace, 2007; Hurd & Weilbacher, 2017). Last, future research could examine how well new educators are trained in co-teaching and interdisciplinary learning before they get to the classroom (DiCamillo & Bailey, 2016; Hurd & Weilbacher, 2017).

In conclusion, interdisciplinary learning is an effective way to engage students in learning. By creating cross-curricular opportunities, teachers can help students to become 21st century learners who are engaged and ready to use higher-order thinking and problem-solving skills.

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