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TABLE OF CONTENTS

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Research Articles

Education Special Edition

Departments

Mississippi Teachers' Perceptions of Environmental Education and Outdoor Instruction During a COVID-19 Pandemic

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ABSTRACT

Environmental education (EE) and outdoor instruction are essential to understanding and addressing different environmental issues in school communities. This study investigated Mississippi teachers' perceptions on environmental education and outdoor instruction during the 2020-2021 pandemic. A state-wide survey examined teachers' thoughts about environmental education and outdoor instruction and COVID-19 limitations in their classrooms and how that may affect their perceptions. Analysis was conducted using SPSS contingency and frequency tables, Chi-square Test of Independence, and content analysis of qualitative data. The results showed that Mississippi teacher participants believed that environmental education in Mississippi K-12 schools is very important and that outdoor instruction is a good way to learn environmental education. Many participants are interested in teaching classes outdoors but stated that they do not take their classes outside often. Results also documented that participants are concerned about the different limitations they face when teaching classes outdoors.

Keywords: environmental education, outdoor instruction, COVID-19 pandemic, COVID-19 classrooms, Mississippi teachers

INTRODUCTION

This study investigates Mississippi teachers' perceptions of environmental education, outdoor education, and classroom settings during the COVID-19 pandemic. Teachers (N=312) self-selected to participate in a survey, between November 3, 2020 and February 3, 2021, on environmental education and outdoor instruction. Conducted during the pandemic, this research is a snapshot of the participants' attitudes and thoughts.

BACKGROUND AND PREVIOUS RESEARCH

Environmental Education

Environmental education (EE) falls under the Science, Technology, Engineering, and Mathematics (STEM) umbrella and includes topics such as population, pollution, resource management, and urban and rural planning. "Interdisciplinary in nature," environmental education is a combination of social sciences and portions of science curricula like biology (Walker, et al., 2017) and makes science relevant through interdisciplinary study (Edelson, 2007). EE is developed to target concerns about the environment and increase knowledge, skills, attitudes, commitment, and motivation to work towards solving those issues and create better management of that environment (United Nations Educational, Scientific, and Cultural Organization [UNESCO], 1975). EE focuses on environmental responsibility, environmental ethnics, and ecological awareness (Fien & Tilbury, 2002). Many schools in Mississippi have not fully incorporated environmental education in programs; EE is instead introduced within existing curriculums. Few (15% or less) traditional science teachers have participated in EE training programs (Stern et al., 2008).

Outdoor Education within Environmental Education

Environmental education can use experiential learning techniques to teach students interrelationships between environmental factors and processes; experiential learning gives an understanding of the interrelationships between biophysical processes and the present-day society (Stapp, 1969). STEM inclusion programs, which may contain environmental education, can focus on experiential learning techniques like outdoor education. Outdoor education was seen as an extension of the traditional school curriculum (Carroll, 2015).

There are different approaches to outdoor education (Dahlgren & Szczepanski, 1998): one is an adventure-focused approach that encourages outdoor pursuits and recreational activities that embrace wilderness survival and challenges. The second is the environmentally-focused approach, like environmental education. This research targets the environmental-focused approach, described as action-centered that incorporates thematic learning processes, and often includes outdoor activities.

In earlier research (Ford, 1986), outdoor education was described as education "about the outdoors" to develop knowledge, attitudes, and skills about the environment; it could occur in any outdoor setting, from remote wilderness settings to a person's backyard or vacant neighborhood lots. The old, highly criticized classic definition of outdoor education was specific on how this type of education focuses on the location and how that location can provide subject matter information to intentionally learn while outdoors (Donaldson & Donaldson, 1958). The definition stated that outdoor education is "education in, about, and for the outdoors" (Donaldson & Donaldson, 1958, p. 17). Like Ford's (1986) definition of outdoor education, educators believed that outdoor education could occur in any setting; some also added that people could learn about more than just the outdoor environment by engaging in the outdoors. Regardless of the semantics in defining the setting, outdoor education is a better way to learn different subjects outside of the standard classroom (Smith, 1955). This education is a window to the real world and can help students improve cognitive, motor, and affective skills. Through authentic observations and situations, outdoor education targets increase learning through practical interactions between actions, emotions, and thoughts (Dahlgren & Szczepanski, 2004). There can be a greater benefit due to a more movement-intensive form of learning (Grahn et al., 1997).

The COVID-19 Pandemic

In 2020, the nation went through a shift in the school system because of COVID-19, officially known as SARS-CoV-2, a severe acute respiratory syndrome (International Committee on Taxonomy of Viruses, 2020). COVID-19 affected classroom environments in different schools around the globe, resulting in many changes to classroom environments; teaching specific topics outdoors may help with spacing and engagement (Centers for Disease Control and Prevention, 2020-2021). A few "key messages and actions" were presented by United Nations Children's Fund (UNICEF), but none of those suggestions listed teaching outdoors to accommodate with space, although practicing social distancing was stressed.

METHODOLOGY

This research conducted a state-wide survey using Qualtrics^{XM}, licensed through Mississippi State University. It consisted of a questionnaire/survey (Appendix A) and a follow-up interview; only the questionnaire/survey will be discussed here. This study was reviewed by Human Research Protection Program (HRPP) and the Institutional Review Board for the Protection of Human Subjects in Research (IRB) and was granted an exemption.

Participants were limited to teachers 18+ years who work and reside in Mississippi. The survey was distributed through the first author's Facebook, and "word of mouth" (including email exchange, direct message). In order to reach more participants, we allowed participants and people who know of the survey to forward the survey to their co-workers/colleagues and any Mississippi teacher. Different Facebook groups/pages received the link to this survey including *Mississippi Teachers Matter* (with 9.2K members), *Mississippi Science Teachers* (with 1.3K members), the Facebook page *Department of Geosciences, Mississippi State University* (with 1.4K followers), and the *Mississippi Science Teachers Association, MSTA.*

This electronic survey was developed using the Qualtrics^{XM} project feature, and it consisted of multiple-choice and short-entry text questions (see Appendix A). The survey had three sections: *Background Information*, *Environmental Awareness in the Classroom*, and *Outdoor Education and COVID-19 impacts*. The background information included the consent page and background: city, county, and zip code; gender, ethnicity, level of education, total years of teaching, grades and subjects taught, and experience in data collection. The survey asked teachers to self-identify what environmental topics they have discussed within their classes and their perceptions of how important it is for children to learn about earth science and environmental science in K-12 classrooms.

In the second section, *Environmental Awareness in the Classroom*, the survey probed how often these teachers take their class outside to learn. Teachers self-reported the subjects they taught in the previous section to better understand the context of outdoor instruction. Other questions addressed the teachers' thoughts on students' behaviors outside of the classroom, and whether conducting outdoor education is considered beneficial. Questions also addressed if the teachers thought students would benefit from learning outdoors and if they were likely to incorporate outdoor learning with their classrooms in the future. The last section of the survey collected information on the limitations some teachers may face outside the classroom.

Survey responses were organized into an Excel file. Invalid blank surveys, or surveys where respondents did not provide critical background information (e.g., county) were removed. However, partially completed surveys, or those whose teachers provided county and demographics but did not answer every question, were included. Survey responses were coded in SPSS software and ArcMap was used to examine the survey population's spatial representation.

DATA & ANALYSIS

Questions in the survey and interviews probed the three research questions of this study: What are Mississippi teachers' perceptions on environmental education and outdoor education? (Q1), what are the classroom limitations or challenges that teachers in Mississippi face during or after the pandemic? (Q2) and can schools incorporate outdoor education to help with COVID-19 classroom adjustments? (Q3). Table 1 shows the correspondence of survey questions to the research question. Not all questions were analyzed through contingency tables and frequency tables since data were collected as a baseline study for further research.

Demographics

Qualtrics^{XM} recorded 352 responses (N =352), but 41 responses (n =41) did not provide data for this research. Therefore, 88.35% of the responses provided demographics for analysis.

The total number of participants used in the survey analysis is 311 (N =311). Questions that a participant did not answer were represented with a blank space. A normality test was conducted using SPSS to determine if certain data are normally distributed throughout the survey population. The Shapiro-Wilk test determined that the data differ significantly from a normal distribution. Therefore, the researcher performed a nonparametric or distribution-free test using Excel to compare the different responses in the survey. SPSS was used to measure each demographic question's frequency; each survey question is considered a variable, and each participant is a case.

The data used in this research are nominal/ordinal or categorical data. Collected demographics from the survey include the following: city, county, zip code, gender, ethnicity, years of teaching, grade levels taught, the highest level of education, subjects that participants currently teach, and environmental topics they have taught with their class. Frequency tables organized the different distributions and total counts of responses, per question, from the participants.

Mississippi has 82 counties; 62 (75.6%) were represented in this research. In order to plot the participants' locations, the researcher created an address locator on ESRI ArcMap and used the US Address−ZIP 5-Digit address locator style as a template to create address locators for postal codes. The address locator's primary reference datum was the Mississippi Automated Research Information System (MARIS) ZIP Code Boundaries shapefile. Participants are spread out in Mississippi with clusters in the Northeast, Southwest, and Coastal regions (Figure 1).

The majority of respondents were in Harrison and Hinds counties; both are 10% of the survey population. 6.1% of the population resided in Tate county, 5.8% of the population were in DeSoto county, and 5.1% in Madison county. Participants' locations are spatially represented in Figure 1 to show the total participants per county, as well as postal codes identified by participants. Postal codes are represented by a point vector on the map and if participants entered the same postal code the points will overlap. To give a more accurate visualization of participant count, this study also used the MSTM Shapefile: MS_Counties_2015.zip. This shapefile is a polygon vector and participants were manually inputted as a count value per county. Some counties are not represented in this research.

Only 8.7% of the case population is male with 91.3% female, and 256 participants identified as White, 43 as Black or African American, and eight as Other. Less than one percent of the survey population was American Indian or Alaska Native, Asian, and Native Hawaiian or Pacific Islander. The majority of survey participants have been teaching 11 to 15 years and five years or fewer, respectively.

A group of 8.4% of participants have been teaching for 25 years or more. The participants were asked to list all the grade levels they have taught and had the option to select all that apply. Elementary school is the most taught grade level in the participant population. The overall accumulated response for the question that asked participants what subjects they teach showed that most participants teach reading/language arts, science, and math. Over half of survey participants have a professional degree, representing 64% of the total survey population. There are a few clusters seen in the demographic maps; for example, females are spread throughout Mississippi and males are clustered in the Central region of Mississippi. The majority of participants identify as White and are spread throughout the state. Participants who identified as Black or African American are represented more in the West-central region of Mississippi. The majority of participants who have a professional degree and 4 year degree are spread throughout the state.

Table 1. Survey Question Alignment to Research Questions

MISSISSIPPI TEACHERS' PERCEPTIONS OF ENVIRONMENTAL EDUCATION AND OUTDOOR EDUCATION DURING A COVID-19 PANDEMIC	Q1	Q2	Q3
SURVEY QUESTIONS			
What environmental topics have you discussed with your class? List all that apply.	¡		
How important do you think it is for children to learn about earth science and environmental science in the classroom (K-12)?	¡		
How often do you take your class outside to learn?	¡		
Are students' behaviors more or less of a challenge outside of the classroom?	¡		¡
Do you think conducting class outside is a good way to study Earth and environmental sciences?	¡		
Do you agree that outdoor education increases students' interest in Earth and environmental sciences?	¡		
Do you think schools should incorporate more outdoor education?	¡		¡
Rank what ability you mostly want to be fostered for students during outdoor education activities? (1 being the most important, 3 being the least important)	¡		¡
How likely (on a scale of 1 to 10, with 1 being least likely and 10 being most likely) are you to incorporate outdoor lessons into your own future classroom?			¡
Do you think your school will provide the necessary material and safety measurement to conduct class outside?		¡	¡
What worries you the MOST about conducting class outdoors?	¡	¡	¡
Do you think transportation, to different outdoor areas near your school, will be a serious issue?		¡	
Do you think conducting some classes outside will help with Covid19 adjustment in your school?			¡

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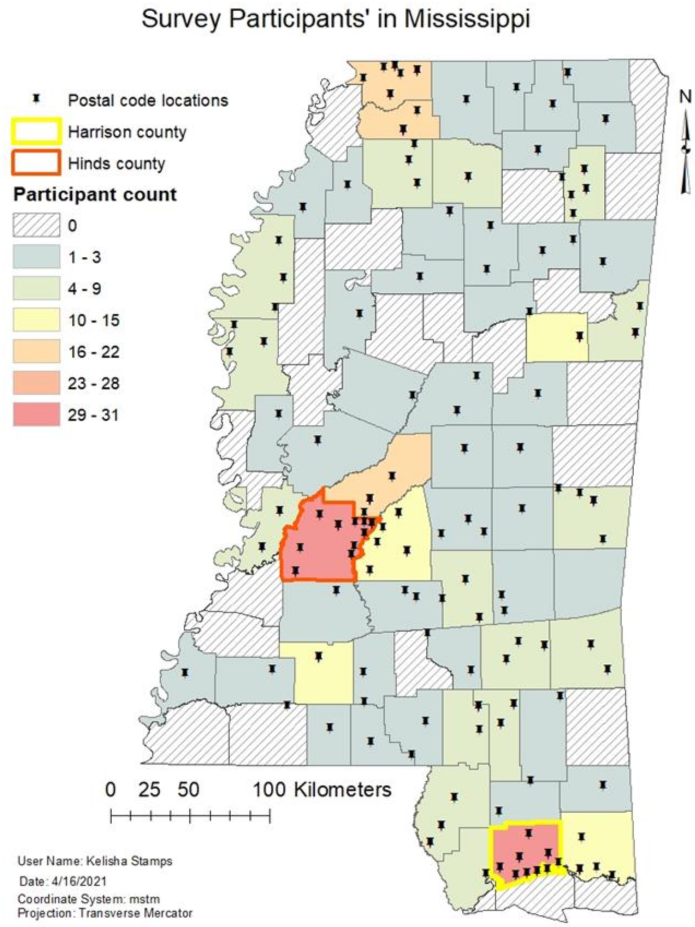

Figure 1. Map representing survey participants' county location, postal codes identified in the 2020-2021 survey. Hinds and Harrison counties are shown in red and highlighted in red and yellow, respectively, as the two counties representing the most participants.

Data Analysis

In this investigation, demographical questions were used to create pivoting tables, using SPSS, to examine different responses within the survey.

Mississippi Teachers' Perceptions on Environmental and Outdoor Education (Q1)

When participants were asked *How important do you think it is for children to learn about earth science and environmental science in the classroom (K-12)?*, 124 out of 311 total participants (40%) chose that it was extremely important regardless of their gender and educational status, and 102 (32.8%) said that it is very important. A total of 14.1 % (n = 44) responded with "moderately important", and 0.96 % (n = 3) responded with "slightly important". Some participants did not respond to that question (n = 38). That questions were summarized in a crosstabulation table (Crosstabs), universally known as a contingency table. This method was used to compare the different categorical data in this study. SPSS also has a pivot (cross) function that can rearrange different variables in columns, rows, and layers (this is known as *pivoting* the table) to show different relationships between different variables and subgroups within those variables.

This research used the pivot function, in the Crosstabs feature on SPSS, to summarize the responses to the question *How important do you think it is for children to learn about earth science and environmental science in the classroom (K-12)?*(column) based on the highest education level (row) and then divided between genders (layer) using SPSS in Table 2 Because gender is a layer, the crosstabs between the rows and columns will represent each layer variable separately and as a total (*Male* per *Highest level of education*, Female per *Highest level of education*, and Total (both) per *Highest level of education*). A Pearson Chi-Square Test of Independence was also included with every contingency table to determine if there is any association with the different categorical variables and to define them as "independent" or "related". Three Chi-Square Tests of Independence determined the overall association between participants' responses to how important they think it is for children to learn about earth science and environmental science in K-12 classrooms, based upon highest education for each gender. In the first test, SPSS subset the categorical variable *Gender* and then ran a Chi-Square test between the row and column variables. This is not equivalent to a "three-way" association, so a second Chi-Square test only measured the association between the highest level of education and the selected column question in Table 2. The third test, in addition to test two did not include a layer, measured the association between gender and the selected column question. All three tests showed a p-value that was greater than the significant level $\alpha = 0.05$ ($p = .667$; $p = .649$; $p = .649$, respectively); therefore, there is not enough evidence to state that there is an association with gender, highest level of education, and participants' responses to the survey question. These variables are considered independent to each other. The analytical summary showed that 97.2% (n =276) female teacher participants and 88.9% (n =24) male teacher participants selected a 4-year degree or professional degree as the highest degree. Female participants, with a 4-year degree or professional degree, stated that it is "moderately important" for children to learn about earth science and environmental science in K-12 (n = 39, 14.1 %), that is less than the percentage of male participants who responded the same way with the same highest educational levels (n = 4, 16.7 %). But more male participants with a 4-year degree or professional degree stated that it is "extremely important" or "very important" for children to learning about earth science (n = 19, 79.2 %), than females with the same highest degree (n = 197, 71.4 %).

This research examined the Crosstabs summary for the survey question *"Do you think conducting class outside is a good way to study Earth and environmental sciences?"* and how often the teachers take their class outside to learn (Table 3). The Chi-Square test showed a significant value (p-value) greater than the alpha value ($p = 0.786$) when participants with "No Response" was not included. When all participants are accounted, and no values are missing the p-value is less than 0.05 (p =0.000…). There is not enough evidence to confidently state that those two questions are related. Only 10.9% of participants take their class outside to learn on a weekly basis, while 29.3% take their class outside on a monthly basis. The number of participants who never take their class outside is n =149. Most, or 73.9% of total participants (n =230) said yes, they definitely or probably think conducting class outside is a good way to study Earth and environmental science. To understand which type of teachers never take their class outside to learn and which do, this study compared that question to the subjects they taught.

In Figure 2, the bar chart represents the percentage of how often participants take their class outside to learn relative to the accumulated percentage of the subjects taught by participants in the multiple answer question "*What subject(s) do you currently teach?"*. Participants who selected that they currently teach computer science, reading/language arts, and history have the three highest percentages of teachers who never take their class outside. 26.9% of teachers (n = 18) who selected science take their class outside on a weekly basis to learn, 26.5% (n = 39) take them outside on a monthly basis, and 19.3% (n = 43) never take their class outside to learn.

Table 2. Contingency table representing "How important do you think it is for children to learn about Earth science and environmental science in the classroom (K-12)?" based on the highest level of education and gender in the 2020-2021 survey.| SPSS.

*Select highest level of education. * How important do you think it is for children to learn about earth science and environmental science in the classroom (K-12)? * What gender do you identify with? - Selected Choice Crosstabulation*

			How important do you think it is for children to learn about earth science and environmental science in the classroom (K-12)?															
			Extremely important		Very important		Moderately important		Slightly important		Not at all important		No Response				Total	
													Skipped		Blank			
			N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Total	Highest level of education.	High school graduate	0	0.0%	1	1.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	0.3%
		4 year degree	37	29.8%	30	29.4%	20	45.5%	1	33.3%	0	0.0%	1	100.0%	12	32.4%	101	32%
		Professional degree	80	64.5%	69	67.6%	23	52.3%	2	66.7%	0	0.0%	0	0.0%	25	67.6%	199	64%
		Doctorate	7	5.6%	2	2.0%	1	2.3%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	10	3.2%
	Total		124	100%	102	100.0%	44	100%	3	100%	0	0.0%	1	100.0%	37	100.0%	311	100...
Female	Highest level of education.	High school graduate	0	0.0%	1	1.1%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	0.4%
		4 year degree	31	28.2%	28	29.8%	20	50.0%	1	33.3%	0	0.0%	1	100.0%	12	33.3%	93	33%
		Professional degree	75	68.2%	63	67.0%	19	47.5%	2	66.7%	0	0.0%	0	0.0%	24	66.7%	183	64%
		Doctorate	4	3.6%	2	2.1%	1	2.5%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	7	2.5%
	Total		110	100%	94	100.0%	40	100%	3	100%	0	0.0%	1	100.0%	36	100.0%	284	100...
Male	Highest level of education.	High school graduate	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
		4 year degree	6	42.9%	2	25.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	8	30%
		Professional degree	5	35.7%	6	75.0%	4	100%	0	0.0%	0	0.0%	0	0.0%	1	100.0%	16	59%
		Doctorate	3	21.4%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	3	11%
	Total		14	100%	8	100.0%	4	100%	0	0.0%	0	0.0%	0	0.0%	1	100.0%	27	100...

Table 3. Contingency table comparing “How often do you take your class outside to learn?” with “Do you think conducting class outside is a good way to study Earth and environmental science?” in the 2020-2021 survey.| SPSS.

*Do you think conducting class outside is a good way to study Earth and environmental sciences? * How often do you take your class outside to learn? Crosstabulation*

		How often do you take your class outside to learn?																			
		Weekly								Monthly											
		Daily		4-5 times a ...		2-3 times a week		Once a week		4-6 times a ...		2-3 times a month		Once a month		Never		No Response		Total	
		N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Do you think conducting class outside is a good way to study Earth and environmental sciences?	Definitely yes	1	33.3%	3	100...	8	61.5%	8	53.3%	5	83%	17	51.5%	29	55.8%	60	40.3%	0	0.0%	131	42.1%
	Probably yes	1	33.3%	0	0.0%	4	30.8%	4	26.7%	1	17%	10	30.3%	17	32.7%	62	41.6%	0	0.0%	99	31.8%
	Might or might not	0	0.0%	0	0.0%	1	7.7%	0	0.0%	0	0.0%	4	12.1%	3	5.8%	11	7.4%	0	0.0%	19	6.1%
	Probably not	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	0.7%	0	0.0%	1	0.3%
	Definitely Not	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
	No Response	1	33.3%	0	0.0%	0	0.0%	3	20.0%	0	0.0%	2	6.1%	3	5.8%	15	10.1%	37	100.0%	61	19.6%
Total		3	100.0%	3	100...	13	100.0%	15	100.0%	6	100...	33	100.0%	52	100.0%	149	100.0%	37	100.0%	311	100.0%

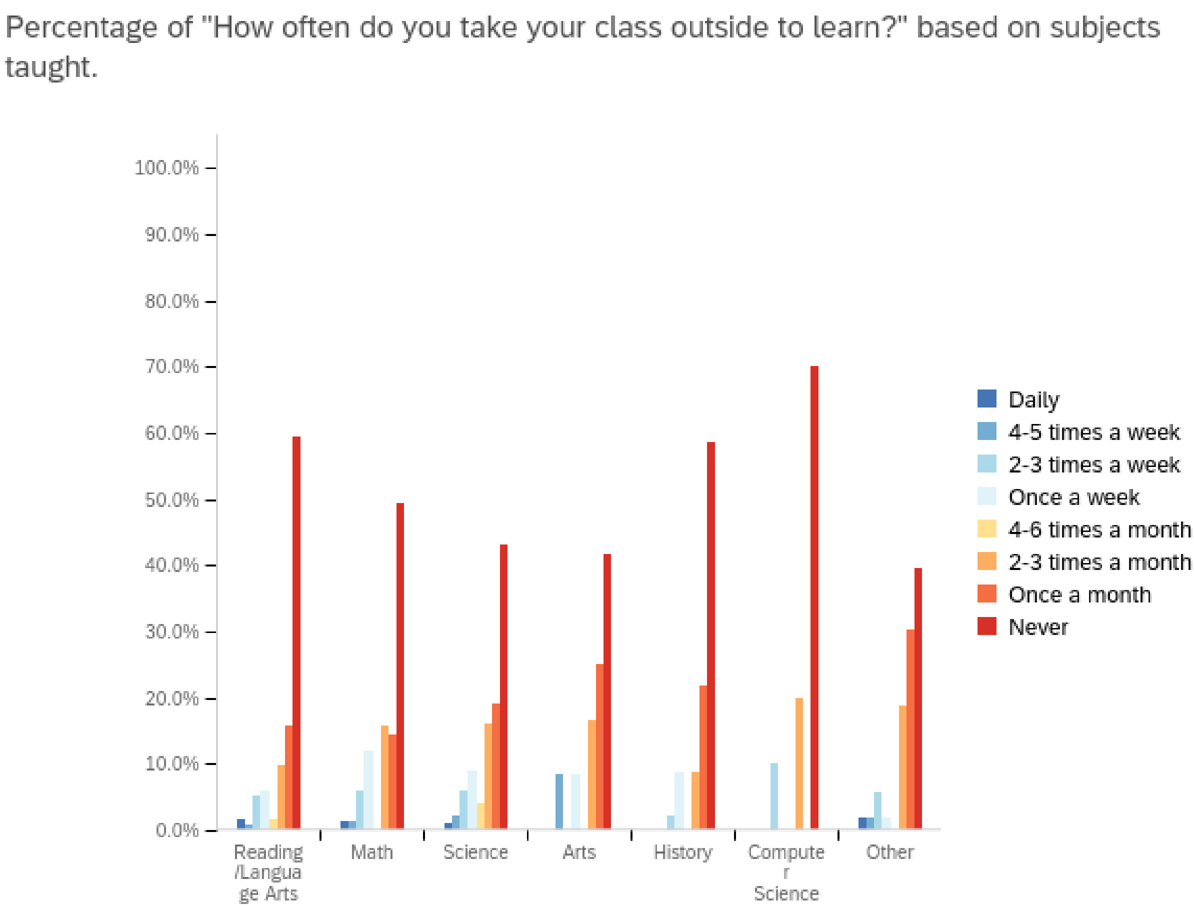

Figure 2. Bar chart representing the question "How often do you take your class outside to learn?" based on subjects taught in the 2020-2021 survey.| SPSS.

Mississippi Teachers' Classroom Limitations or Challenges (Q2)

This research looks further into Mississippi teacher's perceptions on outdoor education and COVID-19 by asking participants, "What worries you the most about conducting class outside?". In Table 4, this study probed the relationship between teachers' concerns about conducting class outside and how often teachers self-reported that they conducted class outside. The p-value was less than the alpha value (p = .000…) when "No Response" values were added in the analysis; however, when the "No Response" is missing there is a p-value that is greater than the alpha value (p = .225). So, there may or may not be a relationship between responses to the two questions. In the summary, the majority of participants (n = 149, 47.9 %) stated that they have never taken their class outside to learn, 16.7 % (n = 52) stated that they take their students outside to learn once a month. 23.8% of total participants answered, "I am not worried" (n = 74), and within that group, 41% (n = 30) answered that they never take their class outside to learn. The majority of total participants (n = 77, 24.7 %) said that students' behavior worries them the most about conducting class outdoors; in that group 67.5 % of those participants (n = 52) represented the largest group who never take their class outdoors. Other reasons why participants are worried about conducting class outdoors are listed in Table 5.

Table 4. Contingency table comparing “How often do you take your class outside to learn?” with “What worries you the MOST about conducting class outdoors?” in the 2020-2021 survey.| SPSS

*How often do you take your class outside to learn? * What worries you the MOST about conducting class outdoors? - Selected Choice Crosstabulation*

		What worries you the MOST about conducting class outdoors? - Selected Choice													
		Assignment results		I am not worried		Students' behavior		Students' safety		Other (type below)		No Response		Total	
		N	%	N	%	N	%	N	%	N	%	N	%	N	%
How often do you take your class outside to learn?	Daily	0	0.0%	1	1.4%	1	1.3%	0	0.0%	0	0.0%	1	1.4%	3	1.0%
	4-5 times a week	0	0.0%	1	1.4%	0	0.0%	0	0.0%	2	7.4%	0	0.0%	3	1.0%
	2-3 times a week	2	7.7%	6	8.1%	3	3.9%	2	6.1%	0	0.0%	0	0.0%	13	4.2%
	Once a week	0	0.0%	5	6.8%	3	3.9%	2	6.1%	1	3.7%	4	5.4%	15	4.8%
	4-6 times a month	0	0.0%	2	2.7%	1	1.3%	0	0.0%	1	3.7%	2	2.7%	6	1.9%
	2-3 times a month	3	12%	11	15%	8	10%	5	15%	2	7.4%	4	5.4%	33	11%
	Once a month	4	15%	18	24%	9	12%	11	33%	6	22%	4	5.4%	52	17%
	No Response	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	37	50%	37	12%
	Never	17	65%	30	41%	52	68%	13	39%	15	56%	22	30%	149	48%
Total		26	100...	74	100...	77	100...	33	100...	27	100...	74	100...	311	100...

Table 5. Other Teacher Concerns When Conducting Class Outdoors In Mississippi

Activities that integrate Math	**Student's attention**
Administration approval	Technology
Administration issues	Time constraints; teaching to standard while having time to explain behavior expectations while outside
Ant mounds, insects	Time in the schedule. Takes awhile to move them in an organized fashion.
Construction zone	Transportation needs
Covid restriction still	Unpredictable Weather
Distraction due to noise factors by being by interstate and due to sports taking place on nearby fields.	We don't have the necessary setup to teach a math class outside.
Heat—we are in MS	Weather and location issues
Necessary materials	Weather and the ability to do this with ALL classes. (We have five lunch shifts and outdoor classes during lunches is next to impossible.
No place to do it.	When students skip school to visit the outdoor classroom.
Not being provided with what I need	teachers using time wisely and using the opportunity
Proper equipment or resources	
Proper materials and training	
Response of admin because I teach a state tested subject	

Outdoor Education and Pandemic Classroom Adjustments (Q3)

Table 6 shows the responses to the question "How likely (on a scale of 1 to 10, with 1 being least likely and 10 being most likely) are you to incorporate outdoor lessons into your own future classroom". A high frequency of participants entered 5 (n = 47) and 10 (n = 47), some participants also included reasons why they chose their ranking.

The researcher also investigated the effect of COVID-19 on Mississippi teachers by comparing the participants responses to "Do you think conducting come classes outside will help with COVID-19 adjustment in your school?" with their responses to "Do you think your school will provide the necessary material and safety measurement to conduct class outside?" (Table 7). In the Chi-Square test, the p-value was less than the alpha value (p = 0.021) when all values where included (containing "No Response") and when "No Response" values were not included (p = 0.000….). Both test showed a significant value less than the alpha value (0.05). There is enough evidence and confidence to state that there may be an association between the responses to the questions in Table 7. When participants were asked if they think their school will provide the necessary material and safety measurements to conduct class outside, 60 out of the 311 participants (n = 60, 19.3 %) said "definitely yes" or "probably yes"; 23.8 % (n = 74) participants did not respond. The majority of participants (n = 177, 56.9 %) said their school "probably not", "definitely not", or "may or may not" provide the necessary materials and safety measurements to conduct class outside. Out of those participants (n = 177), some (n = 18, 10.2%) said that conducting classes outside will "probably not" help with COVID-19 adjustments in their school, 2.2 % (n = 4) said "definitely not", and 35.6 % (n = 63) said conducting class outside "may or may not" help with COVID-19 adjustments in their school. However, most of those participants (n = 92, 52 %) said "definitely yes" or "probably yes" when asked if conducting some classes outside will help with COVID-19 adjustment.

Table 6. Responses to "How likely (on a scale of 1 to 10) are you to incorporate outdoor lessons into your own future classroom?".

How likely (on a scale of 1 to 10, with 1 being least likely and 10 being most likely) are you to incorporate outdoor lessons into your own future classroom?

		N
No Response	Blank	64
	Skipped	2
0		1
1		28
1 - my school does not have an appropriate location and I would likely not receive administrative support		1
1 (retiring after this year)		1
2		9
3		14
4		16
4-5		1
5		47
6		21
7		16
7; when found applicable		1
7-8		1
8		24
9		11
10		47
10 if held in person		1
I teach every student in the school, so 1		1
If my school allowed and had the capability, I most certainly would		1
Right now, in my school, this is not possible. However, if it were a possibility, I definitely would incorporate outdoor lessons in my classroom.		1
This year not all.		1
Very likely when my virtual students come back to school		1

Table 7. Contingency table comparing "Do you think conducting some classes outside will help with COVID-19 adjustments in your school?" with "Do you think your school will provide the necessary material and safety measurement to conduct class outside?" in the 2020-2021 survey.| SPSS.

*Do you think your school will provide the necessary material and safety measurement to conduct class outside? * Do you think conducting some classes outside will help with Covid19 adjustment in your school? Crosstabulation*

		Do you think conducting some classes outside will help with Covid19 adjustment in your school?												Total	
		Definitely yes		Probably yes		Might or might not		Probably not		Definitely not		No Response			
		N	%	N	%	N	%	N	%	N	%	N	%	N	%
Do you think your school will provide the necessary material and safety measurement to conduct class outside?	No Response	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	74	100%	74	23.8%
	Definitely yes	9	17.0%	2	2.6%	4	5.0%	1	4.5%	0	0.0%	0	0.0%	16	5.1%
	Probably yes	9	17.0%	18	23.4%	13	16.3%	3	13.6%	1	20.0%	0	0.0%	44	14.1%
	Might or might not	14	26.4%	29	37.7%	25	31.3%	6	27.3%	1	20.0%	0	0.0%	75	24.1%
	Probably not	13	24.5%	24	31.2%	33	41.3%	11	50.0%	1	20.0%	0	0.0%	82	26.4%
	Definitely not	8	15.1%	4	5.2%	5	6.3%	1	4.5%	2	40.0%	0	0.0%	20	6.4%
Total		53	100.0%	77	100.0%	80	100.0%	22	100%	5	100.0%	74	100%	311	100.0%

DISCUSSION

In this study 311 teachers who are 18 years or older and residing in Mississippi participated in the survey in 2020-2021. In 2019, Mississippi had a population of 2,967,297 people, according to the United States Census Bureau: 59.1 % White (alone), 37.8 % Black or African American (alone), 3.4 % Hispanic or Latino, 1.1 % Asian (alone), 0.6 % American Indian and Alaska Native (alone), 0.1 % Native Hawaiian and Other Pacific Islander (alone). This research surveyed self-selected participants who self-identified their ethnicity. Participants who self-identified as White represent 23.2 % more than the group's population in the 2019 Census, and those who self-identified as Black or African American represent 24 % less than the group's population in the 2019 Census. Other teacher participants in this study self-identified as American Indian or Alaska Native (0. 6 %), Asian (0.3 %), Native Hawaiian or Pacific Islander (0.3 %), and Other (2.6 %). Ethnicity in this study does not appear to be representative of the 2019 population as a whole, but it may be representative of teacher ethnicities within the state.

RESEARCH LIMITATIONS

This study encountered a few limitations that limited the scope of the research. The teacher population represented in the survey may not be representative of all the K-12 teachers in the state. One reason could be that some teachers may not be comfortable with electronic surveys or did not own an electronic device appropriate for completing the survey. Participants represented in the data voluntarily responded to the demographic question asking for the participant's city, county, and postal code. Teachers from 62 counties in Mississippi responded, while no teachers responded from 20 Mississippi counties. Some did not respond to every question; those participants response was identified as *No Response*. Therefore, not all responses analyzed in this research grasp all of those participants' thoughts, and the survey does not give a full insight into the perceptions of all teachers residing in Mississippi.

CONCLUSIONS

With regards to Research Question 1 (Q1), the analysis in this research gives a snapshot of a subset of Mississippi teachers' perceptions of environmental education and outdoor instruction. Participants believe that environmental education being taught in K-12 is important, and they think that outdoor instruction is a good way to study EE. Multiple teachers who participated in the survey said it was important to take students outside, but most did not do it.

With regards to Research Question 2 (Q2), there were a few common barriers that prevented teachers from taking their classes outside to learn. These obstacles differ between teachers, but most teachers in this study are aware of the limitations of teaching in an environment that is outdoors. Analysis showed that there are teachers in Mississippi who have experience taking students outside to learn and are open to doing so in the future. Some teachers have never experienced teaching their class outdoors but are interested in doing that even after the pandemic. However, these teachers surveyed want resources and measurements taken, so teaching outdoors will be successful and fun. Some participants also have concerns about taking students outside.

According to Mississippi teachers in this research, incorporating outdoor education can help with COVID-19 classroom adjustments. Regarding to Research Question 3 (Q3), teachers only play a certain role in schools, and more research needs to be done to understand how outdoor education can improve schools who have been greatly affected by COVID-19 in the classroom. This includes teachers who do not see their students at all (virtual), and schools that do not have access to resources in order to teach outdoors. There are many variables that play a part in COVID-19 prevention, and when it comes to space, outdoor education can possibly help.

These commonalities and insight on direct thoughts and experiences from teachers in Mississippi can help encourage communication throughout Mississippi schools. This research was conducted during the COVID-19 pandemic, and classroom practices throughout Mississippi have been adjusted for safety measures. These teachers' perceptions are influenced by the pandemic and could be a first observation of how Mississippi teachers were adjusting to classroom changes in 2020-2021. Outdoor instruction is not uncommon, and Mississippi is more than ready to dive into a new way of learning that is not only fun to teachers but perceived as a good way of safely teaching during the pandemic.

Impacts differ between the school, teacher, subject, and initial environment, meaning classroom setting during or after the pandemic. These impacts include classroom spacing, social interaction, and changes in teaching. Some students may learn differently and give more information on how there are perceived while outdoors versus their own opinions. Researchers can also ask more questions to teachers in this survey about topics like environmental education and awareness or outdoor field trip experiences. This research is just the start of the conversation that teachers, students, and administration should have to try new learning techniques and possibly improve their classroom settings during the pandemic. This research can open a dialogue for teachers and students, staff, and administration to teach during and after the pandemic successfully. Further research should consider getting the perceptions of K-12 students in Mississippi to correlate with what teachers believe is a good way to learn environmental science and their perceptions of outdoor education.

REFERENCES

Carroll, K. N. (2015). *Mississippi teachers' environmental awareness and usage of the Project Learning Tree curriculum within traditional classrooms. [electronic book]*. Mississippi State, MS: Mississippi State University.

Centers for Disease Control and Prevention. (2020-2021). Operational Guidance for K-12 Schools and Early Care and Education Programs to Support Safe In-Person Learning. https://www.cdc.gov/

Dahlgren, L.-O., & Szczepanski, A. (1998). Outdoor education—Literary education and sensory experience. An attempt at defining the identity of outdoor education. Kisa, Sweden: Kinda Education Center.

Dahlgren, L.-O., & Szczepanski, A. (2004). Rum för lärande—Några reflexioner om utomhusdidaktikens särart [Room for learning—Some reflections on the distinctive nature of outdoor didactics]. In I. Lundegård, P-O. Wickman, and A. Wohlin (Eds.) *Utomhusdidaktik.* Lund: Studentlitteratur.

Donaldson, G. E. and Donaldson, L. E. (1958). Outdoor Education:

A Definition. *Journal of Health, Physical Education and Recreation, 29*(5), 17-63.

Edelson, D. C. (2007). Environmental science for all? Considering Environmental Science for inclusion in the High School Core Curriculum. *Science Educator 16*, 42-56.

Fine, J. & Tilbury, D. 2002. The global challenge of sustainability, in D. Tilbury, R. Stevenson, J. Fien, and D. Schreuder (Eds), *Education and Sustainability: Responding to the Global Challenge*. Cambridge, UK: IUCN, pp. 1–12.

Ford, P. (1986). Outdoor education: Definition and philosophy. *Resources in Education, 21*(8), 123.

Grahn, Patrik & Mårtensson, Fredrika & Lindblad, B. & Nilsson, P. & Ekman, A.. (1997). Ute på dagis (Outdoors in the preschool). *Stad and Land, 145*,1-3.

International Committee on Taxonomy of Viruses (Coronadviridae Study Group). (2020). The species Severe acute respiratory syndrome-related coronavirus: Classifying 2019-nCoV and naming it SARS-CoV-2. *Nature Microbiology, 5*, 236-544.

Smith, J. W. (1955). Outdoor Education and Youth. Washington, DC: American Aliance for Health, Physical Education, Recreation, and Dance.

Stapp, W. B. "The concept of environmental education." *Environmental Education, 1*(1), 30-31.

Stern, M.J.., Powell, R.B., & Ardoin, N.M. (2008). What difference does it make? Assessing outcomes from participating in a residential environment education program. *Journal of Environmental Education, 39*(4), 31-43.

United Nations Educational, Scientific, and Cultural Organization (UNESCO). (1975). "The Belgrade Charter": Framework for Environmental Education. *Nature Study, 29* (3&4, 6,7).

Walker, R., Clary, R.M., & Wissehr, C. (2017). Embedding sustainability instruction across content areas: Best classroom practices from informal environmental education. *Journal of Geoscience Education, 65*, 185-193.

APPENDIX A: EVIRONMENTAL AWARENESS IN THE CLASSROOM 2020-2021 SURVEY

Fill out the following information.

- ◯ City ____
- ◯ County ____
- ◯ Postal code ____

What gender do you identify with?

- ◯ Male
- ◯ Female
- ◯ Other ____

What is your ethnicity?

- ◯ White
- ◯ Black or African American
- ◯ American Indian or Alaska Native
- ◯ Asian
- ◯ Native Hawaiian or Pacific Islander
- ◯ Other

Select highest level of education.

- ◯ Less than high school
- ◯ High school graduate
- ◯ Some college
- ◯ 2 year degree
- ◯ 4 year degree
- ◯ Professional degree
- ◯ Doctorate

How many years have you been teaching?

- ◯ Five years or fewer
- ◯ Six to 10 years
- ◯ 11 to 15 years
- ◯ 16 to 20 years
- ◯ 21 to 25 years
- ◯ 26 years or more

List all of the grade levels you have taught.

- ☐ Early Childhood/Pre-K
- ☐ Elementary school
- ☐ Middle school
- ☐ High school
- ☐ Special Education
- ☐ College Level

What subject(s) do you currently teach? Check all that apply.

- ☐ Reading/Language Arts
- ☐ Math
- ☐ Science
- ☐ Arts
- ☐ History
- ☐ Computer Science
- ☐ Other ____

Have you ever collected data for research?

- Yes
- Maybe - I’m not certain
- No

End of Block: Background Information

Start of Block: Environmental Awareness in the Classroom

What environmental topics have you discussed with your class? List all that apply.

- Air Quality
- Alternative Energy
- Climate Change
- Ecosystems
- Endangered Species
- Global Warming
- Greenhouse Gases
- Recycling
- Water Quality
- Weather
- Other ____
- I do not discuss environmental topics in my classroom.

How important do you think it is for children to learn about earth science and environmental science in the classroom (K-12)?

- Extremely important
- Very important
- Moderately important
- Slightly important

- Not at all important

How often do you take your class outside to learn?

- Daily
- 4-5 times a week
- 2-3 times a week
- Once a week
- 4-6 times a month
- 2-3 times a month
- Once a month
- Never

Are students' behaviors more or less of a challenge outside of the classroom?

- Much more
- Somewhat more
- About the same
- Somewhat less
- Much less

Do you think conducting class outside is a good way to study Earth and environmental sciences?

- Definitely yes
- Probably yes
- Might or might not
- Probably not
- Definitely not

Do you agree that outdoor education increases students' interest in Earth and environmental sciences?

- Strongly agree

◯ Agree

◯ Somewhat agree

◯ Neither agree nor disagree

◯ Somewhat disagree

◯ Disagree

◯ Strongly disagree

Do you think schools should incorporate more outdoor education?

◯ Definitely yes

◯ Probably yes

◯ Might or might not

◯ Probably not

◯ Definitely not

Rank what ability you mostly want to be fostered for students during outdoor education activities? (1 being the most important, 3 being the least important)
______ Cognitive
______ Affective (moods, feelings, attitudes)
______ Psychomotor (motor function)

How likely (on a scale of 1 to 10, with 1 being least likely and 10 being most likely) are you to incorporate outdoor lessons into your own future classroom?
____

End of Block: Environmental Awareness in the Classroom

Start of Block: Outdoor Education and COVID-19

Do you think your school will provide the necessary material and safety measurement to conduct class outside?

◯ Definitely yes

◯ Probably yes

◯ Might or might not

◯ Probably not

○ Definitely not

What worries you the MOST about conducting class outdoors?

○ Assignment results

○ Students' safety

○ Students' behavior

○ Other (type below) ____

○ I am not worried

Do you think transportation, to different outdoor areas near your school, will be a serious issue?

○ Definitely yes

○ Probably yes

○ Might or might not

○ Probably not

○ Definitely not

Do you think conducting some classes outside will help with COVID-19 adjustment in your school?

○ Definitely yes

○ Probably yes

○ Might or might not

○ Probably not

○ Definitely not

End of Block: Outdoor Education and COVID-19

The *Stepfast* Approach to Critical Literature Appraisal for Early Doctoral Students

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ABSTRACT

Background: Teaching critical appraisal techniques can be challenging in the earlier phases of doctoral education before students acquire a firm foundation in statistical methods and research strategies. The pilot study's purpose was to explore the effectiveness of succinct step-by-step guidelines for the selection and appraisal of high-quality research articles. We performed a pilot quasi-experimental study to test the feasibility of this method. Comparison of the independent pre- and post-intervention groups (n=10 and n=9, respectively) using the non-parametric Mann-Whitney U test for independent samples showed a statistically significant difference (r = .52, p = .022). The median pre-implementation evaluation score was 4.24, and post-implementation median was 4.50 on a scale of 1 to 5. Guiding research articles' systematic and critical appraisal is advantageous to Nursing PhD students. The medium-to-large effect size seen in this pilot study suggests that the guidelines are a useful educational tool that warrant further study.-

KEYWORDS: critique, critical thinking, educational techniques

INTRODUCTION

Students' preferred methods of learning styles continue to evolve (Qalehsari et al., 2017). Diversity of learning styles presses nurse educators to identify a variety of teaching strategies that reach multiple students (Mthiyane & Habedi, 2018). Teaching doctoral students to critically appraise research reports is essential, but it can be challenging in the earlier phases of doctoral education before students acquire a firm foundation in statistical methods and research strategies.

Critical appraisal involves assessing study quality including internal validity or trustworthiness and judging the strengths, weaknesses, and overall value and relevance. We constructed a tool to aid students in preparing to lead group journal article discussions; the tool consists of a step-by-step approach, with guiding questions. In this pilot study, we explored the effectiveness of this method for student selection and appraisal of high-quality research articles. The specific aims were 1) to determine the feasibility of the guidelines' implementation in a seminar course with cohorts of novice and experienced students, and 2) to collect preliminary data for evaluating the guidelines' effectiveness. We hypothesized that introducing *Stepfast* guidelines (Fig. 1) would increase critical appraisal quality among first-year Nursing PhD students.

A scoping literature review revealed many articles and textbooks providing guidelines for nursing students to evaluate research articles, all of which presented rather intensive and time-consuming methods. A more useful tool would be limited in size, easy to understand despite limited research vocabulary, and sufficient in scope to help students feel adequately prepared to present an article in a seminar.

Nursing theorist Patricia Benner's Novice-to-Expert Model suggests dual implications for this project, demonstrating both *Novice* and *Expert* roles (Miser, 2006). That is, the *Novice* doctoral nursing student needs guidelines for optimal performance, leading the *Expert* nursing educator to employ skills mastery to respond to that need.

MATERIALS AND METHODS

Study Design

A pilot quasi-experimental study was performed to test the feasibility and acceptability of introducing succinct step-by-step guidelines for critiquing nursing research. Results are compared between a group receiving the intervention and a historical comparison group. The study was ruled exempt by The University of Mississippi Medical Center Institutional Review

Board (tracking number UMMC-IRB-2023-239) under 45 CFR 46.102(d) because it involves normal educational processes and does not constitute research.

Intervention

Miser’s stepwise approach to efficiently screening medical literature for evidence-based medicine inspired the *Stepfast* guidelines (Fig. 1) for selecting high-quality nursing research articles (Miser, 2006).

Fig. 1. *Stepfast* guidelines.

Step 1—Initial Assessment
- Are the title and abstract of interest?
  - What initially caught your attention?
- How credible is the source?
  - Consider the journal, the authors and their affiliations, and the funding source.

Step 2—Assessment of Results/Findings
- Focus on the tables and figures first.
  - How do *you* interpret the data? Consider statistical significance, the effect size, and clinical significance.
  - Read the authors’ interpretation in the text of the Results. Does their interpretation agree with yours?

Step 3—Intent of the Study
- Read the last paragraph of the Introduction.
  - What are the research questions, aims, objectives, and hypotheses?
  - Do the results clearly meet the aims or objectives?
  - Is each hypothesis supported?

Step 4—Validity/Rigor of the Research Design
- Evaluate the study for statistical conclusion, internal, external, and construct validity.
  - Were the data analyzed appropriately? (Statistical conclusion validity)
  - Was there sufficient statistical power? (Statistical conclusion validity)
  - Did the research design adequately control confounding variables? (Internal validity)
  - Are the results likely to apply to my situation? Consider the sample, for example. (External validity)
  - Are threats such as reactivity, compensation, and treatment diffusion minimized? (Construct validity)

Step 5—Reliability/Dependability of the Measures or Data Collection Methods
- How good is the internal consistency?
- What is the evidence of test-retest, interrater, intrarater, and/or parallel test reliability?
  - Which type(s) of reliability are important to establish for this study?

Step 6—Validity/Confirmability of the Measures or Data Collection Methods
- Do you think there is good face validity?
- What is the evidence of content, criterion, and construct validity?
  - Which type(s) of validity are important to establish for this study?

Step 7—Summary and Application
- Overall, what is your assessment of the quality of this research?
  - Synthesize your analysis in the previous steps. What could have been done better? Which limitations are unavoidable? What are the strengths of the research *design*?

The *Stepfast* labeling embeds a dual meaning. The tool holds *fast* to good research principles, encouraging *quick* and methodical appraisal of research reports. The goal of confining the tool to a singlepage necessitated constraining evaluation questions to quantitative research, although comparable qualitative research terms were included in the descriptions, such as questioning validity or rigor in the fourth step, where *validity* applies to quantitative research and *rigor* to qualitative (Johnson et al., 2020).

The *Stepfast* guidelines were introduced in a PhD in Nursing course with two objectives: 1) Develop well-reasoned scholarly research presentations and 2) Critically evaluate scholarly presentations. Students enroll in this pass/fail course until they defend their dissertation proposal so there is a mixture of experience in the classroom that varies each semester. During the Spring 2021 semester, eight students were enrolled with experience ranging from one to nine semesters in the course. A one-hour orientation explained how to use the guidelines for efficient and effective journal article selection by discussing examples. Two of the three first-year students that semester selected quantitative research articles. Preliminary statistical analysis used data from an evaluation tool described below and compared this small experimental sample to a comparison group of ten students who presented their first critique prior to the intervention. The *Stepfast* guidelines appeared to positively impact scores for critiques of quantitative, but not qualitative, research articles. Thus, in Fall 2022, a series of six lectures explained each guideline step more thoroughly and included qualitative research examples. Analysis presented here includes a combination of cohorts who did [Spring 2022 (n = 6)] or did not [Spring 2021 (n = 3)] benefit from the additional lectures as the post-intervention group (n = 9). The comparison group (n = 10) is first-year students who presented critiques in 2016-2020 before introduction of the *Stepfast* guidelines and received evaluation scores using the same tool.

Data Collection, Measures, and Analysis

A course-specific 5-point Likert-like evaluation tool (Fig. 2) provided constructive feedback to presenters. All seminar participants, including faculty and students, completed the numeric tool. An *a priori* decision to use the mean of eight items (items 1-7 and 11; see Fig. 2) for this analysis was made to reduce bias introduced by presentation style.

FIGURE 2. COURSE-SPECIFIC EVALUATION TOOL.

Instructions: Rate each aspect of the presentation by checking the appropriate box (1-5). Provide comments to the presenter below the table, indicating the item number, as appropriate.

Item	1 (Poor)	2 (Deficient)	3 (Adequate)	4 (Good)	5 (Outstanding)
1. Clear statement of the purpose/hypothesis					
2. Adequate presentation of background information					
3. Clear description of appropriate methods					
4. Clear description of pertinent results and statistics					
5. Clear and accurate explanation of conclusions					
6. Identification of significant limitations or caveats					
7. Identification of future directions & unanswered questions					
8. High quality visual aids					
9. Audible and engaging presentation style					
10. Skill in leading the discussion and answering questions					
11. Suitability of the paper for Journal Club discussion					
Note: Scores for items 8-10 (shown in Italics) are not included in the outcome analysis.					

Descriptive statistics summarized student demographics to compare the two nonequivalent groups (Table 1). Differences between confounding variables were assessed using an independent-samples t-test for the continuous variable *age*, and chi-square (X^2) tests for nominal and categorical variables. The assumption of a count of five in all crosstab cells was not fully met for the X^2 analysis.

TABLE 1. STUDENT DEMOGRAPHICS.

Characteristic		Presentation Cohort 2015-2020	2021-2022	*p*
Age	Mean (SD)	38.2 (8.8)	42.6 (8.5)	0.301†
	Median	39	40	
Race				0.822‡
	% White	81.8	77.8	
	% Black	18.2	22.2	
Sex				0.413‡
	% Female	90.9	77.8	
	% Male	9.1	22.2	
Education				0.115‡
	% Bachelor's	18.2	11.1	
	% Master's	81.8	55.6	
	% Doctoral	0	33.3	

†Age was treated as a continuous variable and the *p* value is from an independent Student's *t*-test.
‡All other *p* values are from $\square^2$ tests of nominal or ordinal data. Because of the small sample size, the assumption of a minimum of 5 per cell in the crosstabs was not always met.

The non-parametric Mann-Whitney *U* test was used to test the null hypothesis that the *Stepwise* guidelines and instruction about them did not affect the quality of research article critiques by first-year students in the PhD program in Nursing. The measurement was the mean score of eight items on the evaluation tool submitted by students and faculty who attended each presentation. The comparison group consisted of students who presented their first critique between 2015 and 2020 (n = 10) before implementation of the intervention. The experimental group included an independent sample of first-year students in 2021 and 2022 (n = 9). The class format was equivalent for the two groups because no changes were made during the SARS-CoV-2 pandemic. Statistical tests were performed using independent samples with a significance level of 0.05 with IBM SPSS® statistics version 27.

RESULTS

Demographic information for age, race, sex, and educational level at PhD in Nursing program entry was provided by the Admissions Office and is shown in Table 1 with the 2015-2020 cohort being the comparison group. There was no statistically significant difference between cohort demographics.

Intervention Effectiveness

To evaluate the guidelines' effectiveness in improving the quality of first-year PhD students' research article critiques, scores from the 8-item evaluation tool (Fig. 2) that measured appraisal of various aspects of an article were used. A comparison of the pre- and post-intervention groups (n=10 and n=9, respectively) using the non-parametric Mann-Whitney *U* test for independent samples showed a statistically significant difference (r = .52, p = .022). The median score for pre-implementation evaluations was 4.24 (range = 4.16-4.43), whereas the median for post-implementation evaluations was 4.50 (range = 3.86-4.78) on a scale of 1 to 5.

Feasibility and Acceptability

The intervention was feasible and well accepted. Students unanimously expressed appreciation for the guidelines. Interestingly, almost all students, including more experienced students whose presentations were not included in this analysis, voluntarily structured their presentations based on the *Stepfast* guidelines which were intended to be used primarily for selection of a high-quality article. Previously, presentation outlines more closely aligned with the evaluation tool that was used by all attendees for providing constructive feedback. The stylistic change affirms that even experienced students found the guidelines helpful for both selection and critical evaluation of an article.

DISCUSSION

This pilot study's results suggest the succinct *Stepfast* guidelines are effective for directing first-year Nursing PhD students to select and critically appraise high-quality research articles. The first objective was to determine the feasibility of the guidelines' implementation into a seminar course with mixed cohorts of novice and experienced students. Subjective feedback from students and observed guideline use tentatively indicated feasibility and acceptability.

The second objective was to collect preliminary data for evaluating the guidelines' effectiveness. Although the sample size (n = 19) was small, the overall statistical significance between groups (r = .52, p = .022) warrants continued use of the *Stepfast* guidelines and additional data collection.

LIMITATIONS

The *Stepfast* guidelines' analysis has several limitations. The limitation of a small sample size was mitigated by using a non-parametric statistical test. Another limitation is the outcome measure selection. The step-by-step nature of the guidelines is intended to efficiently *select* high-quality research reports. However, the outcome analysis used scores on a tool intended to measure the quality of *a critical appraisal* of the selected article. Mean scores were used for analysis even though the tool is categorical. The evaluation tool is subjective, and validity and reliability remain untested.

Other research design factors should also be considered when interpreting the relationship between the *Stepfast* guidelines and improved critical appraisals. Faculty and student scores were pooled for the analysis with no normalization for the mix of evaluators, although the faculty-to-student ratio of evaluators varied for each year and for individual presentations. Student education levels posed another confounding variable. Although no statistical difference was detected (p = .115) between presentation cohorts, an important difference should be noted. The post-intervention cohort presenting in 2021-2022 included three students with doctoral degrees such as a doctorate of nursing practice (DNP; Table 1).

CONCLUSION

Guiding research articles' systematic and critical appraisal is advantageous to Nursing PhD students to assist in assessing literature and evidence for research and nursing practice. A tool that balances simplicity of use and comprehension with sufficient complexity to adequately evaluate an article can be highly useful. The intervention was feasible and well-accepted in this pilot study. The hypothesis that the *Stepfast* guidelines would increase the quality of critical appraisals by first-year Nursing PhD students was supported. Further research is needed to test the educational usefulness of these guidelines in different settings and with a more rigorous research design including a validated outcome measure.

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DISCLOSURE

The author declares no actual or potential conflicts of interest.

LITERATURE CITED

Johnson, J. L., Adkins, D., & Chauvin, S. (2020). A review of the quality indicators of rigor in qualitative research. *American Journal of Pharmaceutical Education*, *84*(1), 7120. https://doi.org/10.5688/ajpe7120

Miser, W. F. (2006). Finding truth from the medical literature: How to critically evaluate an article. *Primary Care*, *33*(4), 839-62, vi. https://doi.org/10.1016/j.pop.2006.09.012

Mthiyane, G. N., & Habedi, D. S. (2018). The experiences of nurse educators in implementing evidence-based practice in teaching and learning. *Health SA*, *23*, 1177. https://doi.org/10.4102/hsag.v23i0.1177

Qalehsari, M. Q., Khaghanizadeh, M., & Ebadi, A. (2017). Lifelong learning strategies in nursing: A systematic review. *Electronic Physician*, *9*(10), 5541-5550. https://doi.org/10.19082/5541

Student Perceptions of Impacts of Undergraduate Research on Professional Development

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ABSTRACT

Since 2013, Mississippi State University has sponsored undergraduate research experiences that allow motivated, academically strong students to participate in collaborative research with faculty mentors. This study surveyed past program participants (n=274) to determine if undergraduate research improves student participants' science literacy, enhances retention of students in science careers, and leads to discovery of new information. Survey respondents (n=74, n=45 complete surveys) indicated participation in undergraduate research programs increased self-assessed proficiency on 22 measures of science and professional readiness, increased recruitment into science, technology, engineering, or mathematics (STEM) graduate degree programs by 18%, and led to discovery of new knowledge that was reported in an average of 1.7 professional presentations and 0.2 peer-reviewed scientific publications per student.

KEYWORDS:

INTRODUCTION

Undergraduate research (UR) is increasingly prevalent as a component of undergraduate degree programs in the United States. Across disciplines and institutions, undergraduate research experiences vary greatly and may include informal participation, mentored internships or apprenticeships, directed individual studies, sponsored research experiences for undergraduates (REU), structured UR programs, and course-based undergraduate research experiences (CURE). Undergraduate research can lead to gains in students' research knowledge, communication skills, critical thinking abilities, information acquisition, and other professional science, technology, engineering, or mathematics (STEM) skills (Sabatini, 1997; Gregerman, 1999; Kardash, 2000; Mabrouk and Peters, 2000; Bauer and Bennett, 2003; Lopatto, 2004; Millspaugh and Millenbah, 2004; Seymour et al., 2004; Russel et al., 2007). It can also improve students' personal development, i.e., greater self-confidence, tolerance for others, leadership potential, and independence (Sabatini, 1997; Mabrouk and Peters, 2000; Lopatto, 2004; Russell et al., 2007). Furthermore, these research experiences may influence students' professional STEM aspirations (Hathaway et al., 2002; Bauer and Bennett, 2003; Lopatto, 2004; Lopatto, 2007; Russell et al., 2007; Wilson et al., 2018). For example, Eagan Jr. et al (2013) concluded UR programs provide students with the opportunity to widen their academic knowledge while developing who they are as scientists, leading to greater likelihood of further STEM degrees and/or careers. Undergraduate researchers also contribute new information to the larger body of science knowledge through conference presentations at regional, national, or international levels and peer-reviewed publications (Hunter et al., 2007; Buddie and Collins, 2011).

Along with personal and professional gains through UR experiential learning, the degree of faculty mentor engagement may also impact student outcomes (Hunter et al., 2007; Howitt et al., 2010). Undergraduate researchers indicated the support, guidance, and collegiality they received from their faculty mentor were leading factors influencing their gains in personal and professional confidence (Seymour et al., 2004).

Much of the work on UR impacts has been conducted at research universities in the midwestern [e.g., University of Michigan (Hathaway et al, 2002)] or northeastern U.S. [e.g., University of Delaware (Zydney et al., 2002; Bauer and Bennett, 2003)], liberal arts colleges [e.g., Grinnell (Lopatto, 2007) and Wellesley (Seymour et al. 2004)], or international schools [e.g., Australian universities (Howitt et al., 2010)]. Southeastern U.S. research universities are largely unrepresented in the literature on this topic. This limited representation is noteworthy because these regional institutions serve many students from states that have low science and math achievement at the K-12 level; these disparities are even greater among demographic groups (NAEP 2019). Therefore, there is potential for a significant impact when southeastern student residents participate in UR at universities with strong research programs.

Mississippi State University (MSU) is a land grant institution classified as Carnegie Foundation R1: Doctoral University−Very High Research Activity university and ranked by the National Science Foundation as a “Top 100” research university. Also, MSU is an open-access institution that serves a diverse student body largely from Mississippi and surrounding states. In fall 2022, the MSU undergraduate population (n=18,305) was 74.2% white, 15.6% black/African American, 4.0% Hispanic, 1.9% Asian, 2.6% multiracial, and <1% Hawaiian/Pacific Islander. Students were nearly equally distributed between female (50.5%) and male (49.5%). The confluence of high research productivity and academically and demographically diverse students provides a unique opportunity for impacts in research and education arenas.

Federal organizations such as the National Science Foundation and U.S. Department of Agriculture sponsor REUs through institutions of higher learning (IHL), and many IHL support internally funded UR programs. MSU is one of these, housing the Undergraduate Research Scholars Program (URSP) through its College of Forest Resources (CFR) and College of Agriculture and Life Sciences (CALS) since 2013. In 2015, the MSU Office of Research and Economic Development (ORED) instituted a similar UR program modelled after the URSP. These internally competitive programs provide faculty with financial resources ($2000 - $3000) to engage high-performing (GPA ≥ 3.0), research-oriented undergraduates in collaborative research with faculty mentors, providing students with the opportunity to “enhance scholarly activity” and “discover new knowledge.” These structured UR programs require the student to work with a faculty member to develop and execute a research project, analyze data, and present results at the MSU Undergraduate Research Symposium and a professional meeting. Additionally, participating students are encouraged, but not required, to develop and submit a manuscript to a peer-reviewed journal.

The goal of this study was to quantify student perspectives regarding benefits of undergraduate research at an R1 land-grant university. Specifically, this study sought evidence that MSU UR affects student science readiness, educational experience, the retention of talented students in science careers, and the growth of new information into the larger body of science knowledge. The hypotheses of this study are UR at MSU: 1) increases science readiness, 2) improves student participants’ educational experience (including personal, cognitive, and professional development), 3) enhances retention of students in science disciplines, and 4) leads to discovery of scientific information that contributes to the larger body of knowledge. The study was conceived as a means of evaluating outcomes of MSU URSP and informing design and delivery of future program.

MATERIALS AND METHODS

The target population for this project included all participants in structured URSP sponsored by MSU’s CFR, CALS, and ORED from 2013–2018. The sample frame consisted of databases of undergraduate researchers maintained by URSP program directors. Contact information for recruiting participants was obtained from URSP databases and augmented with university directory information. Individuals were notified in advance of the upcoming survey via email as a test of email address validity. If email addresses had been deactivated or returned undeliverable, individuals were contacted via a secondary email, phone, and/or social media platform, and an updated email address was requested.

The survey instrument was based on those reported in published literature (Hathway et al., 2002; Lopatto, 2004; Hunter et al., 2007; Russell et al., 2007; Howitt et al., 2010) with additional questions specific to the MSU programs. It included items related to UR participants' demographic characteristics (age group, gender, and race), UR project topics and outputs, and personal and professional growth. Specific questions asked survey participants about the number of UR projects they conducted, whether contact with their faculty mentor had been maintained, the number of publications and conference presentations that resulted from the UR project, and their plans regarding pursuit of advanced education. Survey participants were also asked to retrospectively self-assess their professional science readiness skills on a Likert scale of 1 to 5 (1-none, 2-minimal, 3-average, 4-above average, and 5-excellent) before and after their UR experience. Although there are limitations to retrospective self-analysis methods that influence the ability to make inferences, this survey approach was used by the published literature on this topic and, therefore, was used here to better allow for comparison.

Following approval by MSU's Institutional Review Board (project approval number, IRB-18-487), the survey instrument was constructed in Qualtrics® (Qualtrics, Provo, UT), and the survey link was emailed to URSP participants. Reminders were sent out at 2- and 4-weeks post initial email.

RESULTS

Between 2013 and 2018, 298 students participated in one of the three MSU structured UR programs. Current contact information was obtained for 236 UR participants (76%), and of these, 74 responded (31% response rate) and 45 completed the survey (19% completion rate).

Survey participants' ages ranged from 17- to 28-years-old. During the 5-year survey period, student researchers conducted 73 projects (range 1–5 projects/student; mean=1.8 projects) in 14 academic departments (Table 1).

Table 1. Mississippi State University academic departments that sponsored the undergraduate research students (during 2013-2018) who participated in this study.

Academic discipline	Number of Projects
Wildlife, Fisheries and Aquaculture	17
Biochemistry	11
Other	7
Animal and Dairy Sciences	6
Forestry	6
Agriculture Economics	5
Communication	4
Sociology	3
Human Sciences	3
Chemistry	2
Industrial and Systems Engineering	2
Food Science, Nutrition, and Health Promotion	2
Plant and Soil Sciences	1
Computer Science and Engineering	1
Sustainable Bioproducts	1
Biological Sciences	1
TOTAL	72

When asked about their motivations for participating in UR, survey respondents rated "gaining experience for future education/jobs" (87%) and "expanding their understanding of research" (74%) as important or very important factors influencing their decision. The least important factor was mandatory participation in UR as required by a scholarship or other academic criteria (76% rated not important or minimally important). “Working with a particular faculty member” and “making additional money” were equally split between survey respondents who thought these factors were important and those that did not.

Survey respondents reported that UR experience improved their science literacy on 22 indicators of science and professional readiness. The greatest changes in professional science readiness were in “understanding of research processes” and “readiness for more demanding research” (Table 2). Other important science skill areas that showed substantive improvement included “meaningful relationships with professional mentors”, “skills and knowledge of lab and/or research techniques”, “integration of theory and practice”, and “understanding of ethical conduct”. The least improved indicator was “listening skills”.

Table 2. Reflective self-assessment scores of students’ STEM readiness prior to and after their undergraduate research (UR) experience.

Skills	Pre-UR Mean Score (SE)	Post-UR Mean Score (SE)	Change
Understanding of research processes	2.5 (0.09)	4.2 (0.09)	1.7
Readiness for more demanding research	2.4 (0.09)	4.1 (0.09)	1.7
Meaningful relationships with professional mentors	2.7 (0.10)	4.3 (0.08)	1.6
Skills and knowledge of lab and/or research techniques	2.4 (0.10)	4.0 (0.10)	1.6
Integration of theory and practice	2.4 (0.10)	4.0 (0.09)	1.6
Understanding of ethical research conduct	2.6 (0.10)	4.2 (0.09)	1.6
Credibility with faculty members and colleagues	2.8 (0.10)	4.3 (0.08)	1.5
Membership within the learning and/or scientific community	2.2 (0.08)	3.7 (0.09)	1.5
Interpretation of research results	2.4 (0.08)	3.8 (0.08)	1.4
Data analysis	2.3 (0.10)	3.7 (0.08)	1.4
Understanding of primary literature	2.6 (0.10)	4.0 (0.09)	1.4
Understanding of how knowledge is constructed	2.8 (0.09)	4.1 (0.08)	1.3
Scientific writing skills	2.5 (0.09)	3.8 (0.08)	1.3
Oral presentation skills	2.9 (0.10)	3.9 (0.09)	1.0
Self-confidence	2.9 (0.10)	3.9 (0.09)	1.0
Toleration of obstacles	3.2 (0.10)	4.1 (0.08)	0.9
Independent learning skills	3.3 (0.09)	4.1 (0.07)	0.8
Critical thinking skills	3.4 (0.09)	4.1 (0.08)	0.7
Leadership skills	3.2 (0.10)	3.9 (0.10)	0.7
Skills in following directions/instructions	3.6 (0.10)	4.3 (0.08)	0.7
Teamwork skills	3.5 (0.10)	4.1 (0.10)	0.6
Listening skills	3.5 (0.08)	4.1 (0.08)	0.6

Results are shown on a 1-5 Likert scale 1-none, 2-minimal, 3-average, 4-above average, and 5-excellent).

Undergraduate research at MSU produced scientific outcomes that contributed to the overall body of science knowledge. Fifty-three students (67%) presented their work at an MSU-sponsored UR symposia [8% (n=4) as oral presentations; 92% (n=49) as poster presentations]. Additionally, 61% of respondents (n=48) stated they presented outcomes from 73 projects at a professional meeting and/or conference, with some students presenting more than one project. Forty-five percent (n=35) of survey respondents' UR projects were presented at a university conference, 13% (n=10) presented at a state conference, 21% (n=16) at a regional conference, 11.5% (n=9) at a national conference, and 4% (n=3) at an international conference. Sixty-one (84%) of these presentations were posters and 12 (16%) were given orally. Nine students have published research results as co-authors, seven of these in a peer-reviewed journal, one in a conference proceeding, and one that was unspecified. For those projects that have not yielded publication, 37.5% of participants reported no plans to publish their results, 26.5% had plans but had not started writing the manuscript, 31% were in the process of publishing, 3% had a manuscript submitted, and 1.5% had a manuscript in review.

Undergraduate research projects conducted at MSU also impacted student participants' intentions toward graduate school (Table 3). Seventy-three percent of participants said undergraduate research confirmed their decision to pursue graduate school, and 18% reported the undergraduate research experience changed their decision regarding attending graduate school. Nine percent of participants had no plans to pursue further education; of these, 2% indicated they were turned away from the idea of graduate school after their UR experience. At the time of the survey, 33% of former undergraduate research participants reported they were currently enrolled in graduate school and 4% had completed a graduate degree program.

Table 3. The number (percent) of undergraduate students whose decisions regarding graduate school were changed as a result of their research experience.

Graduate School Intentions	n	(%)
UR confirmed intent to pursue graduate degree	33	73.3
UR changed decision towards pursuing graduate degree	8	17.8
UR changed decision away from pursuing graduate school	1	2.2
Still no plans for graduate school	3	6.6

Participation in structured UR seemingly contributed to lasting relationships between participants and faculty mentors. At the time of the survey, 30% (n=18) of respondents reported they were still involved with the UR project, and thus in regular contact with the faculty mentor. An additional 50% of respondents (n=30) reported they remain in contact with their faculty mentor even though the project was completed, whereas only 20% (n=12) reported no further interaction with their faculty mentor after UR project completion.

DISCUSSION

Undergraduates who participated in structured UR experiences at Mississippi State University were motivated by a number of factors, but those related to gaining experience for future professional opportunities and developing research skills were more important than financial, academic, or interpersonal connections with individual faculty mentors. Although this study is among the first to examine UR at a southeastern R1 university, the outcomes support much of the prior research in regard to the effects of UR on development of science professionals (Gregerman, 1999; Mabrouk and Peters, 2000; Bauer and Bennett, 2003; Lopatto, 2004; Seymour et al., 2004; Russell et al., 2007), retention of talented students in science careers (Hathaway, et al., 2002; Bauer and Bennett, 2003; Lopatto, 2004, 2007; Eagan Jr. et al., 2013), and the contribution of knowledge by undergraduate student researchers to the overall science field (Hunter et al., 2007; Buddie and Collins, 2011).

This study determined UR improves student participants' educational experience, including personal, cognitive, and professional development. Undergraduate participants reported gains in all science readiness skills after participating in research, with all skills having ≥ 0.6 improvement from pre-program abilities. Although MSU serves students with potentially different preparation for UR, these research findings mirrored those found in similar studies. For example, Lopatto (2004) reported many undergraduate student researchers had gained skills in science readiness as a result of their research experience, specifically in understanding the research process, readiness for more demanding research, and understanding how scientists work on real problems. Similarly, Russell et al. (2007) reported 83% of UR participants reported higher levels of confidence in research skills, and Seymour et al. (2004) found 91% of students gained professional science-related skills. Other studies reported the highest ranked skills developed by students were becoming intellectually curious, working independently, thinking critically (Bauer and Bennett, 2003), communicating orally (Kardash, 2000), and becoming more confident as a student and researcher (Mabrouk and Peters, 2000). Student feedback on open-ended survey questions in this study provided a direct insight into the skills developed during the UR process.

"*My projects were enlightening and educating…. I feel honored to have worked on this project because it taught me how to work with a team and how to conduct research using the scientific method.*"

Furthermore, this study indicates MSU UR enhanced the retention of talented students in science careers, specifically in higher education. A majority (91%) of undergraduate student researchers rated UR as a cause for them changing their decision towards attending graduate school or solidifying their decision to pursue further education, while a minority (2%) developed an adversity towards attending graduate school. This result has been found in other studies that analyzed student retention in science fields. One survey of undergraduate student researchers determined that 75.6% of respondents pursued further science education after receiving a baccalaureate degree (Hathaway et al., 2002), and another concluded that an UR experience either solidified or changed undergraduate students' prior plans in support of postgraduate science education in 30% of survey respondents; the majority (57%) already had plans to pursue postgraduate education that did not change (Lopatto, 2004). Russell et al. (2007) reported 29% of surveyed undergraduate student researchers had a new plan to pursue a Ph.D. post-UR. However, as observed in our study, UR may also change students' post-graduation plans away from higher science education. Lopatto (2007) reported that 4.2% of undergraduate researchers changed their post-graduation plans away from higher science education. Nevertheless, the UR research experience informs students post-graduate career decisions, more often in favor of further science education than not.

One goal of the MSU URSP is to provide students with the opportunity to contribute to the overall body of science knowledge by reporting the results they obtained throughout research experience. In this study, most (86%) undergraduate researchers advanced their respective scientific fields through the dissemination of their research in a variety of formats at academic venues, with more than 60% presenting in a professional scientific context outside the university. Scientific presentation and reporting are common elements of UR experiences. For example, Buddie and Collins (2011) determined that 45.5% and 33.3% of faculty members had student researchers give an oral or poster presentation, respectively, at a regional, national, or international conference, 41.2% had students present at a university-level research conference, and 33.3% had a student co-author a submitted manuscript. Hunter et al. (2007) found 28% of all undergraduate researchers presented at offcampus conferences in addition to a mandatory on-campus science conference.

Mentoring is also a central component of UR, and students reported their faculty mentor had a significant impact on their UR experience. Some participants explained how UR provided them with the opportunity to relate classroom training to real world application:

> *"…faculty mentorship in a structured system…allows students who typically have little more than classroom experience to use that training in real world application to make the connection between simple data collection and data application."*

Another survey respondent provided this comment regarding their faculty research mentor:

> *"… My [undergraduate research] professor was and continues to be one of the best mentors I have ever had. She has opened so many doors for me and sought out every chance possible to help me learn."*

These student – mentor professional relationships extended beyond the duration of the specific project and influenced future professional opportunities, as illustrated by one student's response:

> *"I really was lucky to have a very supportive supervisor who has kept in contact with me since my graduation and supported various applications/endeavors. Undergraduate research was key for my experience at MSU and is a core factor both for my employment as an organic chemist in an industry lab and for my recent admittance to Ph.D. programs in biochemistry."*

Furthermore, this study found that faculty engagement and commitment to the UR experience is critical to positive outcomes, as illustrated by this student's negative experience:

> *"My original project…fell through…so my professor had to scramble to come up with something new for me…I felt like a burden for a majority of the experience…If the grad student had not been so exceptional and kind, it would have been a real terrible experience…I excelled despite my professor's unwillingness to help me."*

The importance and impact of the relationship between mentor and undergraduate student on UR found in this project resembles the relationships identified in other publications. Hunter et al. (2007) determined that 16% of students' observations about their research programs included descriptions of the importance of establishing relationships with faculty members. In a separate study, undergraduate researchers responded that the support, guidance, and collegiality they received from their faculty mentor is one of the leading reasons for their increase in personal and professional confidence (Seymour et al., 2004). Howitt et al. (2010) found that students who report a positive experience made comments such as "an organized, enthusiastic supervisor" or "my supervisor was amazing…the research and report I produced were...the best pieces of work I've produced…and it was largely because of him." Those students who described their worst experiences also commented on the quality of the supervisor, such as "[the] supervisor was never around" and "poor guidance and little feedback from [the] instructor". These outcomes suggest that mentors who were enthusiastic and supportive of undergraduates' research played a large role in producing positive outcomes for undergraduate students.

The correspondence between the results of this work and prior studies indicates that no matter where UR is being conducted, whether it is in a large southeastern university or in a smaller liberal arts college in the north, the overall benefits for students remain consistent. Therefore, UR is equally important for the growth and development of the future science professionals undertaking the challenge, regardless of where it is being conducted.

Future studies could include data from students pursuing research outside of the three programs analyzed in this study, since these programs target a specific group of students. A comparison between structured, sponsored programs and other more informal UR could provide insight into how different ways of participating in research affects the students' perspectives and outputs. Furthermore, additional work is needed to determine the effects of gender, ethnicity, and academic preparedness, on a student's willingness to pursue UR and STEM careers.

CONCLUSION

This project demonstrates that the three formal UR programs at MSU improve student participants' educational experience (including personal, cognitive, and professional development), enhance retention of talented students in science careers, and lead to discovery of new information that contributes to the larger body of knowledge. Through student feedback, our survey also demonstrates the significant impact faculty mentors have on the overall experience of UR for students.

This work shows the importance of UR at a high research university working with students of various backgrounds and academic preparedness. This study, combined with previous work, indicates the overall importance of UR for developing science professionals at universities nationwide, and even globally. Our intention is that the results from this study will support further institutional facilitation of UR through greater support of student stipends, research funding, and faculty incentives that could lead to a significant increase in BS recipients with professional science experience.

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LITERATURE CITED

Bauer KW, Bennett JS. 2003. Alumni perceptions used to assess undergraduate research experience. J Higher Ed. 2003; 74(2): 210-30.

Buddie AM, Collins CL. Faculty perceptions of undergraduate research. PURM: Perspectives on Mentoring Undergraduate Researchers. 2011; 1(1): 1-21.

Eagan Jr MK, Hurtado S, Chang MJ, Garcia GA, Herrera FA, Garibay JC. Making a difference in science education: the impact of undergraduate research programs. American Educational Research Journal. 2013; 50(4): 683-713.

Gregerman SR. Improving the academic success of diverse students through undergraduate research. Council of Undergraduate Research Quarterly. 1999; 20(2): 54-59.

Hathaway RS, Nagda BA, and Gregerman SR. The relationship of undergraduate research participation to graduate and professional education pursuit: An empirical study. J College Student Development. 2002; 43(5): 614-631.

Howitt S, Wilson A, Wilson K, Roberts P. 'Please remember we are not all brilliant': undergraduates' experiences of an elite, research-intensive degree at a research-intensive university. Higher Education Research and Development. 2010; 29(4): 405-20.

Hunter A, Laursen SL, Seymour E. Becoming a scientist: the role of undergraduate research in students' cognitive, personal, and professional development. Sci Ed. 2007; 91(1): 36-74.

Kardash, CAM. Evaluation of an undergraduate research experience: perceptions of undergraduate interns and their faculty mentors. J Ed Psych. 2000; 92(1): 191-201.

Lopatto, D. Survey of undergraduate research experiences (SURE): first findings. Cell Bio Ed. 2004; 3(4): 270–77.

Lopatto, D. Undergraduate research experiences support science career decisions and active learning. CBE−Life Sci Ed. 2007; 6(4): 297-306.

Mabrouk, PA, Peters K. 2000. Student perspectives on undergraduate research (UR) experiences in chemistry and biology." CUR Quarterly. 2000; 21(1):25-33.

Millspaugh, JJ, Millenbah KF. Value and structure of research experiences for undergraduate wildlife students. Wildlife Society Bulletin. 2004; 32(4): 1185-94.

National Assessment of Educational Progress. "The Nation's Report Card." 2019. *https://www.nationsreportcard.gov/mathematics/states/scores?grade=4.* October 29, 2021.

Russell, SH, Hancock MP, McCullough J. Benefits of undergraduate research experiences. Science. 2007: 316(5824): 548-549.

Sabatini, DA. Teaching and research synergism: the undergraduate research experience. J Professional Issues Engineering Ed Practice. 1997; 123(3): 98-102.

Seymour, E, Hunter AB, Laursen SL, Deantoni T. Establishing the benefits of research experiences for undergraduates in the sciences: first findings from a three-year study. Sci Ed. 2004; 88(4): 493-534.

Wilson, AE, Pollock JL, Billick. JL, Domingo C, Fernandez-Figueroa EG, Nagy ES, Steury TD, Summers A. Assessing science training programs: structured undergraduate research programs make a difference. Bioscience. 2018; 68(7): 529-534.

Zydney AL, Bennett JS, Shahid A, Bauer KW. Impact of undergraduate research. J Engineering Ed. 2002; 91(2): 151-57.

A Preliminary Look at GenSea: Insights into Immersive K12 Teacher Professional Development for Blue Economy Pathways

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ABSTRACT

Background: Making explicit connections between high school classroom STEM content and evolving workforce demands is essential for preparing students for careers in the blue economy. By educating high school teachers about potential career paths, required training, course work, and degree programs for regional jobs, we can support their subsequent classroom practices and mentoring.

Methods: We developed a blue economy-oriented three-day residential professional development program for regional high school teachers using Desimone's (2009) five key elements of effective teacher professional development: content focus, active learning, coherence, duration, and collective participation. This study assessed its impact on participating teachers' knowledge, attitudes, and instructional practices around STEM and the blue economy.

Results: Teachers' enhanced awareness of the job market demands within the blue economy suggests the program effectively conveyed information about emerging and established workforce needs. The program also triggered a transformation in teachers' perceptions of career opportunities in Mississippi, prompting their integration of STEM careers discussions into daily lessons and the development of educational units dedicated to career connections. And teachers' growth in self-efficacy exhibited over the course of the event aligns with research trends found across the literature (Zhou et al., 2023). The documented impacts on teachers' knowledge, attitudes, and instructional practices align with the research objectives and offer valuable insights for future PD program development.

Conclusions: Through ongoing collaboration and adaptation, programs have the capacity to transform STEM education for high school students and teachers by explicitly connecting classroom learning and workforce applications, better-preparing students for evolving workforce demands.

KEYWORDS: GenSea, K-12, Blue Economy, STEM

INTRODUCTION

GenSea is a blue economy career pathways program serving high school students and teachers in the Gulf Coast region. Since its establishment in 2021, GenSea has hosted over 1,200 Mississippi high school students, with field trips taking place at the University of Southern Mississippi (USM) coastal campuses, as well as partner sites such as the NOAA/National Weather Service National Data Buoy Center, the Port of Gulfport, the Grand Bay National Estuarine Research Reserve, and Ocean Aero. USM's Center for STEM Education spearheads the GenSea program, which aims to introduce high school students to STEM careers in the blue economy through a three-dimensional approach: (1) field trip experiences, (2) summer internships, and (3) professional development opportunities for teachers.

The term "blue economy" encompasses three interconnected yet separate concepts: 1. the significant economic impact of the oceans, 2. the imperative to ensure the environmental and ecological well-being of the oceans, and 3. the potential for coastal careers to foster economic growth (Christopherson, 2020). In recent years, the emergence of hi-tech STEM industries on the Mississippi Gulf Coast has fostered a blue economy innovation cluster. Due to its placement at the top of the Gulf of Mexico, the coastal region of Mississippi accommodates a multitude of marine science and technology sectors, comprising industries such as oil and gas extraction, shipbuilding, ocean engineering, aquaculture, and logistics. It also hosts U.S. Navy and Air Force operations, as well as NASA's Stennis Space Center and multiple federal research centers. Additionally, Mississippi university campuses, centers, and labs in the region are well positioned to educate and grow the state's blue workforce. Case in point, USM's coastal operations are geographically and academically poised to provide wide-reaching programs to serve students across the state.

One of the many challenges facing Mississippi, Alabama, and Louisiana is the “brain drain” of young, educated citizens. Over the past decade, Mississippi in particular has seen a sharp decline in the number of college-educated millennials, with many leaving for job opportunities in neighboring states (Smith, 2018). According to Parisi (2018), the number of educated millennials in Mississippi declined by 10% as of 2017. Population depletion has severe economic consequences: estimates indicate Mississippi lost a cumulative $1.4 billion in total income to other states between 2011-2016 (McGraw et al., 2017). Since scientists and engineers from outside the state are often hired to fill technical openings along the Gulf of Mexico’s coast, Mississippi is losing out on opportunities to develop homegrown talent to occupy these positions. One way to potentially address the brain drain issue is to invest in STEM workforce development pertaining to emerging blue economy career pathways.

Preparing a Blue Workforce

In the 21st century blue economy workforce, aspiring professionals will need a diverse range of skill sets and abilities. According to Anderman et al. (2012), future members of the STEM workforce will be required to work flexibly, communicate, and collaborate effectively, solve problems creatively, manage themselves and their development efficiently, and think critically about complex systems. Notably, the available literature indicates the emerging blue economy will also require its workers to have transdisciplinary or convergent understandings of the ocean as well as competencies to integrate these understandings to collaboratively resolve ocean-related issues (Hotaling, 2021; Koch, 2021; Manley, 2021). By 2030, scientists estimate that fewer than 50% of current K12 students will be properly trained in the skills needed for the ocean-related STEM workforce (Manyika et al., 2017). Presently, educational systems in the U.S. are not typically explicitly connecting STEM content in the classroom to potential future career paths. In other words, students are not making the connections from the classroom to practical career applications.

Currently, K12 education, especially in the STEM disciplines, is focused on traditional, didactic methods of teaching and learning, which tend to stress memorization as opposed to the realistic discovery and inquiry-based nature of STEM careers (Penprase, 2020; Hotaling, 2021). Hotaling (2021) noted, “All too often, science especially is taught more as a history course, memorizing dates and accomplishments, instead of a living, breathing field of study (p. 388).” Despite K12 education’s increased attention to STEM-related content in the classroom, students still lack knowledge and resources to meet the demands of the 21st Century workforce (Blotnicky et al., 2018; Athanasia and Cota, 2022). In a study investigating middle school students’ knowledge of science and mathematics requirements for STEM careers, Blotnicky et al. (2018) found that overall students lacked knowledge of STEM career options, both in terms of the subject requirements for these careers and the specific activities involved in them. For students to acquire the essential skills needed for the future STEM workforce, it is crucial for K12 education to offer increased practical learning opportunities, rather than relying solely on theoretical instruction (Bransford et al., 2000).

Several studies have also found a gap between the skills students learn in school and the skills needed in the STEM workforce (Barnett, 2012; Prinsley and Baranyai, 2015; Rus et al., 2015; McGunagle and Zizka, 2020). Bunshaft et al. (2015) posit a disparity exists between the content taught within academic programs and the skills and knowledge perceived to be important by industries. Additionally, employers, educational leaders, and employees often disagree about which skills are most critical to success (Jang, 2015). For example, Prinsley and Baranyai (2015) studied employer perceptions of STEM-qualified workers and found that 1 in 3 employers reported a misalignment between the skills required for STEM employment and those reported by applicants. McGunagle and Zizka (2020) supported these results in their investigation of employability skills currently lacking in STEM manufacturing industries using the perspectives of employers. The existing literature highlights the evolving demands of the 21st century blue workforce, necessitating a broad range of adaptable skills and transdisciplinary understandings. However, the current state of K12 education falls short in equipping students with the necessary knowledge and practical learning opportunities to bridge the gap between classroom content and future career paths. Incorporating STEM career literacy could help teachers to bridge this gap by providing students with the knowledge and skills needed to succeed in STEM careers.

Blue Career Literacy

Traditionally, students learn about various careers and the skills each requires to be successful during high school (Tang et al., 2008). According to Valentine and Kosloski (2021), preparing career literate students involves a variety of experiences to help students acquire the knowledge and skills they need to make informed career-related decisions. Participating in these experiences helps students understand, interpret, and evaluate career options (Valentine and Kosloski, 2021). Further, access to targeted learning opportunities has been shown to increase students' self-efficacy to make informed decisions (Tang et al., 2008).

Passage of the Perkins V Act (2018), known as the Strengthening Career and Technical Education Act for the 21st Century, provided a revised definition of the purpose of career and technical education that includes employability skills. This shift not only underscores the importance of these skills, but also the incorporation of career literacy skills within K12 curricula (Valentine and Kosloski, 2021). Enhancing students' career literacy can enable them to make decisions based on an understanding beyond their immediate environment. This focus on jobs is especially relevant because students often begin excluding themselves from career paths during early adolescence (Gottfredson, 2005). Hence, it is crucial for career literacy skills (Valentine and Kosloski, 2021) to be integrated into K12 teachers' everyday instruction.

Educators are vital components to increasing students' career literacy capabilities (Tang et al., 2008; Choi, 2015). Teachers must be made aware of a wide variety of workforce options and trained to cultivate career literacy and employability skills in their students, especially concerning emerging careers like those in the blue economy. Hotaling (2021) holds that professional development focused on the blue economy is not only needed to increase awareness of career opportunities, but also to enhance teachers' understandings of industry practices and desired employability skills. Fostering career literacy skills in students is critical for informed decision-making and success in building the evolving STEM workforce. The GenSea program recognizes the importance of career literacy in preparing high school students for blue economy career pathways; however, to effectively cultivate career literacy skills, K12 educators, especially STEM educators, must receive appropriate training and professional development opportunities.

Professional Development for Educators

Teachers play a crucial role in shaping students' interest in STEM careers and educational pathways (Autenrieth et al., 2017; Knowles et al., 2018). The increasing demand for STEM professionals and concerns regarding skill gaps in the workforce are driving global initiatives for cultivating interest in STEM careers (English, 2017; Knowles et al., 2018). While many professional development (PD) programs focus on building teachers' content knowledge and pedagogical skills (Garet et al., 2016; Kennedy, 2016), the GenSea Blue Economy Pathways Teacher Professional Development (BEPTPD) stands out for its primary focus on workforce development specifically for blue economy STEM career pathways. This unique approach recognizes the importance of equipping teachers with the knowledge and skills needed to guide students towards blue economy careers. By bridging the gap between classroom content and future career paths, the BEPTPD aims to enhance students' career literacy and promote informed decision-making.

Incorporating STEM professionals and employability skills into PD programs can have a significant impact on teachers' awareness of STEM careers (Knowles et al., 2018). BEPTPD aims to enhance students' understanding of STEM career options by equipping teachers with the knowledge and skills to cultivate career literacy in their students. This approach aligns with the broader goal of preparing students for the 21st-century STEM workforce, where adaptability, communication, collaboration, problem-solving, and critical thinking skills are crucial (Anderman et al., 2012). Strategic collaboration between researchers, educators, scientists, and industry professionals provides the PD experience with real-world practices and industry-specific knowledge (Knowles et al., 2018). Specifically, collaboration ensures that PD programs align with the needs of teachers and students and provide participants with information they need to help their students succeed in STEM careers.

Teacher professional development plays a critical role in equipping educators with the necessary tools to guide students towards STEM careers. However, existing literature on teacher PD lacks a systematic framework that accounts for the inclusion of workforce development and blue economy contexts. This paper will address this gap by expanding upon Desimone's (2009) core conceptual framework for studying the impacts of PD on teachers and students. Specifically, this study maps the impacts of the GenSea BEPTPD program in order to develop an adapted conceptual framework that provides a guide for future research on workforce development-oriented PD and its impacts on both teachers and students. Building upon Desimone's framework, the study will shed light on the contributions of career-focused PD programs in preparing teachers and students for the evolving demands of the STEM workforce.

Blue Economy Pathways Professional Development (BEPTD)

The BEPTPD event, organized by the GenSea program, introduces high school STEM educators to a wide range of career options within the blue economy. GenSea has hosted two cohorts of educators from across the state to participate in immersive field visits and learn about careers in marine science and ocean engineering. Teachers embark on three-day journeys, visiting various technical training sites on the Mississippi Gulf Coast, including the University of Southern Mississippi Coastal Campuses and partner sites such as the NOAA National Data Buoy Center, the Port of Gulfport, the Grand Bay National Estuarine Research Reserve, and Ocean Aero. Throughout the events, teachers had the opportunity to interact with professionals and experts in various STEM disciplines, observe work environments in real-time, and engage in question-and-answer sessions to gain insights into career paths, required skills, and effective teaching practices. Both development events conclude with collaborative reflection and sessions focused on providing hands-on activities that could be incorporated into the classroom to connect blue economy career options with teachers' instructional approaches.

Conceptual Framework

After an extensive review of the PD literature, Desimone (2009) found most studies, regardless of whether they were conceptual, empirical, or a combination of both, shared a common understanding that formed the basis of her core conceptual framework. While relatively simple, Desimone’s (2009) framework serves as a strong basis for constructing a cohesive knowledge base pertaining to the effects of teacher PD. Using this framework to examine the impacts of BEPTPD offers an opportunity to expand the existing knowledge base and enhance our understanding of the most effective components and qualities of professional development programs geared toward workforce development. The conceptual framework integrates the essential elements of impactful professional development, including the factors that mediate its effects, such as school administrations, contextual issues, and individual teachers (Desimone, 2009). Desimone highlights the five key elements that are widely recognized as crucial components of effective teacher professional development: content focus, active learning, coherence, duration, and collective participation. These elements serve as the guidepost for the PD program structure.

Content focus pertains to the specific knowledge and skills that teachers require to effectively fulfill their classroom responsibilities in relation to the subject matter addressed in their professional development. Extensive evidence consistently indicates a strong correlation between activities centered around subject matter content and their impact on student learning outcomes, leading to enhancements in teacher knowledge, skills, instructional practices, and student achievement (Carpenter et al., 1989; Cohen, 1990; Garet et al., 2001; Desimone, 2002; Banilower et al., 2005). The BEPTPD program aligns with the content focus component by providing high school STEM educators with immersive experiences and insights into blue economy career options within marine science and ocean engineering. The content focus aims to enhance their understanding of career paths, required skills, and effective teaching practices in the blue economy field.

Active learning in professional development means providing teachers with opportunities to participate in meaningful discussions and activities that are relevant to their day-to-day work (Main and Pendergast, 2015). This element can help teachers develop new skills and to apply these skills in their classrooms. The effectiveness of professional development is further enhanced when it provides teachers with opportunities for active learning (Loucks-Horsley et al., 1998; Garet et al., 2001). BEPTPD integrates active learning by engaging educators in field visits, interactions with experts, and real-time observations of work environments. Over the course of the program, educators participate in collaborative sessions with professionals and engage in hands-on activities that can be incorporated into their teaching approaches.

The *coherence* component refers to the degree of alignment between teacher learning and their existing knowledge and beliefs (Desimone, 2009). It signifies the connection established between the professional development activity and the practical aspects of the classroom environment (Main and Pendergast, 2015). The BEPTPD program demonstrates coherence by aligning experiences and interactions with professionals to classroom instruction. By doing so, BEPPD bridges the gap between theoretical understanding and practical application by highlighting how blue economy careers align with their STEM subjects.

Duration refers to the requirement for PD to be of adequate length. In other words, PD activities need to be long enough to allow for engagement and cognitive change (Main and Pendergast, 2015). While an exact threshold for duration has not been determined, research suggests that activities encompassing 20 hours or more of contact time receive significant support (Desimone, 2009). The duration of the BEPTPD program spans 21 contact hours' worth 2.1 continuing education credits (CEUs).

Finally, *collective participation* refers to the prospect for teachers to engage in professional development alongside others who share similar contexts, such as schools, districts, grade levels, or departments (Desimone, 2009; Main and Pendergast, 2015). This element creates a conducive environment for interaction and meaningful discussions, which can be a highly impactful method of learning (Main and Pendergast, 2015). The BEPTPD program aligns with collective participation by bringing together cohorts of STEM educators from various high school schools across Mississippi, Louisiana, and Alabama. Educators share similar contexts by participating alongside others with common teaching backgrounds, interests, and experiences. Shared experiences provide a supportive learning environment and the exchange of ideas among educators.

Desimone's (2009) model depicts interactive relationships among the key elements of professional development addressed above with teacher knowledge and beliefs, classroom practice, and student outcomes. It outlines a core theory of action for effective professional development, involving the following steps: 1) Teachers engage in impactful professional development; 2) Professional development enhances teachers' knowledge, skills, attitudes, and beliefs; 3) Teachers apply their new knowledge and skills to improve their instruction or pedagogical approach; 4) Improved instruction leads to increased student learning. This model allows for testing theories of teacher change and instruction, contributing to a comprehensive understanding of how professional development operates. Desimone's concept of non-recursive, interactive pathways acknowledges the significance of context as a mediator and moderator, accommodating additional elements like teacher identity, beliefs, and perceptions within the model.

Research Objectives

The overall goal of the study is to enhance understanding of the impacts and effectiveness of workforce development-oriented PD programs on teachers through the following research objective. The study aims to begin developing a systematic framework that integrates the elements of workforce development and blue economy contexts into the examination of teacher professional development. This process involves building upon Desimone's (2009) conceptual framework and incorporating the specific impacts of the GenSea BEPTPD program. Through this objective, the impacts of the BEPTPD program will be mapped, and an adapted conceptual framework will be developed to guide future research focused on workforce development-oriented professional development.

MATERIALS AND METHODS

The following inquiry employed a qualitative research design to conduct a thematic analysis (TA). The focus of the analysis was to explore and understand the specific impacts of the GenSea BEPTPD program and its contributions to workforce development in the context of STEM education. TA is a method for making sense of qualitative data by identifying patterns of meaning (Clarke and Braun, 2015). The researcher first generates codes, which are then grouped together into themes. Codes are the smallest unit of analysis that capture features of the data that are potentially relevant to the research objectives. Themes are larger patterns of meaning that are underpinned by a central organizing concept. They provide a way to organize and summarize the data, interpret the data, and draw conclusions (Clarke and Braun, 2015).

TA is a flexible method of qualitative data analysis that can be used to identify patterns of meaning in a variety of data sources. TA is not tied to any theoretical framework, so it can be used to address a wide range of research objectives (Clarke and Braun, 2015). The sample size, data collection method, and approaches to meaning generation can all be adapted to the specific needs of the research project. As such, a thematic approach is particularly well-suited for research that seeks to understand the lived experience of participants, their views and perspectives, and their behavior and practices (Clarke and Braun, 2015). Further, this approach can be used to identify patterns within and across data to generate insights into the meaning of these patterns.

Participants

The study included two cohorts of mostly high school STEM educators who participated in the BEPTPD program in June 2022 and 2023. The total number of participants across both cohorts was 37, with 19 educators in the June 2022 cohort and 18 educators in the June 2023 cohort. Most educators taught secondary STEM subjects such as engineering, biology, chemistry, physics, and computer science, while a smaller portion ($N< 4$) taught science subjects at the primary and middle school levels. The selection process for attendees was based on the quality of their applications, and a panel of GenSea staff and researchers reviewed the applications and made the final selections. No specific knowledge, skill, or specialization was required for acceptance into the program. The applications were evaluated based on their quality and alignment with the target population of high school STEM teachers from the region. Efforts were made to prioritize teachers from traditionally underrepresented, marginalized, and underfunded populations, ensuring their inclusion in the program. Housing, transportation, and a $300 award were provided to the selected teachers.

In terms of gender and ethnicity demographics, the sampled population self-identified as majority white and female. All participants identified themselves as either female or male, with nearly 79% of the sampled population identifying as female. These data align with the gender and ethnicity demographics of Mississippi's educator workforce, which, as of 2019, was approximately 80% female with nearly 50% reporting as white and female (Skinner, 2019). GenSea received IRB approval (USM IRB #22-569) to collect data measuring teachers' demographic information, knowledge, and attitudes about technical job options before and after professional developments.

Data Collection

All data collection methods employed in this study were aligned with Desimone's (2009) conceptual framework and theory of action, which focused on capturing the core components of professional development; changes in teachers' knowledge, attitudes, and beliefs; and the impacts on teachers' instructional practices. A multi-source approach ensured that the data collection methods provided a nuanced view of teachers' perspectives and lived experiences. The following sources of data were utilized:

1. Pre-Post Survey Instrument: A survey instrument was administered to participants one week before and one week after the BEPTPD event. The survey included Likert and open-ended, free-response questions to assess teachers' baseline knowledge, attitudes, and beliefs related to blue economy careers and their instructional practices. Only teachers' open-ended, free responses on the surveying instrument were used in the analysis of this study. Further, the post-event survey included additional questions to capture any changes or shifts in these areas following the PD experience. Both the pre- and post-survey instruments were administered via Qualtrics.
2. Daily Post-Experience Reflections: Teachers were encouraged to engage in reflective practices by documenting their daily experiences, insights, and reflections throughout the BEPPD program. These reflections were collected at the end of each day and provided valuable qualitative data that offered deeper insights into the teachers' learning journey, the impact of the PD activities on their knowledge and practices, and their overall experiences during the event.
3. Focus Groups: A focus group session was conducted with participants after the BEPPD events. The focus group allowed for in-depth discussions among teachers to explore their perceptions, experiences, and the impacts of the PD program on their professional growth and instructional practices. The discussions were audio-recorded and transcribed verbatim for analysis.

Analysis

Data collected from the four sources highlighted above were independently coded using In Vivo coding techniques guided by Desimone (2009). These codes were then combined, categorized, and analyzed together using thematic analysis to identify meaningful patterns and themes. The process followed the guidelines outlined by Saldaña (2015) for thematic analysis. This procedure involved initially identifying codes within the data, grouping related codes into categories, and further developing higher-level categories. Higher-level categories, or groups, were reviewed and synthesized to generate overarching themes through analytic memoing. The emerging themes were then applied to address the research objectives of the study. The data analysis process followed a four-step approach: identifying codes, creating code categories and groups, reviewing and synthesizing the groups, and finally applying the themes to the research objective. A brief overview of the four-step process is provided below.

In the first step, descriptive codes were assigned to summarize passages of data using In Vivo coding. Codes were placed alongside the relevant text within the coding document. The focus group transcript was coded first, followed by the coding of teachers' responses from the survey instruments and daily reflections. Finally, the field observations were coded. Codes were identified by carefully reviewing the data line-by-line, identifying key phrases, descriptions, and explanations that related to Desimone's conceptual framework and theory of action. After coding the four data sources, the codes were iteratively combined, reviewed, and refined for further analysis. In Step 2, codes were examined for similarities, then organized into more meaningful categories to establish higher-level categories. During Step 3, a comprehensive review of the higher-level categories was conducted to develop themes. In Step 4, the researcher reflected on the emerging themes and their significance in relation to the development of a conceptual framework.

Steps 3 and 4 were supported by analytic memos composed during field observations. According to Saldaña (2015), the use of analytic memoing aids in the reflection on how themes can address the research questions, while Birks et al. (2008) and Amanfi (2018) describe analytic memoing as a means of extracting meaning and developing a deeper understanding of the phenomenon being studied. The rigorous process of data analysis, guided by Desimone's framework and Saldaña's thematic analytical approach, allowed for the identification of meaningful patterns and themes across the data sources.

RESULTS

Impact on Knowledge

Thematic analysis revealed three themes regarding the impacts of the BEPTPD on teachers' knowledge.

Theme 1: Increased Awareness of Career Pathways and Opportunities

Teacher responses indicated their awareness was impacted in two ways after attending the development. First, teachers indicated the event broadened their awareness of STEM occupations in the blue economy. Teachers discovered previously unknown career pathways, with one teacher sharing, "Before attending this professional development, my knowledge was very low. I had no idea of how many pathways were available for young people to obtain job positions in the blue economy." While another referred to the diverse array of career opportunities in the blue economy, "The event has grown my knowledge of career opportunities in the blue economy, specifically the wide variety of job opportunities that exist." Second, teachers gained awareness regarding academic and training opportunities in the blue economy. After the event, teachers felt well-informed about technical on-the-job training programs and 2-year educational pathways in addition to traditional 4-year degrees. One teacher proclaimed, "Not only are college degrees needed but there is also a need for technicians and skilled labor involving either a 2-year degree or on-the-job training for the job." Overall, the coding indicated that teachers' awareness was significantly impacted by attending the development.

Theme 2: Increased Understanding of Workforce Skill Demands

The analysis revealed the BEPPD event increased teachers' understanding of the skills required in the blue economy. Teachers gained valuable insights into the competencies students need to possess to be employable. Upon reflection of their experience, a teacher stated, "Through the tours, presentations, and interactions with industry professionals, I gained a more comprehensive understanding of the skills and qualifications necessary for success." Responses emphasized the need for soft skills like organization, time management, and communication. Notably, teachers learned about the interdisciplinary nature of blue economy STEM, where workers must be able to apply their expertise across various disciplines. One teacher reflected, "It demonstrated how multiple entities and careers work together like a well-oiled machine to deliver the products, data, and resources." Another teacher supported that claim by sharing, "This event has shown me how different jobs within marine science intertwine. Most of the site visits included jobs that were interchangeable across the industry."

Theme 3: Enhanced Awareness of Job Market Demands

In addition to greater awareness of career pathways, teachers learned about the workforce needs of emerging and established blue economy industries. In their reflections, a teacher noted, "I learned about the state of the job market, how many careers are out there, and the workforce needs. They [careers] are out there and they are in our backyard." Teachers also significantly shifted their understanding of job availability and personnel needs. They expressed how their awareness was impacted, with one saying, "I did not realize there was such a big blue economy here, and they all need workers." While another added, "I was unaware of the need for more people to go into various fields and stay in Mississippi."

Impact on Attitudes and Beliefs

The findings of the thematic analysis yielded three themes pertaining to changes in teachers' attitudes and beliefs.

Theme 1: Increased Feelings of Support

The analysis indicated that the event heightened teachers' feelings of support. Exposure to and interaction with fellow educators and STEM professionals allowed teachers to grow their professional networks. As one teacher shared, "The contacts made throughout the PD exposed all of us to information that will be invaluable for our students." Teachers also indicated that the PD increased their access to resources. For example, one teacher wrote, "The event equipped me with a wealth of resources that I can now share with my students." These sentiments were supported by another teacher who reflected, "I have discovered new resources to utilize in my goal of enlightening students to the possibilities that they have here locally."

Theme 2: Increased Feelings of Preparedness and Confidence to Teach

Teacher responses conveyed that the development positively impacted their confidence and preparedness to connect their instruction to blue economy STEM careers. A teacher explained, "Attending the professional development event has significantly enhanced my feelings of preparedness to guide students in exploring careers in the blue economy and related STEM fields." Moreover, the analysis indicated that teachers' sense of preparedness was inextricably linked to their confidence, with one teacher noting, "I feel significantly more confident as I am better equipped to connect classroom learning to real-world applications." Increased confidence was highlighted throughout the data with most participants linking it to their increased feelings of support and preparedness.

Theme 3: Change in Perceptions of Opportunities in Mississippi

A notable transformation emerging for the analysis was a shift in teachers' perceptions of career opportunities in Mississippi. The findings indicated that most teachers entered the development with narrow perceptions of job prospects available in the state. After the event, teachers' perceptions were expanded, now including robust understandings of the opportunities Mississippi has to offer. One teacher reflected on this perceptual change by stating, "My perceptions and beliefs about STEM career opportunities in Mississippi have completely changed because of the PD. I was in the dark about all the wonderful careers on the coast." Furthermore, teachers' perceptual changes inspired them to guide their students toward these opportunities, with a teacher adding, "This event totally altered my attitudes toward opportunities in Mississippi. I had no idea coming in, now I can discuss the topic intelligently and help students visualize their pathways."

Impact on Instruction

Finally, the thematic analysis revealed three themes regarding teachers' perceived impacts on their instruction and teaching practices.

Theme 1: Incorporation of Authentic STEM Experiences

The analysis yielded three ways teachers planned to incorporate authentic experiences into their lessons. First, teachers planned to incorporate more out-of-school experiences for their students, as a teacher shared, “Whenever possible, I will plan field trips or outdoor learning experiences that connect students with the local coastal environment.” Second, they planned to create lessons and projects using real-time data, with one teacher planning, “I have a unit on statistics, and I will probably incorporate real-world application problems from the buoy data center.” Lastly, teachers planned to use their newfound connections with STEM professionals to create scientist-led in-class experiences. One teacher stated, “I will invite professionals from the blue economy, such as marine biologists, conservationists, or environmental activists, to speak to my students or arrange virtual sessions with experts.”

Theme 2: Integration of STEM Careers

The findings indicated that teachers were actively strategizing to integrate STEM careers into their instruction after the development. Many of the participants indicated they wanted to integrate career discussions into their daily instruction, with one teacher saying, “I've already started planning. All my classes will have ‘Potential Career’ components during our bellwork time, having students research and visit the industry websites to get a feel for what they're doing.” Another teacher added, “I teach marine science so additional career focus will be added into my teaching materials. And now I can directly link careers to lessons and supplementary activities we are doing.” Additionally, teacher responses revealed they planned to use what they learned to create educational units and events dedicated to promoting career opportunities. For instance, one teacher noted, “I will make a presentation for students and colleagues when we return to school, but one big project I am now working on with a colleague is a career day/night with our upperclassmen.”

Theme 3: Integration of Employability Skills

Lastly, the analysis indicated teachers were inspired to integrate many of the required career skills they were exposed to throughout their development. One teacher shared, “I will assign research projects that require students to investigate blue economy-related topics. They can explore issues such as renewable energy, marine conservation, sustainable fisheries, or coastal development. By conducting research, analyzing data, and presenting their findings, students will develop critical thinking, research skills, and the ability to communicate their ideas effectively.” Also, teachers planned to use their newfound knowledge of soft and interdisciplinary skill requirements in their instruction. After the event, a teacher explained, “This professional development event will have a transformative impact on my instructional practices. It will guide me to create more meaningful and relevant learning experiences, foster interdisciplinary connections, and equip students with the skills and knowledge necessary to navigate and contribute to the ever-evolving world of the blue economy.” While another added, “We're going to have to work on soft skills, character, and work ethic - 100% ethical, 100% integrity. It may be that none of my students end up in these careers specifically but preparing them that way will equip them for future success.”

DISCUSSION

The primary objective of this study was to begin developing a systematic framework that integrates elements of workforce development and specifically blue economy contexts into Desimone’s (2009) existing conceptual framework for studying the impacts of teacher professional development. The findings convey the program significantly impacted teachers' awareness of career pathways and opportunities within the blue economy. Teachers displayed a broadening of their understanding of available career options, varying educational pathways, and the skills required for these positions. Furthermore, teachers' enhanced awareness of the job market demands within the blue economy suggests that the BEPTPD program effectively conveyed information about emerging and established industries' workforce needs. These results support previous research addressing the impacts of professional development on teachers’ STEM career awareness (Knowles et al., 2018).

Furthermore, the BEPTPD event enhanced

teachers' feelings of support, both through exposure to fellow educators and STEM professionals, as well as through the acquisition of resources. The program increased teachers' feelings of preparedness and confidence to teach, showing a positive impact on their self-efficacy in connecting classroom learning to real-world applications. The growth in self-efficacy exhibited over the course of the BEPTPD event aligns with research trends found across the literature (Zhou et al., 2023). Additionally, the program triggered a transformation in teachers' perceptions of career opportunities in Mississippi. By the end of the event, teachers had expanded their perspectives and were inspired to combat regional brain drain issues by guiding students toward local opportunities. Overall, changes in teachers' attitudes and beliefs were consistent with the theory of action outlined in Desimone (2009) in that the development significantly altered teachers’ attitudes and beliefs towards their instructional practices.

The impacts on instruction were evident in the findings as well. Teachers expressed intentions to incorporate authentic STEM experiences by organizing out-of-school experiences, integrating real-time data into lessons, and engaging STEM professionals in classroom activities. The integration of STEM careers into instruction was another key theme, highlighting teachers' strategies to infuse career discussions into daily lessons and create educational units dedicated to promoting career opportunities. Lastly, teachers planned to integrate employability skills learned during the program into their instruction. Skills such as, critical thinking, interdisciplinary connections, communication, and organization, emerged throughout the analysis, which are aligned with the skill requirements called for in the literature (Hotaling, 2021; Anderman et al., 2012).

The results of this study have important implications for both the field of education and workforce development. By successfully enhancing teachers' knowledge, attitudes, and instructional practices related to blue economy STEM careers, the BEPTPD program offers a promising approach to addressing the gap between classroom education and the demands of the workforce. Through collaborative efforts between educators, professionals, and researchers, this program demonstrated the potential to improve teachers' ability to prepare students for 21st-century STEM careers (Knowles et al., 2018). However, more investigation could explore the longitudinal impacts of the BEPTPD program on teachers' instructional practices and students' career trajectories.

Future research efforts by GenSea researchers aim to develop and validate an instrument to quantitatively assess the impacts of BEPTPD on teachers' attitudes, beliefs, and instructional practices. Doing so will allow researchers to draw more meaningful inferences about the program's impacts in addition to the presented qualitative findings. A mixed-methods approach could provide a more holistic framework of the program's impacts on high school STEM teachers. Furthermore, future inquiry will address the impacts the BEPTPD has on students. Currently, GenSea researchers are designing research that will track student outcomes of their teachers' professional development. This line of inquiry will assess how their teachers' professional development influences students' attitudes, perceptions, and interests in STEM careers.

As the GenSea program continues to grow and expand its reach across the region, the initiative actively seeks new industry partners while strengthening existing collaborations. This approach ensures that new teaching and learning experiences will be available with each iteration of the program. Adding more STEM industry partners will guarantee that BEPTPD continues to offer teachers new opportunities for professional development, ultimately leading to a more impactful and sustainable program for educators and students alike.

In conclusion, the BEPTPD program demonstrates the potential of workforce development-oriented PD to effectively bridge the gap between classroom content and future career paths in the blue economy. The documented impacts on teachers' knowledge, attitudes, and instructional practices align with the research objectives and offer valuable insights for future PD program development. Through ongoing collaboration and adaptation, programs have the capacity to transform STEM education for high school students and teachers by explicitly connecting classroom learning and workforce applications, better-preparing students for evolving workforce demands.

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REFERENCES

Anderman EM, Sinatra GM, Gray DL. The challenges of teaching and learning about science in the twenty-first century: Exploring the abilities and constraints of adolescent learners. Studies in Science Education. 2012;*48*(1):89-117.

Athanasia G, Cota J. “The U.S. should strengthen STEM education to remain globally competitive: Perspectives on Innovation.” Center for Strategic and International Studies. Apr. 2022. https://www.csis.org/blogs/perspectives-innovation/us-should-strengthen-stem-education-remain-globally-competitive

Autenrieth R, Lewis C, Butler-Purry K. Enrichment experiences in engineering (E3) summer teacher program: Analysis of student surveys regarding engineering awareness. Journal of STEM Education: Innovations and Research. 2018;*19*(4).

Banilower ER, Heck DJ, Weiss IR. Can professional development make the vision of the standards a reality? The impact of the national science foundation's local systemic change through teacher enhancement initiative. Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching. 2007;*44*(3):375-395.

Barnett K. Student interns’ socially constructed work realities: Narrowing the work expectation-reality gap. Business Communication Quarterly. 2012;*75*(3):271-290.

Blotnicky KA, Franz-Odendaal T, French F. A study of the correlation between STEM career knowledge, mathematics self-efficacy, career interests, and career activities on the likelihood of pursuing a STEM career among middle school students. International Journal of STEM Education. 2018*;*5(22).

Bransford JD, Brown AL, Cocking RR. How people learn. Washington, DC: National Academy Press. 2000.

Bunshaft A, Curtis-Fink J, Gerstein A, Boyington D, Edwards T, Jacobson C. Focus on employability skills for STEM workers. Points to experiential learning. STEM connector’s STEM Innovation Task Force. 2015.

Carpenter TP, Fennema E, Peterson PL, Chiang CP, Loef M. Using knowledge of children’s mathematics thinking in classroom teaching: An experimental study. American Educational Research Journal. 1989;26(4):499-531.

Choi Y, Kim J, Kim S. Career development and school success in adolescents: The role of career interventions. The Career Development Quarterly. 2015 Jun;63(2):171-86.

Christopherson R. “America’s Blue Economy Worth nearly $373 billion.” Middlebury Institute of International Studies at Monterey. 4 Jun. 2020. https://www.middlebury.edu/institute/academics/centers-initiatives/center-blue-economy/cbe-news/americas-blue-economy-worth-nearly-373

Cohen DK. A revolution in one classroom: The case of Mrs. Oublier. Educational Evaluation and Policy Analysis. 1990 Sep;12(3):311-29.

Desimone L. How can comprehensive school reform models be successfully implemented? Review of Educational Research. 2002 Sep;72(3):433-79.

Desimone LM. Improving impact studies of teachers’ professional development: Toward better conceptualizations and measures. Educational Researcher. 2009 Apr;38(3):181-99.

English LD. Advancing elementary and middle school STEM education. International Journal of Science and Mathematics Education. 2017 May;15:5-24.

Garet MS, Porter AC, Desimone L, Birman BF, Yoon KS. What makes professional development effective? Results from a national sample of teachers. American Educational Research Journal. 2001;38(4):915-45.

Garet MS, Heppen J, Walters K, Smith T, Yang R. Does content-focused teacher professional development work? Findings from three

Institute of Education Sciences studies. National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences. 2016.
Gottfredson LS. Using Gottfredson's theory of circumscription and compromise in career guidance and counseling. Career development and counseling: Putting theory and research to work. 2005 Jan:71-100.
Hotaling L. Preparing the workforce for the new blue economy. In Preparing a Workforce for the New Blue Economy. 2021 Jan 1;387-405.
Jang H. Identifying 21st century STEM competencies using workplace data. Journal of Science Education and Technology. 2016 Apr;25:284-301.
Kennedy MM. How does professional development improve teaching?. Review of Educational Research. 2016 Dec;86(4):945-80.
Knowles J, Kelley T, Holland J. Increasing teacher awareness of STEM careers. Journal of STEM Education. 2018 Aug 14;19(3).
Koch L. OP/ED: How to prepare the workforce for the new blue economy?. Preparing a Workforce for the New Blue Economy. 2021 Jan 1:451-5.
Loucks-Horsley S, Stiles KE, Mundry S, Love N, Hewson PW. Designing professional development for teachers of science and mathematics. Corwin Press; 2009 Nov 24.
Main K, Pendergast D. Core features of effective continuing professional development for the middle years: A tool for reflection. RMLE Online. 2015 Jan 1;38(10):1-8.
Manley J. Interview: Industry trends. Preparing a Workforce for the New Blue Economy: People, Products and Policies. 2021 May 27:371.
Manyika J, Lund S, Chui M, Bughin J, Woetzel J, Batra P, Ko R, Sanghvi S. Jobs lost, jobs gained: What the future of work will mean for jobs, skills, and wages. 28 Nov. 2017. https://www.mckinsey.com/featured-insights/future-of-work/jobs-lost-jobs-gained-what-the-future-of-work-will-mean-for-jobs-skills-and-wages
McGraw J, White N, Kirby-McLemore J, William Winter Institute. "New Census data, Same old story: People keep leaving Mississippi - jake mcgraw." Rethink Mississippi. 23 Dec. 2017. http://rethinkms.org/2017/12/21/new-census-data-ol-story-people-keep-leaving-mississippi/
McGunagle D, Zizka L. Employability skills for 21st-century STEM students: the employers' perspective. Higher Education, Skills and Work-Based Learning. 2020 May 21;10(3):591-606.
Parisi M. "Mississippi Fact Sheet: Population Growth, Millennials, Brain Drain, and the Economy." National Strategic Planning & Analysis Research Center. 19 Jan. 2018.
Penprase BE, Penprase BE. Theories of teaching and learning. STEM Education for the 21st Century. 2020:35-50.
Prinsley RT, Baranyai K. STEM skills in the workforce: what do employers want?. Brisbane: Office of the Chief Scientist. 2013. https://www.chiefscientist.gov.au/sites/default/files/OPS09_02Mar2015_Web.pdf
Rus RC, Yasin RM, Yunus FA, Rahim MB, Ismail IM. Skilling for job: A grounded theory of vocational training at industrial training institutes of malaysia. Procedia-Social and Behavioral Sciences. 2015 Aug 24;204:198-205.
Skinner K. "Who's teaching Mississippi's children? A deep dive into race, gender of state's educators." Mississippi Today. 6 Sep. 2019. https://mississippitoday.org/2019/09/06/whos-teaching-mississippis-children-a-deep-dive-into-teacher-demographics/
Smith SG. Brain Drain in Mississippi: Why Some of the State's Best and Brightest are Leaving. 2018. https://egrove.olemiss.edu/hon_thesis/842/
Strengthening Career and Technical Education for the 21st Century Act, P. L. 115 – 24 § 132 Stat. 2018. https://uscode.house.gov/statutes/pl/115/224.pdf
Tang M, Pan W, Newmeyer MD. Factors influencing high school students' career aspirations. Professional School Counseling. 2008 Jun;11(5).
Valentine KS, Kosloski MF. Developing the Key Constructs of Career Literacy: A Delphi Study. Journal of Research in Technical Careers. 2021 May;5(1):1-22.
Zhou X, Shu L, Xu Z, Padrón Y. The effect of professional development on in-service STEM teachers' self-efficacy: a meta-analysis of experimental studies. International Journal of STEM Education. 2023 Dec;10(1):1-20.

Education as a Tool to Combat HIV Stigma

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ABSTRACT

Background: Historically stigmatized conditions such as mental illness, leprosy, certain cancers, human immunodeficiency virus (HIV), and recently, COVID-19, have resulted in discrimination, even by health care providers. Education for health professions students which includes interaction with patients can be instrumental in decreasing stigma and discrimination. ***Method:*** This single group study utilized pre and posttest scores of Accelerated Bachelor of Science nursing students to measure HIV knowledge, attitudes, perceived discrimination, and equity for people living with HIV (PLWH) after an educational intervention which included interaction with PLWH. Themes from student written reflections were also identified. ***Results:*** There was a significant increase in post-test scores ($p < .001$) of HIV pathology, transmission, and prevention questions. Analysis of attitudes, discrimination, and health and social equity revealed significant differences post-intervention. ***Conclusion:*** Education for nursing students which includes PLWH is an effective model for addressing stigma and discrimination. Patient-centered interventions can address other stigmatized illnesses and be replicated for students of other health professions.

KEYWORDS: AIDS, HIV, stigma, public health, health equity, social equity, transmission, prevention, patient involvement, education

INTRODUCTION

Human Immunodeficiency Virus (HIV) and its associated condition, Acquired Immunodeficiency Syndrome (AIDS), have been U.S. public health concerns for 4 decades. Since the first cases of the then fatal illness, later called AIDS, were reported in the United States in June 1981, more than 700,000 U.S. residents have died of HIV-related diseases (Kaiser Family Foundation, 2021). Currently, there are over one million people living with HIV (PLWH) in the country (CDC, 2019). However, due to early detection, increased knowledge about disease transmission and prevention, and the development of pre-exposure prophylaxis (PrEP) and antiretroviral therapy (ART), HIV-related deaths have decreased since the peak in 1995. In the United States, the number of new HIV infections declined 73% between 1984 and 2019, and the age-adjusted HIV death rate has dropped by more than 80% since 1995 (Bosh et al., 2021). However, despite medical advances, HIV remains one of the top 10 leading causes of death for specific age and racial groups, and rates of diagnoses and mortality for those in the southern region of the United States remain high (Bosh et al., 2020; Kaiser Family Foundation, 2021).

Although prevention tools, early diagnosis, and ART have been instrumental in decreasing HIV diagnoses and death, current HIV statistics suggest barriers to diagnosis, treatment, therapy adherence, and care retention remain. Barriers documented in the literature include lack of transportation, lower levels of education and literacy skills, and provider shortages in rural areas. Economic instability, unemployment, lack of insurance coverage, and even adverse events from ART therapy are additional factors (Dekoven et al., 2016; Chen et al., 2017; CDC, 2019). Further hindering access to treatment and its affordability, several states have not expanded Medicaid, and federal and private funding is low, more so in the southern United States than in other regions of the country (Reif et al., 2017). This is concerning because currently, 8 of the 10 states with the highest numbers of newly diagnosed HIV cases are southern states, most of which are considered rural. In 2012, southern states recorded the highest mortality rates among residents diagnosed with HIV (Reif, et al., 2016). In 2013, 9 states in the "Deep South" (Alabama, Florida, Georgia, Louisiana, Mississippi, North and South Carolina, Tennessee, and Texas) reported 40% of new U.S. HIV diagnoses. In 2017, more new HIV diagnoses were in the South than in all other U.S. regions combined (Centers for Disease Control and Prevention (CDC), 2021), in contrast to the 1980s when the disease had a more significant impact on larger metropolitan areas, primarily on the east and west coasts (CDC, 1982).

Another more veiled impediment to HIV care is the reality of stigma. Rueda et al. (2016) describe HIV stigma as dismissive and discriminatory, marginalizing people diagnosed with or suspected of HIV infection, a condition historically associated with perceived irresponsible behaviors such as intravenous drug use or sexual promiscuity. The stigmatization of HIV and the discrimination that often follows can lead to depression, lower social services usage, and lower medication adherence rates (Rueda et al., 2016). Due to the socially and religiously conservative culture of the southern region of the United States, HIV stigma may be more prevalent, and patients may fear how others perceive them. Discrimination from family, friends, and even health care providers has been documented (Stringer et al., 2016).

One way to assuage societal stigma, which may lead to discrimination against people living with HIV, is to provide training and education to health professions students. Low levels of knowledge about prevention, transmission, and treatment, along with a lack of understanding of the lived experiences of PLWH, can lead to stigmatizing behavior when treating infected patients (Phillips et al., 2018). Although there is ample research about community education and health facility staff training with PLWH as presenters or panelists (Frye et al., 2017), few educational programs in schools of health professions include PLWH as part of the formal curriculum. Therefore, student interaction with PLWH has been limited (Rathbun, et al., 2020).

MATERIALS AND METHODS

During a recent fall semester, a doctoral student in health administration who was also a nurse practitioner treating HIV patients in an infectious disease clinic of a large academic medical center (AMC) in Mississippi, conducted a single group pretest-posttest study involving 45 students enrolled in the final semester of a pre-licensure Accelerated Bachelors of Science in Nursing (BSN) program in the AMC's School of Nursing. Students participated in pretest assessments to measure existing knowledge of HIV, such as prevention strategies, treatment, and transmission risks, attitudes, perceived discrimination, and health and social equity of PLWH. A comprehensive educational intervention module followed.

The educational module included didactic content with interactive discussions and activities developed in a digital instructional platform that allowed quizzing and polling. While the first portion of the educational module focused on the history of the virus, pathogenesis, primary prevention, transmission, diagnosis, and treatment of HIV, the final portion of the educational experience included a panel of patient volunteers, all PLWH, who interacted with the students. Before the panel discussion, students were asked to develop questions about the lived experiences of PLWH. The students' questions were presented to the panel of PLWH, and students were encouraged to interact with panelists. The panel was diverse, representing a variety of races, genders, sexual orientations, geographical residences, and risk factors associated with contracting the virus. Panelists were very transparent with students, relaying their experiences living with HIV. They spoke freely with the students about their diagnosis, medical treatment plan, and the reactions of others toward them. They relayed stories of how stigma has affected their lives and described times they felt discrimination from others, including health care providers. Afterward, a posttest, which included the same questions as the pretest, was completed by students.

Pretest and posttest data were collected using two unique validated instruments. Used for both the pre and post assessment, the first instrument, adapted and used with written permission from developers Carey and Schroder (2002), consisted of questions assessing basic knowledge of HIV prevention, diagnosis, and transmission. The second instrument included in the study's pre and post intervention data collection tool was created by Genberg et al. (2009) to examine stigma related to PLWH/AIDS. Eighteen questions from this instrument were scored on a five-item Likert scale (“strongly agree" = 5 to "strongly disagree" = 1), as students were asked to choose the answer that best aligned with their beliefs about specific statements. Written permission was granted to adapt and use this data collection instrument as well.

RESULTS

The first instrument (Carey and Schroder, 2002) measured knowledge in three domains: HIV transmission, prevention, and acute signs and symptoms of the infection. Total scores on the assessment reflected a significant increase in overall student knowledge after the comprehensive supplemental educational intervention ($p \leq .0.001$). When stratified by questions specifically related to HIV prevention strategies and HIV transmission, a statistically significant increase was also found ($p = .05$ and $p = .01$, respectively). There were not enough questions on the assessment specifically related to recognizing acute signs and symptoms of HIV disease, therefore, a statistical analysis of those data was not performed.

Analysis of responses on the second questionnaire, which assessed students' attitudes, perceived discrimination, and health and social equity for PLWH before and after the educational intervention, revealed a significant increase in awareness of how PLWH may be treated by others (reflecting a deeper understanding of possible discrimination) and beliefs about equitable treatment of PLWH (health and social equity). For example, to the statement “People living with HIV or AIDS should be ashamed,” a decrease in the number of “strongly agree” and “agree” responses on the posttest resulted in a significant difference in the mean scores when compared to the pretest, at the .05 level of significance ($p = .012$). The same result was observed upon analysis of the pre and posttest levels of agreement with "People who have AIDS are disgusting" ($p = .023$).

On the statements related to students’ perceived discrimination of PLWH by others in the community and by patients’ families, analysis of response data suggested a gap in social awareness regarding HIV stigma and possible discrimination that the educational intervention addressed. On the statements, "PLWH or AIDS in this community face neglect from their family," and "PLWH or AIDS in this community face physical abuse," posttest responses were higher than pretest scores and statistically significant at the .05 level ($p = .02$ and $p = .009$ respectively). This higher level of agreement with these statements may suggest a deeper understanding and compassion for the challenges PLWH face.

Upon completion of the module, students were asked to assess the instructor's knowledge of the topic, the educational content, delivery methods, and value. Quantitative scores on the assessment were very high, and students provided written reflections on their learning experience. Two themes that emerged from the student reflections were the importance of the patient's experience living with HIV and the student’s own potential bias about HIV and its related conditions. Sample student responses are presented below:

“There is a huge stigma around HIV/AIDS, and this has helped me recognize my previous bias. I am grateful for the opportunity to learn from and hear from people who have been living with HIV for years.” (Student 1)

“I enjoyed the honest communication with HIV survivors. Before the discussion began, I wanted to feel sorry for them. I am old enough to remember all the stigma attached to HIV/AIDS so I may have a different perspective than the younger members of the class. The open and honest communication helped me understand that they do not want my pity, just my respect." (Student 2)

“It can be very easy to dehumanize diseases when learning about their pathology. It was extremely helpful to hear the thoughts and feelings of PLWH, and I will definitely take what I learned from them and this module into my practice.” (Student 3)

DISCUSSION

One of the aims of the educational intervention in this study was addressing the stigma related to one particular medical diagnosis, HIV infection, which may lead to discrimination against PLWH. However, research reveals that patients may face the same when diagnosed with other stigmatized conditions such as obesity, certain cancers, mental illness, and, more recently, COVID-19 (Puhl and Brownell, 2003; Pescosolido, 2013; Ernst et al., 2017; American Psychological Association [APA], 2020). Stigma plays a role in delayed diagnoses, as individuals may conceal symptoms to evade discrimination, which undermines treatment and eventually poses public health risks (Nyblade et al., 2019; APA, 2020). This study confirms previous research which has found that by including patients and their lived experiences in health professions curricula, students may be less likely to form biases and display stigmatizing attitudes and behaviors, becoming more knowledgeable, compassionate, person-centered caregivers (Patten et al., 2012; Martinez-Martinez et al., 2019).

CONCLUSION

Utilizing patients and their experiences to educate health professions students has been documented for decades; however, research has revealed that most educational initiatives involving patients are not standardized nor assessed and do not involve a standard vocabulary nor interactivity between the patient and learner (Towle, et al., 2010). Active patient participation in the formal healthcare curricula may foster collaborative, compassionate, patient-centered care, and as suggested by the findings of the current study, may also cultivate a more empathetic healthcare workforce.

LITERATURE CITED

American Psychological Association. Combating bias and stigma related to COVID-19. March 25 2020. https://www.apa.org/topics/covid-19/bias

Bosh KA, Johnson AS, Hernandez AL, Prejean J, Taylor J, Wingard R., Valleroy, L.A, Hall I. Vital signs: Deaths among persons with diagnose HIV infection—United States, 2010–2018 Morbidity and Mortality Weekly Report. 2020; 69(46). Centers for Disease Control and Prevention. http://dx.doi.org/10.15585/mmwr.mm6946a1

Bosh KA, Hall HI, Eastham L, Daskalakis, DC, Mermin JH. Estimated annual number of HIV infections—United States, 1981–2019 Morbidity and Mortality Weekly Report. 2021; 70(22). Centers for Disease Control and Prevention. http://dx.doi.org/10.15585/mmwr.mm7022a1

Carey MP, Schroder KE. Development and psychometric evaluation of the brief HIV Knowledge Questionnaire. AIDS education and prevention: Official publication of the International Society for AIDS Education. 2002; 14(2): 172–182. https://doi.org/10.1521/aeap.14.2.172.23902

Centers for Disease Control and Prevention. HIV Surveillance Supplemental Report 2019. May 2021; vol. 32. http://www.cdc.gov/hiv/library/reports/hiv-surveillance.html.

Centers for Disease Control and Prevention. Diagnose and treat to save lives: Decreasing deaths among people with HIV. 2020; https://www.cdc.gov/hiv/statistics/deaths/index.html

Centers for Disease Control and Prevention. Update on acquired immune deficiency syndrome (AIDS)--United States. Morbidity and Mortality Weekly Report. 1982; 31(37): 507–514. https://pubmed.ncbi.nlm.nih.gov/6815471/

Chen Y, Chen K, Kalichman SC. Barriers to HIV medication adherence as a function of regimen simplification. Annals of Behavioral Medicine. 2017; 51(1): 67–78. https://doi.org/10.1007/s12160-016-9827-3

Ernst J, Mehnert A, Dietz A, Hornemann B, Esser P. Perceived stigmatization and its impact on quality of life: Results from a large register-based study including breast, colon, prostate and lung cancer patients. BMC Cancer. 2017; 17(1): 741. https://doi.org/10.1186/s12885-017-3742-2

Frye V, Paige MQ, Gordon S, Matthews D, Musgrave G, Kornegay M, Greene E, Phelan JC, Koblin BA, Taylor-Akutagawa V. Developing a community-level anti-HIV/AIDS stigma and homophobia intervention in New York City: The project CHHANGE model. Evolution and Program Planning. 2017; 63: 45-53. http://dx.doi.org/10/1016/j.evalprogplan.2017.03.004

Genberg B L, Kawichai S, Chingono A, Sendah M, Chariyalertsak S, Konda KA, Celentano D. Assessing HIV/AIDS stigma and discrimination in developing countries. AIDS and Behavior. 2008; 12(5): 772–780. https://doi.org/10.1007/s10461-007-9340-6

Kaiser Family Foundation. The HIV/AIDS epidemic in the United States: The basics. June 7, 2021; https://www.kff.org/hivaids/fact-sheet/the-hivaids-epidemic-in-the-united-states-the-basics/

Martínez-Martínez C, Sánchez-Martínez V, Sales-Orts R, Dinca A, Richart-Martínez M, Ramos-Pichardo JD. Effectiveness of direct contact intervention with people with mental illness to reduce stigma in nursing students. International Journal of Mental Health Nursing. 2019; 28(3):735-743. https://doi.org/10.1111/inm.12578

Nyblade L, Stockton MA, Giger K, Bond V, Ekstrand ML, Lean RM, Mitchell E, Nelson RE, Sapag JC, Siraprapasiri T, Turan J, Wouters E. Stigma in health facilities: Why it matters and how we can change it. BMC Medicine. 2019; 17(1): 25. https://doi.org/10.1186/s12916-019-1256-2

Patten SB, Remillard A, Phillips L, Modgill G, Szeto A, Kassam A, Gardner DM. Effectiveness of contact-based education for reducing mental illness-related stigma in pharmacy students. BMC Med Edu. 2012; 12(120): 1-9. https://doi.org/10.1186/1472-6920-12-120

Pescosolido BA. The public stigma of mental illness: what do we think; what do we know; what can we prove? Journal of Health and Social Behavior. 2013; 54(1): 1–21. https://doi.org/10.1177/0022146512471197

Phillips JC, Cain V, Dewart G, De Padua A, de la Cruz AM, Rickards T, McGinn M, Cator V, Pauly B, Gagnon M. Teaching HIV-specific content for pre-licensure nursing and health professions students: a review and synthesis. AIDS Care. 2018; 30(12): 1614-1621. http://doi.org.10.1080/09540121.2018.1510108

Puhl R, Brownell KD. Ways of coping with obesity stigma: review and conceptual analysis. Eating Behaviors. 2003; 4(1): 53–78. https://doi.org/10.1016/s1471-0153(02)00096-x

Rathbun RC, Durham SH, Farmer KC, Zuckerman AD, Badowski ME. Evaluation of human immunodeficiency virus curricular content in schools of pharmacy in the United States. Currents in Pharmacy Teaching and Learning. 2020; 12(8): 910-917. https://www.sciencedirect.com/science/article/pii/S1877129720301222

Reif SS, Safley D, Wilson E, Whetten K. HIV/AIDS in the U.S. deep south: Trends from 2008-2013. Southern HIV/AIDS Strategy Initiative. Center for Health Policy and Inequities Research, Duke University. 2016; https://southernaids.files.wordpress.com/2011/10/hiv-aids-in-the-us-deep-south-trends-from-2008-2013.pdf

Reif S, Safley D, McAllister C, Wilson E, Whetten K. State of HIV in the U.S. deep south. Journal of Community Health. 2017; 42(5): 844-853. doi:10.1007/s10900-017-0325-8.

Rueda S, Mitra S, Chen S, Gogolishvili D, Globerman J, Chambers L, Wilson M, Logie CH, Shi Q, Morassaei S, Rourke SB. Examining the associations between HIV-related stigma and health outcomes in people living with HIV/AIDS: A series of meta-analyses. British Medical Journal. 2016; 6(7). e011453. doi: 10.1136/bmjopen-2016-011453.

Stringer KL, Turan B, McCormick L, Durojaiye M, Nyblade L, Kempf MC, Lichenstein B, Turan JM. HIV-related stigma among healthcare providers in the deep South. AIDS and Behavior. 2016; 20:115-125. https://link.springer.com/article/10.1007/s10461-015-1256y

Towle A, Bainbridge L, Godolphin W, Katz A, Kline C, Lown B, Madularu I, Solomon P, Thistlethwaite J. Active patient involvement in the education of health professionals. Medical Education. 2009; *44*(1): 64-74. https://doi.org/10.1111/j.1365-2923.2009.03530.x

CARES Online High School Course Project

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ABSTRACT

The CARES Online High School Course Project was funded to produce courses to assist high schools across Mississippi with challenges to in-class instruction such as a pandemic, natural disaster, or other disruptions. The courses are AP Computer Science, Biology I, CCR English I, CCR English II, CCR English III, CCR English IV, Chemistry, Exploring Computer Science, Foundations of Algebra, Foundations of Biology, US History, US Government, and World History. The courses were prepared in Canvas and include an instruction manual called a "Teacher Resource Guide" as well as a Course Map connecting each course component to the appropriate state education standard. The courses developed from the CARES Online High School Course Project are freely available to Mississippi high school teachers at ***helpdesk@rcu.msstate.edu***.

KEYWORDS: On-line, High School, CARES ACT, Canvas Course

KEYWORDS: On-line High School

BACKGROUND

In response to the Coronavirus pandemic, Mississippi Governor Tate Reeves announced a statewide school closure in March of 2020 that stayed in effect through the remainder of the Spring and Summer sessions. Many teachers found themselves working from home without training or materials to prepare them for online teaching. Educators realized Mississippi needed a set of prepared online courses for teachers to use when confronted with barriers to traditional face-to-face instruction.

The Mississippi State University Research and Curriculum Unit was especially well-prepared to address the problem. Since 1965 the MSU-RCU had been partnering with K-12 educators, higher education, and industry to develop programs, curricula, training, and assessments resulting in an educated and prepared workforce. The MSU-RCU was able to quickly apply and receive funding from the Governor's office to create a set of online course materials. These resources are designed to be freely accessible to teachers, customizable by educators, open-source, highly engaging (Guo et al., 2015), and cover a wide range of general high school courses.

Funding came from the Coronavirus Aid, Relief, and Economic Security (CARES) Act Education Stabilization Fund ((SUMMARY OF HIGHER EDUCATION PROVISIONS IN H.R. 748, THE CORONAVIRUS AID, RELIEF, AND ECONOMIC SECURITY (CARES) ACT), thus the project was titled the "CARES Online High School Course Project". The U.S. Department of Education awarded CARES funds through the Governor's Emergency Education Response (GEER) Fund by formula to the nation's Governors in 2020 and 2021. The CARES Online High School Course Project was funded to produce courses to assist high schools across Mississippi with challenges to in-class instruction such as a pandemic, natural disaster, or other disruptions.

The CARES Online High School Course Project produced thirteen courses that are freely available to assist high schools across Mississippi with challenges to in-class instruction. The courses are AP Computer Science, Biology I, CCR English I, CCR English II, CCR English III, CCR English IV, Chemistry, Exploring Computer Science, Foundations of Algebra, Foundations of Biology, US History, US Government, and World History. The courses were prepared in Canvas and include an instruction manual called a "Teacher Resource Guide" as well as a

Course Map connecting each course component to the appropriate state education standard. These courses are considered "turn-key" courses because they are ready to be used for instruction without any additional changes. Schools will find these courses an excellent resource for new teachers or teachers who are new to a subject. The courses developed from the CARES Online High School Course Project are available to Mississippi high school teachers at ***helpdesk@rcu.msstate.edu***.

COURSE DEVELOPMENT TEAM

The MSU-RCU group consisted of Sean Owen as Principal Investigator (PI), Ben Alexander as Co-PI (Alexander et al. 2020), Avery Adkins as Project Manager and Online Learning Specialist, and Katie Bookser as Actor and Videographer. The course contents were organized and prepared by high School teachers who had been recognized for exceptional teaching and who were recruited as Content Specialists. Each Content Specialist prepared an online high school course in Canvas along with an instruction manual called a "Teacher Resource Guide."

COURSE EXAMPLE

The courses developed from the CARES Online High School Course Project are freely available to Mississippi high school teachers at ***helpdesk@rcu.msstate.edu*** (Table 1).

Demonstration viewings of three courses are available:

1. Biology I: https://rcumsu.instructure.com/courses/27
2. English IV: https://rcumsu.instructure.com/courses/30
3. Foundations of Algebra: https://rcumsu.instructure.com/courses/28

The Teacher Resource Guides associated with each course are available as supplementary files.

Each Teacher Resource Guide describes how to use the Canvas course and details the contents of the course (Fig.1).

Table 1

Course name	Course Duration (semesters)
1. AP Computer Science	1
2. Biology I	2
3. CCR English I	1
4. CCR English II	1
5. CCR English III	1
6. CCR English IV	1
7. Chemistry	2
8. Exploring Computer Science	1
9. Foundations of Algebra	1
10. Foundations of Biology	2
11. US History	1
12. US Government	1
13. World History	2

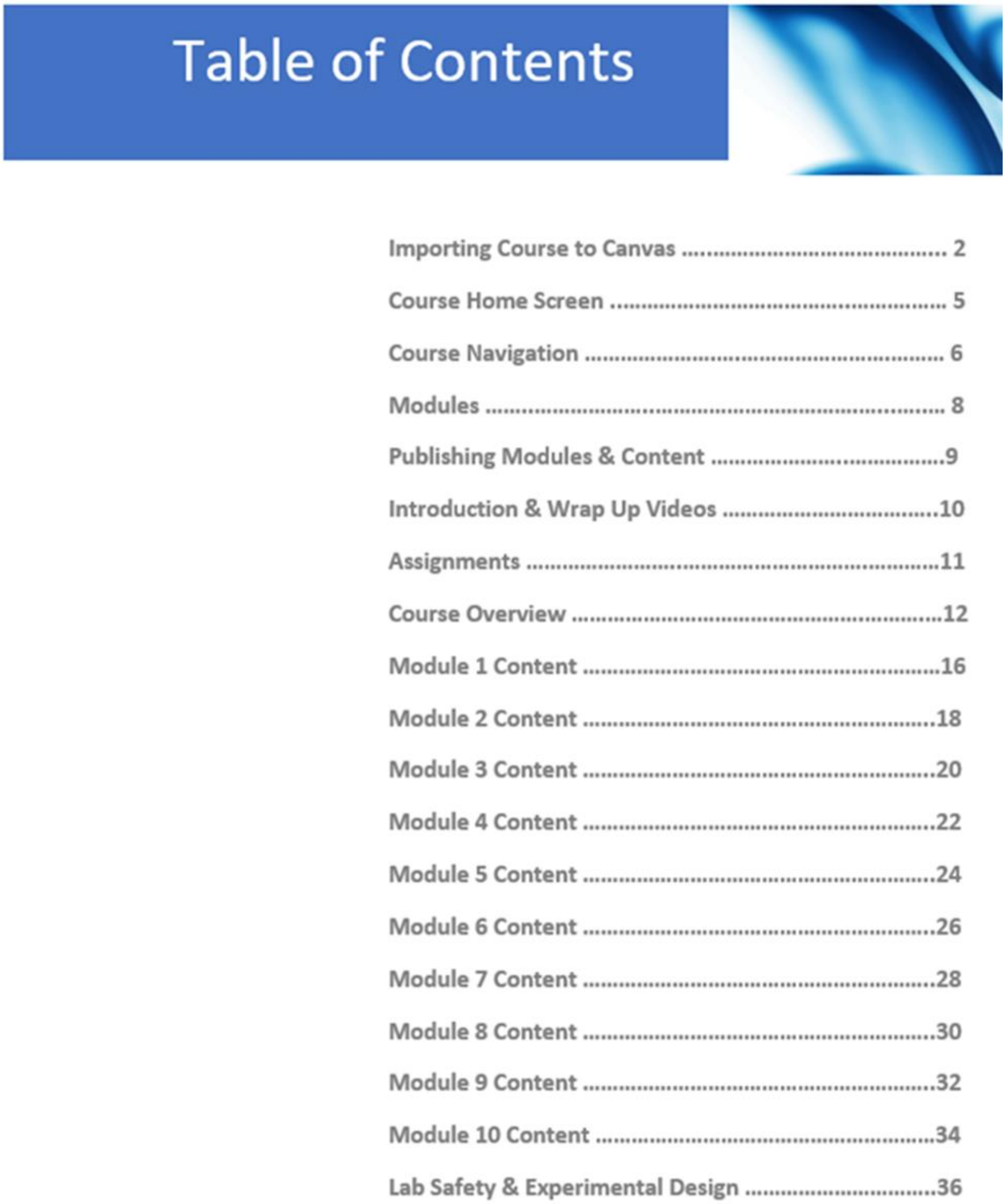


Table of Contents

Figure 1. An example table of contents from the course "Chemistry".

The first sections of the Teacher Resource Guide explain how to work in Canvas.

1. **Importing Course to Canvas.** In course navigation, click the **Settings link.** Click the **Import Course Content** link in the top right corner of the Settings page. In the Content Type drop-down menu, choose the **Canvas Course Export Package** option. Click the **Choose File** button. Choose the .imscc file to import. For example, the Canvas course file for Biology I is labelled "cares-template-biology-export.imscc". Click the **Open** button. To import ALL content from the course, select the **All Content** radio button. To adjust the due dates associated with the course events and assignments, click the **Adjust events and due dates** checkbox. Click the Import button. A progress indicator

displays the upload status by percentage. The Current Jobs section displays the status of the import(s). View the content from any completed imports by accessing any link in the Course Navigation.

2. **Course Home Screen.** Teachers, students, and parents will see this screen when they enter the course (Fig. 2). Each of the graphics under **Quick Links** automatically takes one to the important parts of the course. Tips are included, such as "always let students know that they need to access the course through the Modules tab. This will help them see the layout and flow of the course in the way it was intended to be seen".

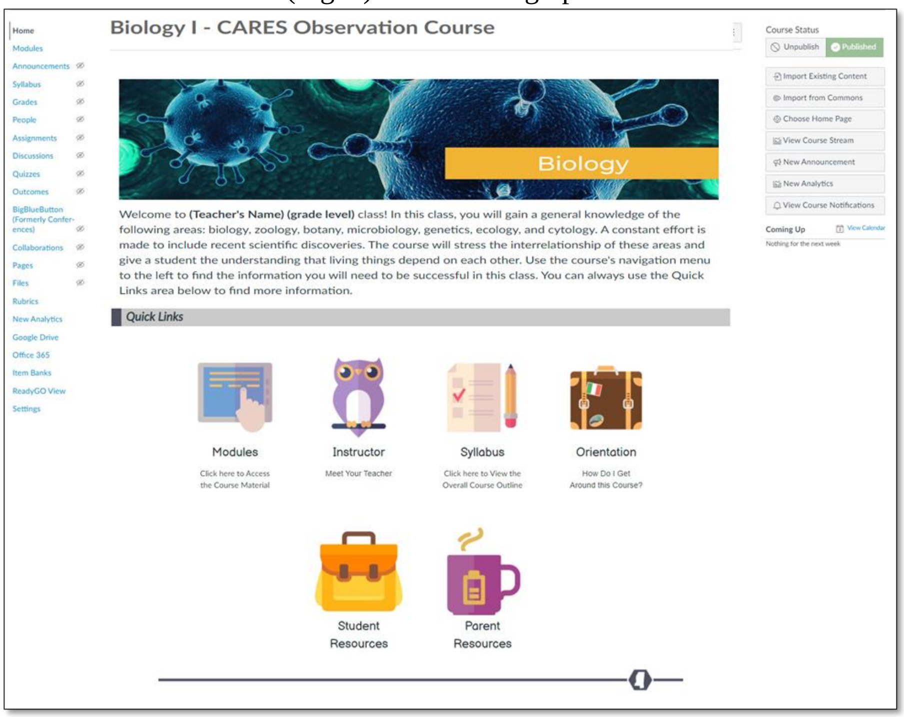


Figure 2. An example home page from the course "Chemistry."

Figure 3. An example navigation of the course navigation menu. It will be found on the left side of the Home Page.

3. **Course Navigation. This section explains that** there can be too many links in this section for most students to manage, which can lead to confusion. One can easily simplify this menu (Fig. 3) for students based on what the needs will be. If one chooses to hide items from the navigation, one will not be deleting them from the course. In the course navigation, click **Settings.** At the top of the page, click the **Navigation** tab to access the menu items. Be sure to click **Save** when completed with the menu.

4. **Modules.** The Modules within this course are designed to cover every standard within the course's curriculum. Most of the modules found within the courses will have smaller lessons inside of them. It is important for students to see and understand how the modules look (Fig. 4). The flow of each lesson was designed within the Modules section of Canvas. The courses have icons within each module. Below, is a key to explain each icon's meaning (Fig. 5).

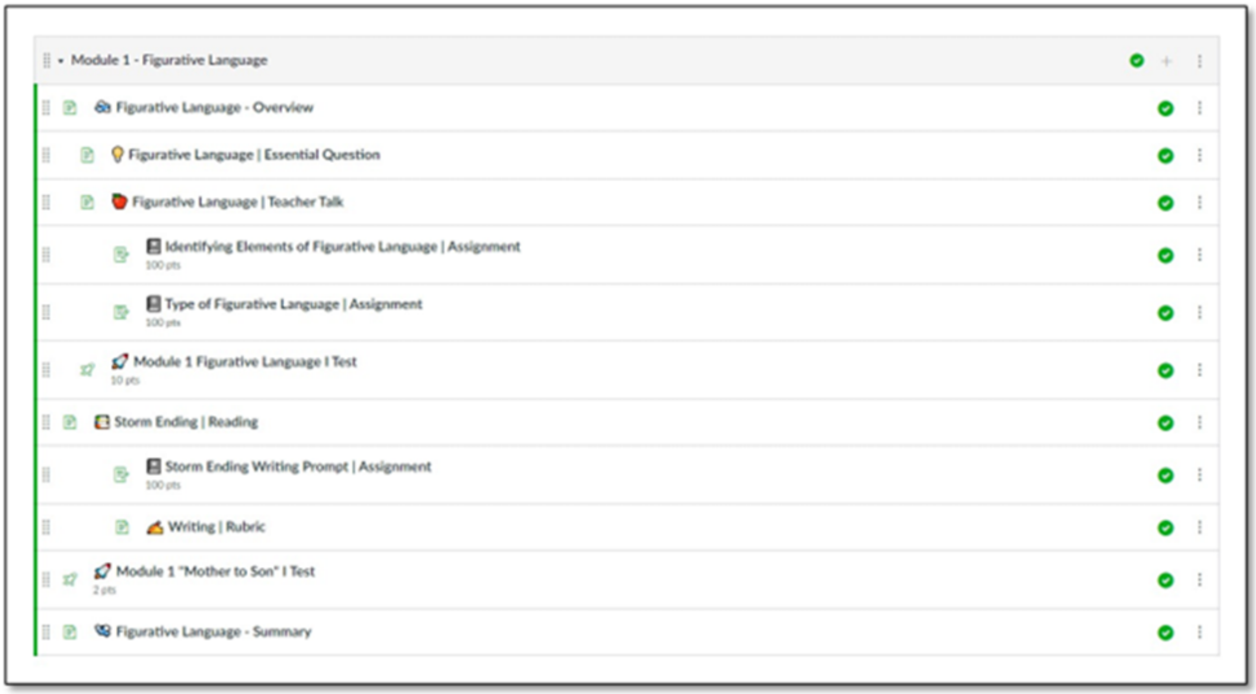


Figure 4. An example module page from the course "Chemistry."

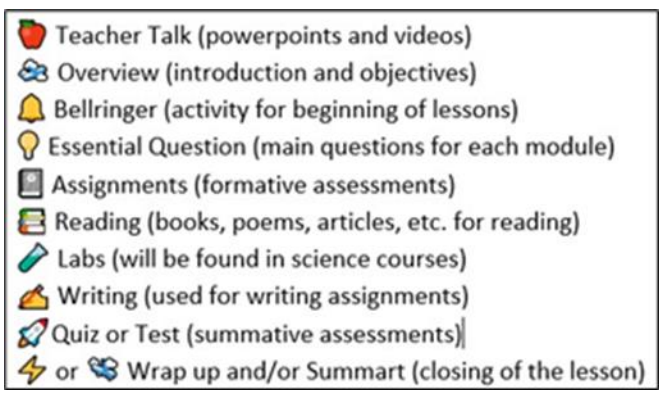


Figure 5. The icons used in the Canvas courses.

5. **Publishing Modules & Content.** Each module will need to be published for the students to see the content within it. If the module is not published, the students will **NOT** be able to see anything inside of it **EVEN IF** the content is published (Fig. 6). There will be a green check mark at the top of the module if it is published.

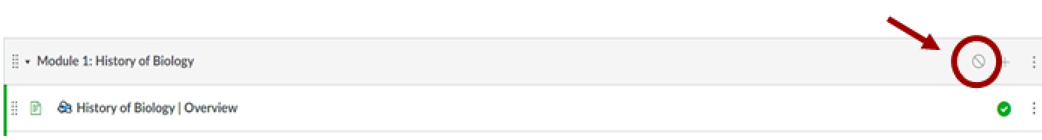


Figure 6. A module will not be visible to students when it has a red check mark to the right of the module name.

Publishing content works the same way as publishing the module. One can click or unclick the published button to the right of each piece of content within the module (Fig. 7). This gives one the option to only show parts of the module if needed.

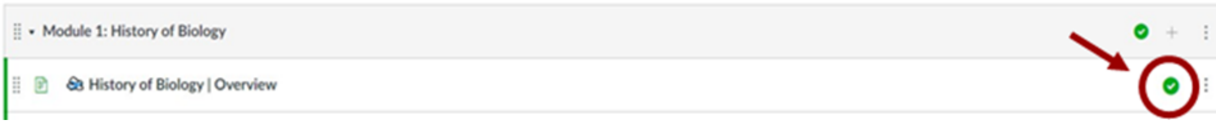


Figure 7. A module with a green check mark will be visible to students. Content must also have a green check mark to the right side to be published.

6. **Introduction and Wrap-up videos.** Every module will have an *Introduction Video* and a *Wrap Up Video*. These videos will be embedded into the **Overview** and **Wrap Up** sections as YouTube videos. This was designed to help the students get a clearer understanding of the educational expectations for each module. Below is an example of what the embedded videos will look like (Fig. 8).

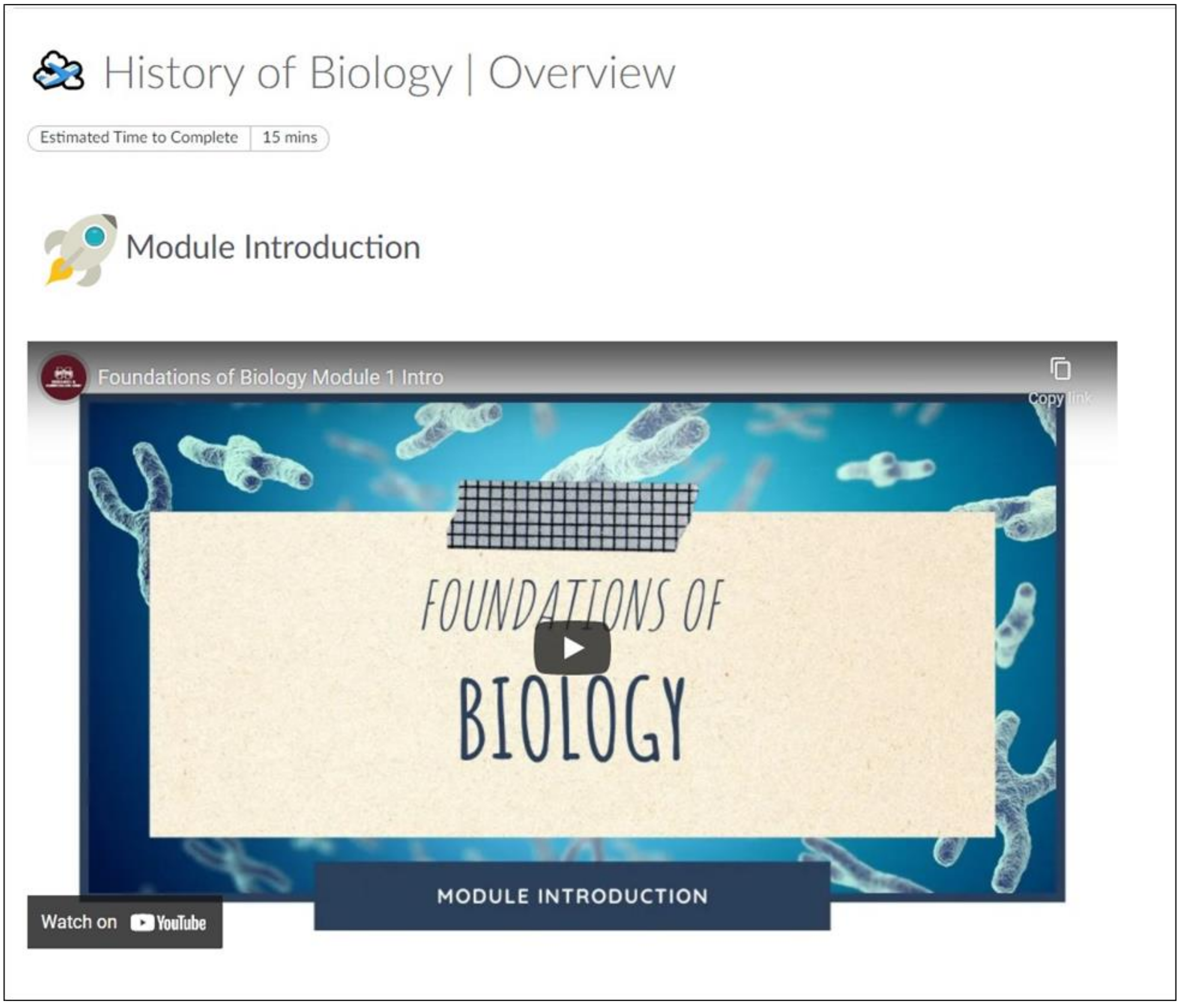


Figure 8. An example of the embedded videos from the course "Foundations of Biology."

7. **Assignments.** Every assignment that has been created within these courses can be adjusted to one's liking. All assignments use links to *Adobe Acrobat PDF files*, *Google*

Docs, or *Word Documents*. If one chooses to change the style of the assignment, it is possible to download the assignment and save it in another format. The assignments will come without any specific settings. When one clicks **Edit** in the top right corner of the assignment, it will move to a screen that allows one to change anything within the assignment. One can **adjust these settings** to one's liking by changing the point value, assignment group, grade display, submission type, allowed attempts, due dates, and what group of students to whom it is assigned. If one wants it to be **a group assignment**, one can click the box and form groups within the class. One can also make an assignment a Peer Reviewed assignment. This will be helpful when wanting feedback from students. It is necessary to click **Save** when done adjusting the settings.

8. **Course Overview.** This section is provided to summarize the course for students. Here is an example from the course "Chemistry":

This online Chemistry course is organized into 12 Modules that map directly to the Mississippi College and Career Readiness standards for Chemistry. The standards and the detailed matching course components are shown as a "Course Map" in the Canvas course.

The Modules only are listed here:

1. Mathematical and Computational Analysis
2. Atomic Theory and Structure
3. Periodic Table
4. Bonding
5. Naming Compounds
6. Chemical Reactions
7. Gas Laws
8. Solutions
9. Acids and Bases (Enrichment)
10. Thermochemistry (Enrichment)
11. Equilibrium (Enrichment)
12. Organic Nomenclature (Enrichment)

Each Module contains these items, designed to be used in this order:

1. Introductory videos for each topic (can be used in class or for pre-class homework),
2. Readings in the free online textbook, Chemistry: Atoms First 2e
3. Slide sets that support the textbook readings (these slide sets are the traditional classroom teaching material and they have completed example problems from the textbook),
4. Canvas practice quizzes, homework sets, online simulations and other follow-up activities for each topic that include problems from the textbook (can be used in class or for homework,
5. Canvas graded Module Examination quizzes that include versions of problems from the slide sets and practices quizzes.
6. Concepts are first introduced in videos, then reinforced in textbook readings, classroom slides, slide set problems, Canvas activities, and finally assessed in Module Examinations, providing students with up to five times repeated exposure and practice before being assessed.

Pacing guides are included to suggest the relative length of time needed for individual modules (Table 2). Based on the school setting, the need for review and midterm/final exam days may be adjusted or removed. One will want to learn the state test date (or testing window) as soon as possible. Knowing this date early on can help one adjust if there is more or less time prior to state testing than what is shown above. When pacing for the term, be sure to account for potential interruptions such as holidays, major sporting events, homecoming week, inclement weather, and benchmark testing (e.g., Case 21, ELS, NWEA).

Tips are included, such as this from the course “Chemistry”: It is better to leave a few days of “wiggle room” at the end of a term so that if a module is interrupted (or needs to be lengthened for remediation or review), one can extend without “borrowing time” from other modules. If there is extra time at the end of a term, one can always fill with additional activities.

Table 2. A sample pacing guide from the course “Chemistry.”

Concept	**Year-Round Schedule (180 days, 45–60 minute class time)**	**Block Schedule (90 days, 90-120 minute class time)**
Back to School, Lab Safety & Inquiry	10 days	5 days
Module 1: Macromolecules	12 days	6 days
Module 2: Cellular Structure & Function	14 days	7 days
Module 3: Cellular Transport	12 days	6 days
Module 4: The Cell Cycle & Cell Division	15 days	7 days
Module 5: Genetics	10 days	5 days
Module 6: Complex Genetics	10 days	5 days
Review & Midterms	*7 days (90 days total)*	*4 days (45 days total)*
Module 7: Central Dogma	17 days	8 days
Module 8: Photosynthesis & Respiration	11 days	5 days
Module 9: Evolution	14 days	6 days
Module 10: Ecology	16 days	8 days
Review for State Test	*15 days*	*7 days*
State Test to Finals	*10 days*	*9 days*
Finals	*7 days (90 days total)*	*2 days (45 days total)*

9. **Module Contents.** This section is where the course resources are arranged for students to view. An example from the course “Chemistry” is shown (Fig. 9). Key terms are also provided in this section. Only the first ten are shown from the course “Chemistry.”

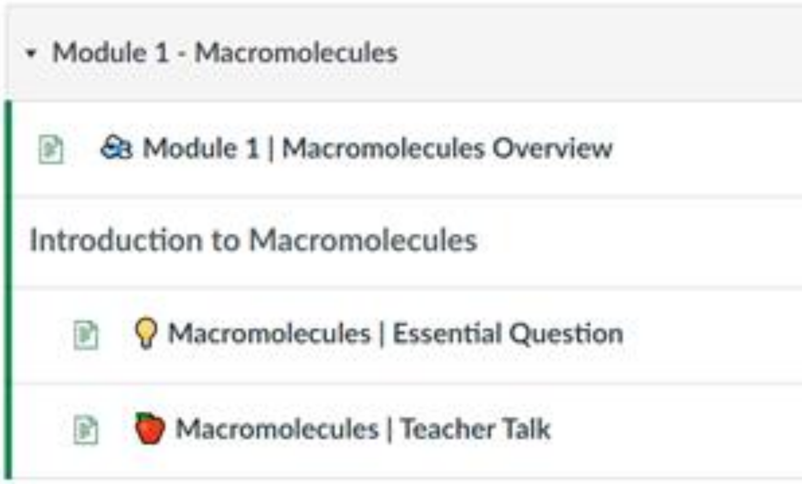


Figure 9. An example of the module contents from the course "Chemistry."

1. **Anion** - negatively charged atom or molecule (contains more electrons than protons)
2. **Atom** - smallest particle of an element that can enter into a chemical combination.
3. **atomic mass** - average mass of atoms of an element, expressed in amu
4. **atomic number (Z)** - number of protons in the nucleus of an atom
5. **atomic orbital** - mathematical function that describes the behavior of an electron in an atom (also called the wavefunction)
6. **Bohr's model of the hydrogen atom** - structural model in which an electron moves around the nucleus only in circular orbits, each with a specific allowed radius
7. **Cation** - positively charged atom or molecule (contains fewer electrons than protons)
8. **Celsius (°C)** - unit of temperature; water freezes at 0 °C and boils at 100 °C on this scale
9. **chemical change** - change producing a different kind of matter from the original kind of matter
10. **chemical property** -behavior that is related to the change of one kind of matter into another kind of matter

A set of Guiding Questions are provided to promote discussion in class. Examples from the course "Chemistry" include:

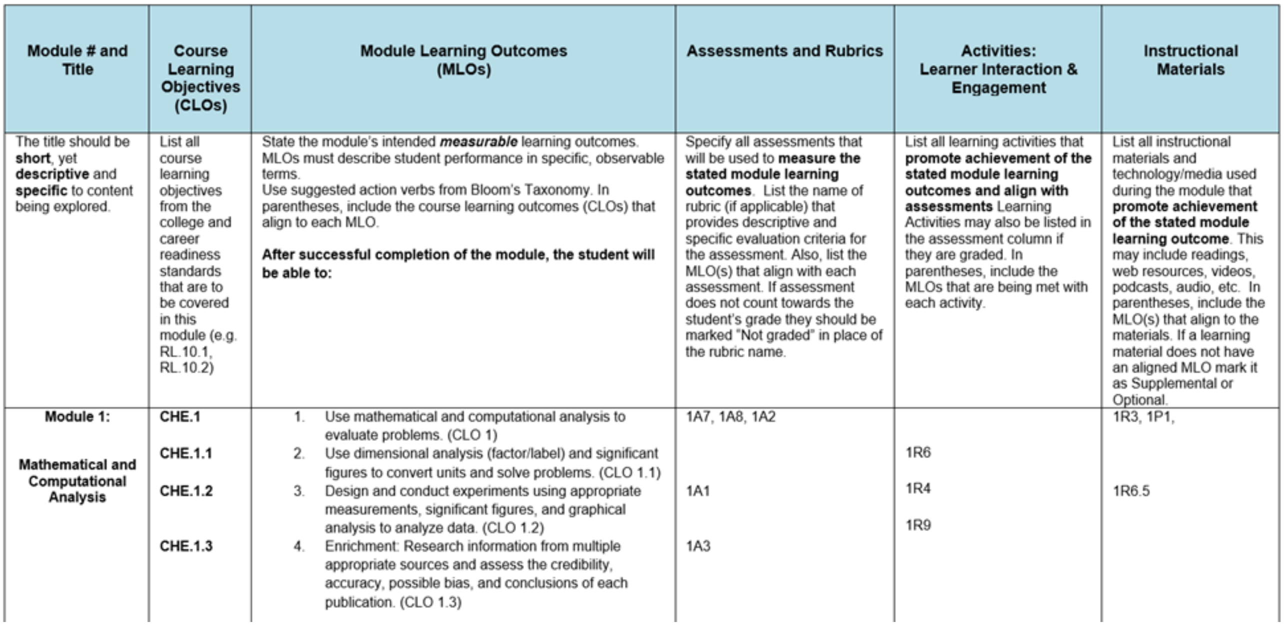
1. Describe the structure (elements found within) of the four major types of macromolecules.
2. What do the four types of macromolecules look like in diagrams?
3. What are the monomers and polymers for each of the macromolecules?
4. Provide examples (as molecules and in foods, where appropriate) of each of the four major types of macromolecules.
5. What are the functions of the four major types of macromolecules?
6. How do enzymes interact with substrates? How do they influence biological chemical reactions?
7. Explain the lock-and-key analogy with enzymes.
8. How do various environmental conditions impact enzyme function?

A set of Common Misconceptions and Challenges are listed. Examples from the course "Chemistry" include:

1. This is a challenging module because students have little to no background in chemistry prior to this course, and there is a lot of new vocabulary. Allow time for vocabulary review and interactive games (especially with students in pairs or small groups) to help students build confidence with the terminology. Getting students to say the words aloud or talk about the terms in context will help with confidence and retention.
2. Because of diet trends and marketing, students may have misunderstandings about what different macromolecules do for our bodies (e.g., assuming proteins are a preferred energy source) or that certain macromolecules are good or bad (because of low-carb or low-fat diet trends).
3. Frequently reinforce the many benefits each group provides for living things and maintain positive language when discussing different macromolecule categories.
4. Nearly all students struggle to visualize what these molecules look like (because they have little to no background in chemistry).
5. Be sure to provide several examples of atomic models and help students identify trends and patterns in molecule diagrams so they are not overwhelmed by these images. For example, show a molecular diagram of a carbohydrate and lipid side-by-side so students can make comparisons (similar elements, very different quantities, and arrangements).
6. The more students are involved in generating these connections, the better their understanding will be.

10. Lab Safety & Experimental Design. This section is found in laboratory courses such as Chemistry and Biology. The content can be used as a guide for reviewing lab safety, equipment, and experimental design. One may present to students in whatever format that is most useful -- these pages are meant to supplement class discussions and activities for these topics. This information is not mandatory in the state curriculum but will support the science and engineering practices which are interwoven into the Biology and Chemistry standards.

In addition to Teacher Resource Guides, a separate set of documents called Course Map Guides are included. Course Map Guides detail the connection between each state education standard and the course components (Fig 10).



Module # and Title	Course Learning Objectives (CLOs)	Module Learning Outcomes (MLOs)	Assessments and Rubrics	Activities: Learner Interaction & Engagement	Instructional Materials
The title should be **short**, yet **descriptive** and **specific** to content being explored.	List all course learning objectives from the college and career readiness standards that are to be covered in this module (e.g. RL.10.1, RL.10.2)	State the module's intended ***measurable*** learning outcomes. MLOs must describe student performance in specific, observable terms. Use suggested action verbs from Bloom's Taxonomy. In parentheses, include the course learning outcomes (CLOs) that align to each MLO. **After successful completion of the module, the student will be able to:**	Specify all assessments that will be used to **measure the stated module learning outcomes**. List the name of rubric (if applicable) that provides descriptive and specific evaluation criteria for the assessment. Also, list the MLO(s) that align with each assessment. If assessment does not count towards the student's grade they should be marked "Not graded" in place of the rubric name.	List all learning activities that **promote achievement of the stated module learning outcomes and align with assessments** Learning Activities may also be listed in the assessment column if they are graded. In parentheses, include the MLOs that are being met with each activity.	List all instructional materials and technology/media used during the module that **promote achievement of the stated module learning outcome**. This may include readings, web resources, videos, podcasts, audio, etc. In parentheses, include the MLO(s) that align to the materials. If a learning material does not have an aligned MLO mark it as Supplemental or Optional.
Module 1: **Mathematical and Computational Analysis**	**CHE.1** **CHE.1.1** **CHE.1.2** **CHE.1.3**	1. Use mathematical and computational analysis to evaluate problems. (CLO 1) 2. Use dimensional analysis (factor/label) and significant figures to convert units and solve problems. (CLO 1.1) 3. Design and conduct experiments using appropriate measurements, significant figures, and graphical analysis to analyze data. (CLO 1.2) 4. Enrichment: Research information from multiple appropriate sources and assess the credibility, accuracy, possible bias, and conclusions of each publication. (CLO 1.3)	1A7, 1A8, 1A2 1A1 1A3	1R6 1R4 1R9	1R3, 1P1, 1R6.5

Figure 10. An example of a Course Map Guide from the course "Chemistry." An abbreviated version is shown here. Full map guides are available through the MSU-RCU link in the abstract.

LITERATURE CITED.

Alexander B, Owen S, Thames C. Exploring differences and relationships between online formative and summative assessments in Mississippi career and technical education. Asian Association of Open Universities Journal. 2020; 15(3):335–349.

Guo P, Kim J, Rubin R. How video production affects student engagement: an empirical study of MOOC videos. Proceedings of the first ACM conference on Learning @ scale conference. 2014; 41-50.

SUMMARY OF HIGHER EDUCATION PROVISIONS IN H.R. 748, THE CORONAVIRUS AID, RELIEF, AND ECONOMIC SECURITY (CARES) ACT. [accessed 2023 Aug 11]. https://www.acenet.edu/Documents/Summary-CARES-Act-HigherEd-Provisions-032620.pdf.

SUPPLEMENTS INFORMATION

https://msacad.org/wp-content/uploads/2023/12/Teacher-Resource-Guide-AP-Computer-Science.pdf

https://msacad.org/wp-content/uploads/2023/12/Teacher-Resource-Guide-Chemistry.pdf

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- One inch margins on 8.5 x 11 inch paper;
- Text should be left-justified using twelve point type;
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- To begin a sentence (Twenty-one species were found in…)
- When 2 numeric expressions are adjacent in a sentence. The number easiest to express in words should be spelled out and the other left in numeric form (The sections were divided into eight 4-acre plots.).
- Measurements and physical symbols or units shall follow the International System of Units (SI *Le Système international d'unités*) with metric units stated first, optionally followed by United States units in parentheses. *E.g.*: xx grams (xx ounces); and
- Avoid personal pronouns.

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Abstract. In 250 or fewer words summarize any new methods or procedures critical to the results of the study and state the results and conclusions.

Introduction. Describe the knowledge and literature that gave rise to the question examined by, or the hypothesis posed for the research.

Materials and methods. This section should describe the research design, the methods and materials used in the research (subjects, their selection, equipment, laboratory or field procedures), and how the findings were analyzed.

Results. The text of the results should be a descriptive narrative of the main findings, of the reported study. This section should not list tabulated data in text form. Reference to tables and figures included in this section should be made parenthetically in the text.

Discussion. In this section compare and contrast the data collected in the study with that previously reported in the literature. Unless there are specific reasons to combine the two, as explained by the author in the letter of transmittal, Results and Discussion should be two separate sections.

Acknowledgments. Colleagues and/or sources of financial support to whom thanks are due for assistance rendered in completion of the research or preparation of the manuscript should be recognized in this section rather than in the body of the text.

Literature cited. List references alphabetically. Cite references in the text by author and year of publication (e.g., Smith, 1975; Black and Benghuzzi, 2011; Smith et al., 2010; Smith, 2011a, 2011b). The following examples illustrate the style to be used in the literature list.

Black DA, Lindley S, Tucci M, Lawyer T, Benghuzzi H. A new model for the repair of the Achilles tendon in the rat. J Invest Surg. 2011; 24(5): 217-221.

Pearson HA, Sahukhal GS, **Elasri** MO, Urban MW. Phage-bacterium war on polymeric surfaces: can surface-anchored bacteriophages eliminate microbial infections? Biomacromolecules. 2013 May 13;14(5):1257-61.

Bold, H.C., C.J. Alexopoulos, and T. Delevoryas. 1980. Morpholgy of plants and fungi, 4th ed. Harper and Row, New York. 819 pp

Web-page

- name of author(s) -if known
- title of the work - in quotes, if known
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Ackermann, Ernest. "Writing Your Own Web Pages." *Creating Web Pages*. 23 Oct. 1996. http://people.umw.edu/~ernie/writeweb/writeweb.html 10 Feb. 1997.

File available by anonymous FTP

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- Date accessed

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American Civil Liberties Union. "Briefing paper Number 5, Drug Testing in the Work Place." 19 Nov. 1992. ftp://ftp.eff.org/pub/Privacy/Medical/aclu_drug_testing_workplace.faq
13 Feb. 1997.

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