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Editor's Note

Welcome to the Spring issue [volume 23 (1)] of the *Inquiry Journal*. At the outset, we would like to thank Dr. Margaret Sova McCabe, Interim Vice Chancellor of the Division of Research & Innovation (DRI) for her unflinching support to the Office of Undergraduate Research (OUR) in all its endeavors to improve the quality of undergraduate research on this campus. We would also like to express gratitude to Dr. Cynthia Sides, Assistant Vice Chancellor of DRI, and her staff for their relentless behind-the-scenes efforts to support the multitude of activities undertaken by OUR. I would like to take this opportunity to personally offer my big thank you to Amy Epps, the Undergraduate Research Coordinator, for her untiring efforts to carry on the activities undertaken by OUR, especially for her role in coordinating the stringent peer-review of manuscripts submitted for plausible publication in the *Inquiry Journal*. This is no small feat, as the high standards she upholds significantly contribute to the *Inquiry Journal's* esteemed reputation. We hope to receive continued support of our faculty and the undergraduate student community to the *Inquiry Journal*.

We are pleased that the journal has been receiving high-quality research papers from undergraduate students and institutions abroad, as can be observed from the [Readership Dashboard](#) from January to June 2024. This issue features a research article from Neelabh Datta, an undergraduate student from the University of Kolkata, India, which elucidates the molecular mechanisms on how damaged DNA in cancer cells activate the cellular alarm system, cGAS-STING. We congratulate Neelabh on his outstanding undergraduate research and thank him for considering the *Inquiry Journal* as an avenue to disseminate his high-quality research. The issue also features a research article entitled “Assessing Teachers’ Dispositions Towards Culturally

Responsive Pedagogy in Northwest Arkansas High Schools” by Rylie Ford, an undergraduate student from the Department of Curriculum and Instruction, College of Education and Health Professions, University of Arkansas, Fayetteville. Based on an extensive online survey, Rylie reports that NWA secondary teachers have a positive perception toward culturally responsive pedagogical practices. Further, Rylie’s research concludes that factors such as the subject area and working experience of the teachers significantly impact teacher dispositions. We congratulate Rylie for her interesting research. Finally, we congratulate Matt Coutts and coworkers, from the Department of Electrical Engineering, University of Arkansas, Fayetteville, on their research article which analyzes different vision-language models for memory consolidation. Their research suggests interesting leads to effective memory consolidation operations. We applaud Matt and his coworkers for their fascinating and valuable research reported in this issue of the *Inquiry Journal*.

The visibility and access of the journal has significantly increased. In this context, we would like to congratulate both the undergraduate students and their faculty mentors for considering the *Inquiry Journal* as an avenue to publish their research. Given its global impact, we are quite hopeful that the faculty on this campus will seriously consider the *Inquiry Journal* as a venue for publishing their best research in the future. The *Inquiry Journal* is published as a digital repository (ScholarWorks@UARK) and is amenable to citation in research articles published in other research repositories. In this context, we would like to personally thank the faculty who had generously allocated their precious time to peer review research papers published in the *Inquiry Journal*. We believe that the academic rigor afforded *via* the peer-review process is one of the main reasons for the reliability and current high worldwide visibility of the journal.

Credit is also due to Sophia Nourani, a former undergraduate student worker, who tirelessly strived hard to interview the faculty who have shown significant interest to provide opportunities to undergraduate students to get involved with their high-quality research. This issue highlights two such outstanding faculty members, Dr. Jeffery Lewis (Department of Biological Sciences) and Dr. Xiangbo Meng (Department of Mechanical Engineering), who have a wonderful track record of working with undergraduate students. I salute these faculty members for their commitment to support high-quality undergraduate research on this campus.

Our special thanks also go to Dr. Suzanne McCray, Vice Provost, Office of Nationally Competitive Awards (ONCA), Emily Wright, Senior Associate Director, ONCA, and Dr. Chelsea Hodge, Director of Grants and Research Innovation, Honors College, for their contributions to material(s) published as the ONCA Notice and Honors Corner. It will be our endeavor to permanently feature both Honors Corner and ONCA Notice in the future issues of the *Inquiry Journal*. Lastly, we greatly acknowledge the help provided by Dr. Melody Herr for her constant encouragement and help in improving avenues to make the *Inquiry Journal* more accessible to a larger audience. We hope to continue working with all stakeholders in our pursuit to include additional new features in the *Inquiry Journal* which will be likely to be of broad interest to the undergraduate students on this campus.

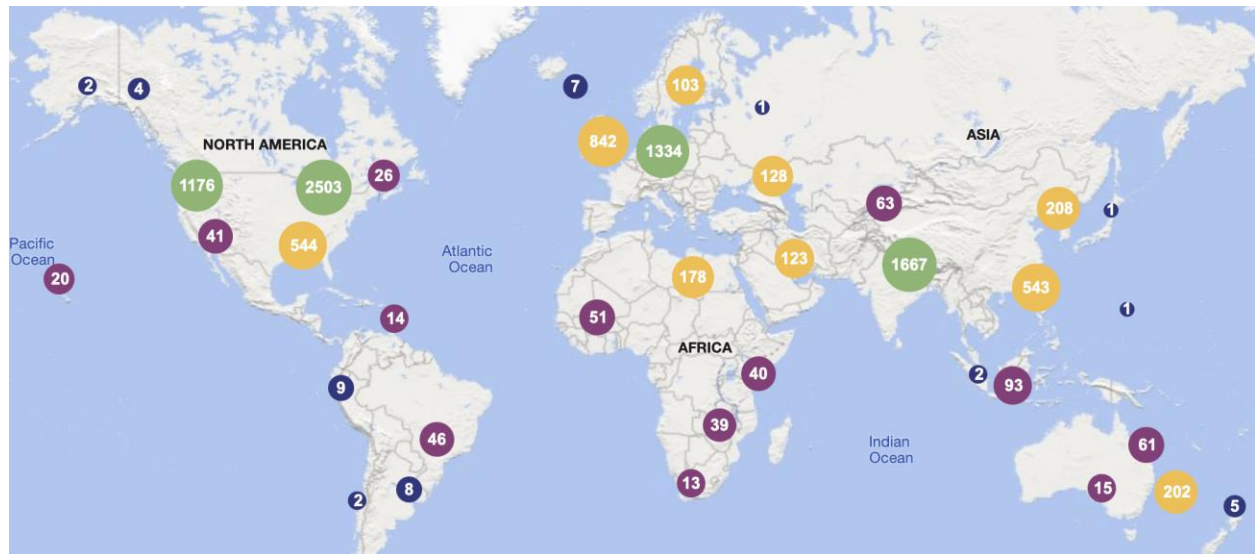
Suresh K. Thallapuram

Director, Office of Undergraduate Research

Division of Research & Innovation

Inquiry Journal Dashboard

We are pleased to see the increasing visibility of the creative work published in the *Inquiry Journal* (please take a look [at the dashboard](#) of the *Inquiry Journal*). The map below indicates the number of downloads per region. We are proud of our global viewership of the *Inquiry Journal* and hope that these numbers continue to grow.



Worldwide viewership of the *Inquiry Journal* (Jan, 2024-Jun, 2024)

Faculty Highlights

Dr. Jeffrey Lewis

Dr. Jeffrey Lewis has been a professor and researcher within the Department of Biological Sciences at the University of Arkansas since 2013. Dr. Lewis teaches multiple courses in microbiology, including Biological Regulation & Subcellular Communication and Genomic Data Analysis & Visualization.



Dr. Lewis' research lab focuses on how cells respond to stressful environments. He described when any type of cell, like bacteria, yeast, or human cells, are hit with different stresses, there is a complete remodeling of gene expression to help the cells thrive in these conditions. These responses are extremely complex and involve multiple lines of communication between networks in an organism.

“This complexity suggests that there's really intricate, *intricate* regulation and coordination of reactions to stress,” Dr. Lewis explained. “Understanding how these responses are orchestrated is extremely important.”

Dr. Lewis claims stress research feeds into nearly all aspects of cell biology, with implications for further understanding human diseases, how they evolve and the creation of regulatory networks in response to them.

Dr. Lewis received his B.S. in Santa Barbara, California, where he was first exposed to undergraduate research. He continued to receive his Ph.D. from the University of Wisconsin in Madison. He expressed the significance of undergraduate research in the academic experience, saying the work provides fresh insight for both the faculty and students.

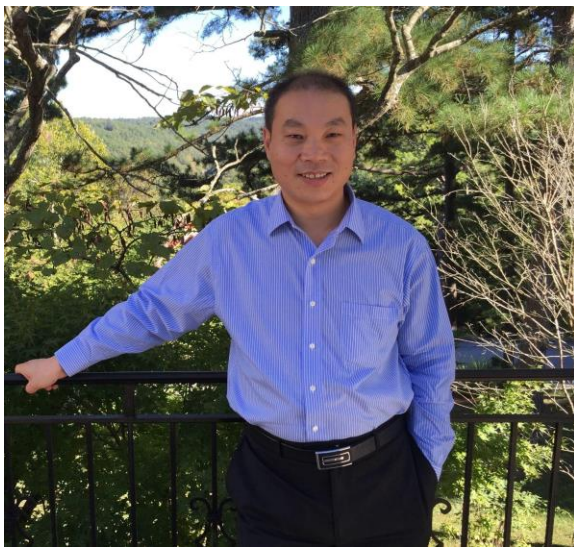
“I knew absolutely nothing about research or doing any lab work,” Dr. Lewis said. “After doing well as an undergraduate in that lab, I did a PhD at Wisconsin. It put me on track for a career in microbiology.”

In his free time, Dr. Lewis enjoys spending time with his wife and children and playing sports such as softball and ultimate frisbee.

Dr. Xiangbo Meng

Dr. Xiangbo Meng is a professor and researcher in the Department of Mechanical Engineering at the University of Arkansas. Dr. Meng was a Research Fellow in the Energy Systems Division at Argonne National Laboratory in Lemont, Illinois, from 2012 until joining UARK faculty in 2016.

Dr. Meng teaches three courses at UARK that are vital for undergraduate engineering students hoping to pursue the use of heat transfer in energy production. His classes focus on the concept of heat transfer and the use of hybrid electric vehicles and lithium-ion batteries.



Dr. Meng emphasized the importance of his research in the global discussion of cleaner, more reliable energy sources. Expanding on recent discoveries that lithium batteries can provide a clean, albeit expensive, alternative energy source to fossil fuels, Dr. Meng hopes to find a more cost-effective option.

“We heavily rely on things like fossil fuels, coal, natural gas and oil. These are not renewable and the combustion is causing heavy pollution and environmental issues like global warming,” Dr. Meng said. “It is not sustainable and we need to find other solutions.”

Dr. Meng described how he and his students are actively trying to discover new opportunities for renewable energy through developing new battery technologies.

“Our goal is to develop batteries that can provide a safer, higher energy density with a lower cost and longer lifetime than lithium.”

Dr. Meng said undergraduate research is extremely beneficial to both him and his students, and he appreciates the opportunity to lead them to their potential interests and have a good team member in his lab. He stated many students don't recognize their own potential.

Dr. Meng received two PhDs from the University of Western Ontario in Ontario, Canada. In his free time, which he says he does not have often, he enjoys being with his family and friends.

Research Articles

Survey of Memory Consolidation Techniques for Video Question Answering

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Abstract

Video Question Answering (VideoQA) is a field of research focused on developing models that can engage in natural conversations with humans about the content of videos. Currently, the most successful approaches involve analyzing videos frame-by-frame, which is computationally and memory-intensive. To imitate human memory, the Atkinson-Shiffrin memory model can formulate the machine's video understanding capability through Vision-Language Models. Reducing the number of frames processed by the model is a crucial operation in this approach category and can be handled by a memory consolidation algorithm. The memory consolidation algorithm should be able to determine the keyframes to transfer from short-term to long-term memory. However, due to the complexity of events in videos, this approach may need to pay more attention to critical information by efficient and appropriate operations. This paper

aims to compare video understanding capabilities by analyzing the memory consolidation algorithms. Specifically, we present experiments evaluating simple but effective memory consolidation operations on the ActivityNet-QA dataset to construct an optimal memory consolidation process.

Introduction

Large Language Model-based assistants, i.e., chatbots, like the well-known ChatGPT and GPT-4 (Achiam et al., 2023), exhibit a remarkable ability to answer a wide range of questions posed to them. This capacity has sparked interest in replicating that proficiency in multimodal applications (Li, Li, Savarese, & Hoi, 2023). This interest has resulted in the development of visual question-answering programs, which aim to answer questions related to images. Interestingly, visual question-answering programs have demonstrated notable success in their domain. In fact, OpenAI recently began rolling out visual question-answering understanding features to ChatGPT (OpenAI, 2023).

Programs that look to extend large language models (LLMs) to other modalities are known as Multimodal Large Language Models (MLLMs). A popular approach to developing vision-language MLLMs involves aligning frozen, pre-trained vision and language models (Li et al., 2023; Maaz, Rasheed, Khan, & Khan, 2023). It avoids the high training costs associated with training vision-language models. Cross-modal alignment, then, is the focus of this approach. BLIP-2 (Li, Li, Savarese, & Hoi, 2023) achieves cross-modal alignment using a lightweight transformer, e.g., Q-Former, that serves as the middleman between the frozen LLM and the frozen image encoder, providing the LLM with the most useful visual features. Q-Former has served as an integral piece in video understanding programs (Zhang, Li, & Bing, 2023). While

this approach has improved the state-of-the-art in video understanding tasks, these models struggle to handle long videos (Song et al., 2023; Zhang, Li, & Bing, 2023). It is because these models rely on frame-wise feature extraction. Thus, long videos with thousands of frames computationally overwhelm these models.

The Atkinson-Shiffrin model (Atkinson & Shiffrin, 1968) is proposed as a viable approach to improving long video understanding (Song et al., 2023). It is structured around a short-term and long-term memory buffer, as illustrated in Fig. 1. The model utilizes a sliding window to analyze the video. It shows that the Atkinson-Shiffrin model reduces both computational complexity and memory costs and improves long-term temporal connection (Song et al., 2023). Our analysis identifies potential structural limitations that may hinder the model's performance.

In this study, we investigate several simple operational modifications to the Atkinson-Shiffrin model, specifically exploring variations of the memory consolidation algorithm. Our objective is to observe and evaluate the impact of these modifications on the overall performance of the VideoQA tasks.

Related Work

Multi-modal Large Language Models

Given the recent success of Large Language Models (LLMs), it is only natural to look to equip these models with multi-modal capabilities. BLIP-2 (Li, Li, Savarese, & Hoi, 2023) presents a notable framework for designing MLLMs built around a Query transformer (Q-Former) that links a frozen pre-trained image encoder with a frozen pre-trained LLM. The BLIP-2 framework has become a popular approach to building MLLMs. Video-LLaMA (Zhang, Li, &

Bing, 2023) creates and utilizes a video Q-Former and an audio Q-Former to build an MLLM with both image, video, and audio understanding abilities.

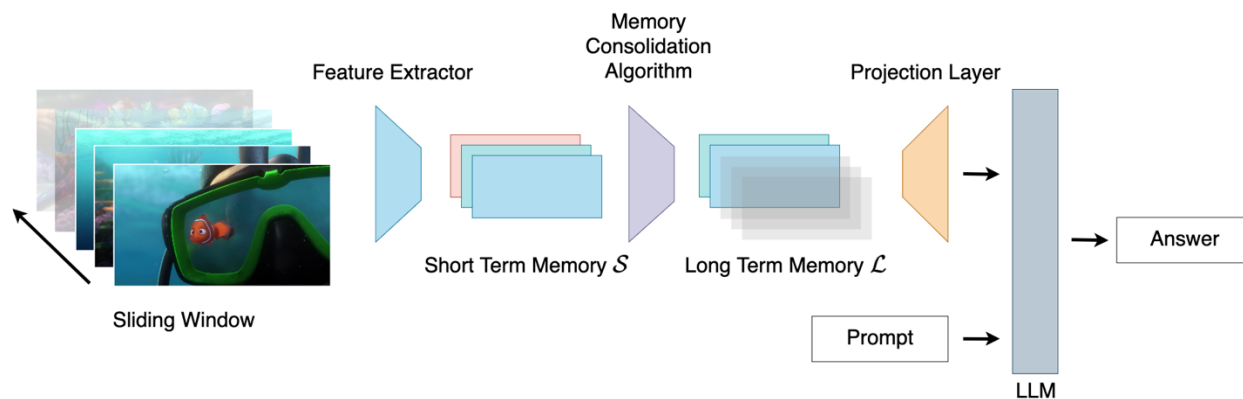


Figure 1 The Atkinson-Shiffrin model is proposed for the VideoQA task. It is structured around short-term and long-term memory.

Long Video Understanding

Handling long videos is a challenge facing video understanding frameworks (Song et al., 2023; Zhang, Li, & Bing, 2023). Considering the use of image-based models for frame-wise feature extraction, the struggle of these frameworks in understanding long videos is unsurprising. As videos get longer, the number of frames grows, and memory requirements grow exponentially. MovieChat (Song et al., 2023) is a recent work that uses the Atkinson-Shiffrin memory model to reduce the number of frames that need to be handled by the program.

The number of frames is reduced through a hierarchical clustering memory consolidation algorithm that merges pairs of consecutive frames based on the pair's similarity. This approach is built on the assumption that temporally adjacent frames within a movie scene, for example, are typically redundant.

Methodology

Problem Setup

Video Question Answering (VideoQA) is the task of responding to natural language prompts about the contents of a video. A VideoQA program takes a video and a prompt as inputs and should output a response to the prompt in natural language that is correct, given the context of the input video. A program that can perform VideoQA well must have a solid understanding of the text, audio, and video modalities and how the modalities align with one another.

This paper focuses on the text and video modalities specifically. LLMs have shown to handle the text modality well (Achiam et al., 2023; Touvron et al., 2023; Touvron et al., 2023) and are a critical part of most VideoQA programs. Video foundation models have improved at representing the contents of a video as tokens, but struggle to capture long-term temporal connections in long videos. The struggle of video foundation models to represent videos accurately has limited the video understanding of VideoQA models. This research explores the use of a memory consolidation algorithm as a method of improving the ability of VideoQA to videos.

Overall Framework

The framework includes a visual feature extractor, a short-term and long-term memory buffer, and a large language model. The system takes a video and a prompt as inputs. First, the input video is divided into smaller video clips. Each video clip is then converted on a frame-by-frame basis into a set of abstract numerical representations, called tokens, by way of the visual

feature extractor. These tokens are packed with the information that is used to develop a response to the input prompt.

Keeping a large number of frames in memory concurrently is very expensive. To avoid this, the framework processes the video using a sliding window, which breaks the video into several fragments. The sliding window allows the visual feature extractor to process the video without needing to store all of its frames at once. Though the sliding window alleviates memory requirements related to feature extraction, storing the tokens produced by the feature extractor remains a concern.

To address this, this framework is structured around the Atkinson-Shiffrin memory model. The idea is that, following generation, tokens will be moved into short-term memory. In short-term memory, a memory consolidation algorithm will consolidate the tokens into a smaller set of representative tokens. These representative tokens are merged into long-term memory. The long-term representative tokens are passed to the LLM to respond the input prompt.

Visual Feature Extractor

For visual feature extraction, the framework avoids using video-based foundation models like ViViT (Arnab et al., 2021). Instead, we use an image-based model to extract features from the video on a frame-by-frame basis. The decision to forgo the use of video-based foundation models revolves around the lack of a video foundation model that aligns well with the text modality. This framework uses EVA-CLIP (Fang et al., 2023) and the Q-Former from the BLIP-2 (Li, Li, Savarese, & Hoi, 2023) for image feature extraction. Video clips formed by the sliding window are passed into the visual feature extractor, frame-by-frame.

Memory Consolidation

The frame features held in the short-term memory buffer are merged into representative frames by the memory consolidation algorithm. These representative frames are stored in the long-term memory and presented to the LLM for response generation. The memory consolidation algorithm was built with the assumption that consecutive frames are often redundant and that videos can be understood with the set of most informative frames. Thus, the memory consolidation algorithm is built to reduce redundancy.

Given a set of frame features, the memory consolidation algorithm calculates a metric between pairs of consecutive frame features. The pair with the highest score is merged and remains in short-term memory. Again, the metric between pairs of consecutive frame features is calculated, and the pair with the highest score is merged. This process repeats until only two frames remain. The remaining two frames are moved to long-term memory and the short-term memory buffer is cleared, ready for the frame features of the following video clip. An illustration of the baseline memory consolidation algorithm can be found in Fig. 2. Below are the different memory consolidation techniques we explored in this research.

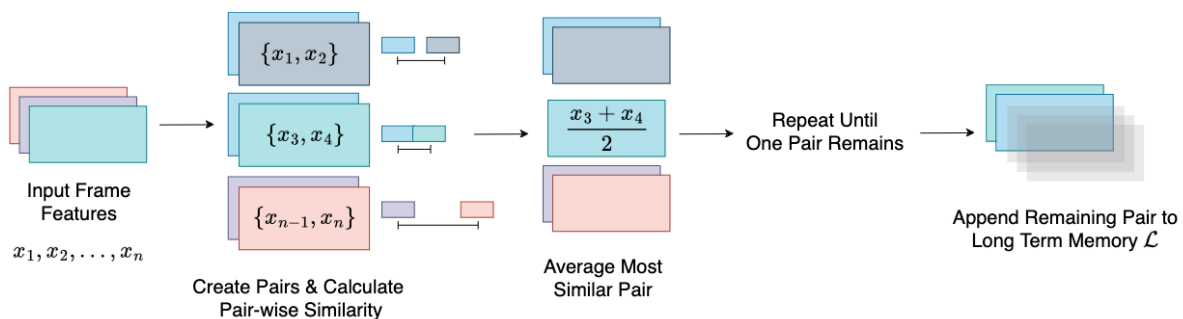


Figure 2 The core memory consolidation algorithm.

No Consolidation. To gain the impact the memory consolidation algorithm has on the model’s ability to perform well on the VideoQA task, we removed the memory consolidation algorithm altogether. Removing the consolidation algorithm allows us to compare the value in the Atkinson-Shiffrin memory model and determine whether the added model complexity is worth it.

Cosine Similarity. This approach is shown in Alg. 1. The assumption behind this approach is that movies often contain scenes that are slowed down to emphasize a moment, but for video understanding, the movie can be understood without redundancy.

Algorithm 1 Similarity-based Consolidation Algorithm

Require: \mathcal{S} ▷ short-term memory
1: **while** $len(\mathcal{S}) > R_L$ **do** ▷ iterative merge
2: **for** \mathbf{x}_i in \mathcal{S} **do**
3: $s \leftarrow cosine_sim(\mathbf{x}_i, \mathbf{x}_{i+1})$ ▷ tokens similarity
4: **end for**
5: $m \leftarrow max(s)$ ▷ the maximum value index
6: $\mathbf{x}_m \leftarrow average(\mathbf{x}_m, \mathbf{x}_{m+1})$ ▷ merge
7: **del** \mathbf{x}_{m+1}
8: **end while**

Cosine Distance. Instead of merging frames based on what consecutive frame feature pair is most similar, we merge frames based on what consecutive frame pair is most different. To do this, we take the frame feature pair with the highest cosine distance instead of the highest cosine similarity. It was done assuming that this would improve the model’s ability to detect anomalies in videos. This approach is similar to Alg. 1, with similarity replaced by distance.

Furthest Frame Pair. The goal of the memory consolidation algorithm is to merge the frames from the short-term memory buffer into representative frames that best capture the ideas presented by the video clip. Taking the two frames that were furthest from each other, without

requiring them to be consecutive, would present the two most distinct frame features from the video clip, as presented in Alg. 2.

Algorithm 2 Furthest Pair Consolidation Algorithm

```

Require:  $S$  ▷ short-term memory
for  $x_i$  in  $S$  do
  for  $x_j$  in  $S$  where  $j > i$  do
     $s \leftarrow \text{cosine\_dist}(x_i, x_j)$ 
    if  $s > \text{max}$  then ▷ max distance
       $\text{max} = [x_i, x_j]$ 
    end if
  end for
end for
 $\mathcal{L}.\text{append}(\text{max})$ 

```

Large Language Model

The baseline model uses 7 billion parameters Llama 2 (Touvron et al., 2023). More specifically, they use the Vicuna-7b-1.5, an LLM created by fine-tuning Llama 2. The LLM is frozen in this model and aligned with the video modality by a Q-Former as presented in BLIP-2 (Li, Li, Savarese, & Hoi, 2023). We make no changes to the LLM used by the baseline model in our survey.

Experimental Details

Dataset

To assess the VideoQA abilities of the modified model, we utilize the ActivityNet-QA dataset (Yu et al., 2019), a fully annotated, large-scale dataset for VideoQA. We evaluate the model's zero-shot VideoQA capabilities via the evaluation process as the same as in Video-ChatGPT (Maaz, Rasheed, Khan, & Khan, 2023). We also use this dataset to collect some

qualitative evaluations. Additionally, we use the UCF-Crime dataset (Sultani, Chen, & Shah, 2018), which consists of untrimmed surveillance videos containing anomalies from 13 anomaly categories. This dataset does not support the VideoQA task, to evaluate the model’s ability to detect anomalies in videos.

Evaluation Metrics

The ActivityNet-QA dataset contains three types of questions, including motion, spatial relationship, and temporal relationship (Yu et al., 2019). The dataset conducts evaluation based on accuracy but expects only a “yes” or “no” response. Our model, however, produces human-like, free-form textual responses and elaborates further than a “yes” or “no”. Thus, to test the accuracy of our model, we use GPT to compare our model’s responses to the ground truth as in other work (Maaz, Rasheed, Khan, & Khan, 2023). GPT scores are based on its subjective understanding of the question, the ground truth, and our model’s response. It means that the evaluation scores will vary on a run-to-run basis, as shown in Table 1, which is undesirable. This aspect of our evaluation of ActivityNet-QA is important to keep in mind. We note this gap in VideoQA evaluation methods as a topic that needs further exploration.

Table 1. Evaluation Results Differ Run-to-Run

Run	Yes Count	No Count	Accuracy	Score
1	85	355	0.193	1.718
2	95	345	0.216	1.875
3	89	351	0.202	1.850

Quantitative Results

Each modification to the model is quantitatively assessed using a subset of the ActivityNet-QA dataset. The accuracy metric represents the percentage of yes or no questions that the model answered correctly. Since our model generates more elaborate responses that do not explicitly state “yes” or “no,” we need a way to infer whether the model’s response implies a yes or a no to the input prompt. To achieve this, we used GPT to interpret our model’s response as a yes or a no and used this interpretation to determine the model’s accuracy. The score metric, provided by GPT, measures the semantic relevance of the model’s response to the input prompt. Of the two metrics, we believe that answering questions correctly is more critical in practical applications of VideoQA models. For that reason, our interpretation of the results values accuracy more than it does score.

Of the methods we tested, the cosine similarity memory consolidation algorithm had the highest accuracy, outperforming the next best algorithm, the furthest frame pair, by 10%. The algorithm with the highest score was the furthest frame pair with a score of 3.00, followed closely by the cosine similarity with a score of 2.97. Results can be found in Table 2. Despite its lower score compared to the furthest frame pair algorithm, we conclude cosine similarity as the best operation for VideoQA models due to its significantly higher accuracy and nearly identical score. Our conclusion is also built upon our assumption that accuracy should be weighted more heavily than score when evaluating models for VideoQA.

Table 2. Evaluation results on Activitynet-QA dataset

Modification	Accuracy	Score
No Consolidation	0.290	2.22
Furthest Frame Pair	0.305	3.00

Cosine Distance	0.275	2.37
Cosine Similarity	0.405	2.97

Qualitative Results

We gather qualitative results using both the ActivityNet-QA dataset to evaluate the general VideoQA capabilities of the model and the UFC-Crime dataset to gauge the anomaly detection abilities of the model. To evaluate the general VideoQA capabilities of the model, we prompt the model with generalized questions as shown in Fig. 3. In evaluating the anomaly detection abilities of the model, we tailor our questions to the anomalous event present in the video, as shown in Fig. 4.

The results from our qualitative analysis were promising. The responses from the Atkinson-Shiffrin memory model contained accurate information, for the most part. However, there was a problematic number of hallucinations or inaccurate information, leaving plenty of room for improvement in the model's capabilities.



Q: What is happening in this video?

A: The video shows a man cutting a man's hair in a salon. The man is cutting his hair while a woman watches him. The salon is equipped with a hairdryer, curtains, a brick wall, a black shirt, a black dress, a white wall, a black and white image, and a black purse.

Figure 3 Question and answer concerning a video from the ActivityNet-QA dataset.

Text in green is accurate information, text in yellow is unrelated or unclear information, and text in red is inaccurate information.



Q: Can you describe the explosion in this video?

A: The video shows a car explosion in a busy road with multiple cars, buses, and bicycles. The explosion happens in the middle of the road and causes a large amount of destruction and damage. There are also numerous vehicles involved in the accident, including a white car, a gray and white car, a black car, a truck, a silver car, and a bus. The explosion also takes place on a highway with a stop sign and traffic lights. The drivers and passengers are seen in the vehicles, while pedestrians can be seen in the background.

Figure 4 Question and answer concerning a video from the UCF-Crime dataset (Sultani, Chen, & Shah, 2018).

Text in green is accurate information, text in yellow is unrelated or unclear information, and text in red is inaccurate information.

Conclusion

In this work, we have demonstrated the potential of the Atkinson-Shiffrin memory model to enhance machine video comprehension when paired with an effective memory consolidation algorithm.

In our quantitative study, the cosine similarity memory consolidation algorithm performed the best. However, we note that the metrics used, despite being standard among similar research, are undesirable as results rely on the subjective analysis of a large language model. We note this as an opportunity for future research to explore better, standardized evaluations.

In our qualitative analysis, the models demonstrated good video understanding capabilities, but still included a troubling number of hallucinations. We hypothesize that the

model's tendency to elaborate unnecessarily as an avenue for inaccuracies to be introduced in the model's response but leave further exploration for another time.

Vision-Language Models have become a topic of interest in machine video understanding. Our survey of memory consolidation algorithms builds upon previous research by identifying the best performing consolidation strategy for the Atkinson-Shiffrin memory model.

Acknowledgements

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About the Authors

Matt Coutts

Matt Coutts is an honors undergraduate student studying computer science at the University of Arkansas. In Fall of 2023, Matt joined the Computer Vision and Image Understanding (CVIU) Lab at the university, where he has conducted undergraduate research in image and video understanding systems. He was awarded an Honors



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Assessing Teachers' Dispositions Towards Culturally Responsive Pedagogy in Northwest Arkansas High Schools

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Abstract

Culturally responsive pedagogy (CRP) entails the use of cultural knowledge, prior experiences, and learning styles of ethnically and culturally diverse students to make instruction more relevant and effective for them. Furthermore, practices within this pedagogy are validating, inclusive, emancipatory, and ethical, and help diverse students succeed academically while maintaining their cultural identity. Numerous studies have indicated that using culturally responsive pedagogy increases student academic achievement, sense of self, and emotional well-being (Ladson-Billings, 1995a; Gay, 2018). Considering the varying degrees of cultural and linguistic diversity in Northwest Arkansas (NWA) schools and the lack of reported professional development relating to CRP, this study aimed to examine NWA secondary teachers' dispositions (values, attitudes, and beliefs) toward culturally responsive pedagogical practices. Employing a mixed methods survey research design, the study integrated self-reported Likert scale ratings and open-ended questions for a more in-depth understanding of teachers' challenges while incorporating CRP into their classrooms. This study presents the online survey results of 131 teachers from 9-12 grades from various regional districts. Findings indicate that NWA secondary teachers report having positive perceptions toward culturally responsive pedagogical practices.

Further analysis also suggests factors, such as subject area taught and years of teaching experience, that may impact teacher dispositions. These findings are significant because they indicate potential areas of concern regarding equitable teaching relevant to teacher preparation, training, and support for CRP. They can be used to develop more meaningful, tangible, and supportive professional development. These results could also impact the decisions made by school administrators regarding matters related to CRP, affecting both teachers and the overall school culture.

Introduction

When students of racial/ethnic minoritized backgrounds, particularly Black, Hispanic, and Native American students, enter high school, they experience a significant gap in achievement compared to that of their White and Asian counterparts (Browns-Jeffrey & Cooper, 2011). To understand this gap within a specific context, it's essential to consider the unique demographics of Northwest Arkansas (NWA).

According to the 2020 Census, Washington County was ranked 20th out of 75 (53.4%) on the diversity index in the state of Arkansas, and Benton County was 26th (US Census, 2021). There are over 60 languages spoken in the region of Northwest Arkansas, English, Spanish, and Marshallese are among the top. In Springdale School District, 44% of students speak English and 41% speak Spanish. In Bentonville, the top languages after English and Spanish are Telugu, Tamil, and Hindi (*NWA Council Diversity Booklet*). In addition to ethnic and linguistic diversity, the region also has varying socioeconomic levels. For example, 40% of Fayetteville School Districts student population qualifies for free/reduced lunch, the rest of the region are as follows: Rogers School District – 60%, Springdale School District – 72%, and Bentonville School District – 20% (ADE, 2024).

In the diverse region of Northwest Arkansas, school districts have varying demographics and achievement levels. For instance, one district's high school has a 37% minority enrollment and 30% of the students are economically disadvantaged; the school scored in the 95th percentile on the standardized exam, the ACT Aspire Test.¹ A second district's high school has an 82% minority enrollment and 80% of the students are economically disadvantaged; the school scored in the 17th percentile on the test. Additionally, the first school's gap between the school and the state's proficiency levels on state assessments among underserved students is 2.2%. The second school's gap is -3.6%. A negative value means the state outperformed the school (USN, 2019-2020a; USN, 2019-2022b; "ADE School Info"). To provide a more equitable educational experience for all students, "culturally responsive pedagogy" (CRP) emerges as a dynamic and essential approach that acknowledges and incorporates students' diverse cultural backgrounds, experiences, and perspectives to foster inclusive and effective learning environments.

Teacher dispositions are a crucial factor in students' social and academic development in the classroom. The beliefs, values, and attitudes of teachers inform whether or not they will engage in equitable education. The National Council for Accreditation of Teacher Education (NCATE) defines dispositions as "The values, commitments, and professional ethics that influence behaviors toward students, families, colleagues, and communities and affect student learning, motivation, and development as well as the educator's professional growth. Dispositions are guided by beliefs and attitudes related to values such as caring, fairness, honesty, responsibility, and social justice" (NCATE, 2006, p. 53). Teachers must examine their racialized identities, the social and culture aspects of a person's identity that are shaped by their

¹ The "ACT Aspire Test," is a state-mandated, end-of-the year summative assessment that is used to assess all public schools in Arkansas grades 3-10. It tests, English, math, reading, writing, and science (Arkansas Division of Elementary and Secondary Education, ACT Aspire).

race and societal perceptions and stereotypes attributed to that race, to truly begin dismantling policies and practices that oppress students of diverse backgrounds. Choosing to ignore race or take a “colorblind” mindset, may give an illusion of equity, but only ignores the issues (Whitaker & Valtierra, 2018).

While scholarship has reported only positive effects of culturally responsive pedagogy, current teacher preparation programs, and professional development may fail to highlight its practices. Based on Northwest Arkansas’ school districts’ websites, listed professional developments, and personal communication, there is a lack of evidence reporting districts mandating professional development/training explicitly related to culturally responsive pedagogy for all faculty members. This pedagogy should be a part of all schools' professional and cultural philosophy but is particularly pertinent for areas with varying degrees of cultural, linguistic, and socioeconomic diversity.

Given these observations, this study sought to explore the perspectives of teachers in the region regarding practices and values associated with CRP. Specifically, this research examined NWA secondary teachers’ values, attitudes, and beliefs relevant to culturally responsive pedagogy and its practices. Additionally, this study aimed to identify factors influencing teacher dispositions towards CRP, barriers hindering the use of CRP, and potential avenues for supporting teachers in implementing CPR. This investigation involved the survey and analysis of responses from teachers from schools in the region to assess their dispositions towards culturally responsive practices.

Professor of Education, Geneva Gay (2018) defines culturally responsive teaching as “Using cultural knowledge, prior experiences, frames of reference, and performance styles of ethnically diverse students to make learning encounters more relevant to and effective for them”

(p. 36). This study employed the use of the Dispositions for Culturally Responsive Pedagogy Scale (DCRPS), created by Whitaker and Valtierra (2018). The scale, intended to assess the values, attitudes, and beliefs of K-12 teachers, combines national standards with theory and standards related to inclusive education. Particularly, the survey statements in the scale align with Gay's definition of CRP by focusing on three main factors: praxis, community, and social justice. Results of this survey were expected to reflect the dispositions teachers from various secondary schools have toward culturally responsive pedagogy. This information may benefit local schools in their approach to future professional development and Diversity, Equity, and Inclusion (DEI) training.

Background and Significance

Culturally Responsive Pedagogy

Culturally Responsive Pedagogy, which is known by a wide variety of names such as culturally relevant, sensitive, centered, congruent, reflective, mediated, and contextualized pedagogy or teaching is based on practices that help to close achievement gaps, connect content to prior knowledge, create a sense of belonging, and foster an equitable classroom environment. Studies document that English Language Learners, students in poverty, and students of color receive less instruction that develops higher-order skills resulting in a large number of culturally and linguistically diverse students being dependent learners (Hammond, 2015).

One of the earliest leading pedagogical theorists in this field is Gloria Ladson-Billings who introduced "culturally relevant teaching" in 1994 and set the fundamental frameworks for many of the ideas still enforced today. Ladson-Billings began her research by examining the work of anthropologists who studied teaching practices that would align more with the home and community cultures of students of color. She references Mohatt and Erikson's work in 1981 that

coined the terms “culturally congruent” and “culturally responsive” (Ladson-Billings, 1995a). Ladson-Billings also notes that all of the terms that were employed in early research connotated an accommodation, or assimilation, of the students’ culture with mainstream culture. “Culturally responsive,” was the exception, she saw it as a more synergistic relationship between home and school culture, rather than a compromise made at the expense of the students’ home culture.

In 1988, Ladson-Billings began investigating eight teachers, in a predominantly African-American area, who were nominated by community members as outstanding teachers. At the time, there was much research on African American students' academic failure, but not their success. Ladson-Billings observed that the students in the eight classrooms were successful, and not just in terms of standardized testing. Furthermore, the teachers brought students' culture into the classroom, mitigating the negotiation of academic success between cultural connections. Ladson-Billings took note of the beliefs and ideologies of these eight teachers, and her goal was to create a pedagogy that provided a way for students to maintain their cultural identity while succeeding academically. She explained that culturally relevant teachers must encourage academic success and cultural competence, as well as help students recognize and understand social inequalities (Ladson-Billings, 1995b).

Building from Ladson-Billings’s work, Gay (2018) developed a framework that focuses on strategies and practices teachers can employ to be culturally responsive. She argues that culturally responsive teaching is validating, inclusive, empowering, transformative, emancipatory, and ethical. Her work argues that when culturally responsive teaching is done appropriately, it promotes academic excellence of all students, and in time, could reduce the consequences students face from unfair distribution of power, resources, and opportunities (p. 283).

Additionally, CRP helps students engage in critical thinking and build what Zaretta Hammond refers to as “intellective capacity,” or the increased power the brain creates to process complex information effectively (2015, p. 36). Hammond examines the inequalities in access to rigorous and supportive education for culturally and linguistically diverse (CLD) students. When these inequalities are not addressed through methods such as CRP, it perpetuates a cycle of barriers that CLD students will continue to face (Brown-Jeffy & Cooper, 2011).

CRP and Teacher Preparation/Professional Development

While research on culturally responsive pedagogy reports highly effective positive outcomes for all students, scholarship suggests that effective teacher preparation for CRP has yet to be achieved (Jensen, 2021; Kolano et al., 2014). In a study done on the level of preparedness that white veteran teachers feel in managing increasing diversity in the classroom, Jensen (2021) sought to investigate the experience of veteran teachers because most research on growing diversity in the classroom was focused on new teacher candidates. She intended to identify future professional development needs to support the change in student demographics. When it came to the teachers’ perceptions of their preparedness, most reported quite limited levels of preparedness. Further, when asked about their school district's professional development, most said it was not good. Many teachers felt unprepared in their ability to create and foster a culturally competent and diverse classroom. A theme that emerged was the differing definitions of what cultural competency meant to them. The research concluded that teachers were excelling in their relationships with students in the classroom, but districts were not doing a good job of providing professional development on equity in education.

A 2013 study on multicultural teacher education investigated the perceived effectiveness of teacher-training programs and professional development (PD) of 157 teachers. The study analyzed the teacher's experiences in preparing to work with ELLs and other diverse learners. The researchers argued that the lack of culturally congruent practices in the classroom was due to teacher preparation programs' failure to prepare teachers for ethnically, culturally, and linguistically diverse students. The study concluded that when provided with multicultural course work preservice teachers were engaged in it, but many preparation programs are not consistently addressing diversity and multiculturalism in a variety of ways, specifically field experience (Kolano et al., 2014).

In a similar study done in 2016, a group of researchers collected data on a team of teachers and principals who began a three-year effort to embed professional development (PD) focused on cultural competency into the job. Following the PD, 120 teachers were surveyed on their experience. While most agreed that it helped them examine areas of cultural competency such as poverty, they did not agree that the PD would help to close the achievement gap. The research noted that elective and special education teachers were significantly more positive than core subject teachers regarding how the training improved instruction. Furthermore, the research identified two challenges for acknowledging cultural differences: lack of time and implementation apathy from colleagues (Mette et al., 2016). Teachers who may not have as much perceived experience with issues of diversity, such as Math or Science, may not see it as beneficial to their subject area.

Furthermore, Dion (2020) investigated diversity and inclusion in world language (WL) teachers' instruction by interviewing 17 secondary WL instructors. Her findings suggested that most participants incorporate cultural diversity into their practices, several drew upon student

interests, and some considered the intersection of their identities in their approach to diverse instruction. Her research highlights some of the key themes of WL teachers' practices: cultural diversity, student diversity, and teachers' experiences, interests, and identities. She also highlights some practical implications that would make WL instruction more diverse and inclusive, most notably that the consideration of student interests and characteristics is often the missing piece in instruction. Her work is significant because it highlights the culturally responsive capabilities and training within the subject area, and the importance of language courses to proliferate cultural and linguistic diversity. Furthermore, communicating an understanding of diversity is vital in WL because there has been a relative decline in student enrollment in language courses across the country.

Lastly, Martell's case study of three self-identifying CRP social studies teachers describes how the teachers went about teaching race in U.S. History classes. He concludes that all three teachers used conversation as a part of their class, and they continued to emphasize the presence and effects of race in each lesson. They described challenging previous misconceptions and working to "open the eyes" of their students (2018, p. 71).

Study Rationale

In an article written in partnership with the National Center for Culturally Responsive Education Systems, Richards (2007) discusses why we need to address diversity in schools. He builds off of previous literature in the field such as Ladson-Billings and explains how to meet the instructional needs of an ever-growing diverse student population. He presents three culturally responsive dimensions: 1) institutional, 2) personal, and 3) instructional. These dimensions are critical to long-lasting reforms within education to make it more culturally responsive. Within the institutional dimension, he identifies the organization of the school, school policies and

procedures, and community involvement as key factors to culturally responsive school institutions. He notes a particular concern, the impact of school policies on the allocation of resources. Furthermore, he lays a framework for the personal dimension, identifying ways that teachers can be culturally responsive. Ultimately, he highlights teacher self-reflection and examination of their attitudes and beliefs. He concludes that teachers must recognize the “power” they have because the daily contact they have with students provides teachers with an opportunity to either “further the status quo” or make a difference that will impact the achievement and lives of each student.

Studying teachers’ perceptions of culturally responsive pedagogy in the specific region of Northwest Arkansas is significant due to its unique demographic factors, varying district resources, proximity to a state university, and lack of specified CRP training. According to Northwest Arkansas Council’s Diversity Report in 2022, from 1990 to 2021 the region's racially and ethnically diverse population increased from 5% to 29%, and it is only expected to increase. Additionally, diversity in NWA school districts is growing faster than the diversity of the overall population of the region. However, certain districts are seeing an increase in diversity more than others, for example, at one district's high school, roughly 81% of students are of racial/ethnic minoritized backgrounds, compared to a nearby school with only 25% of students being of a minoritized backgrounds (NCES, 2022). Moreover, Arkansas is especially unique in that it is home to more than 15,000 Marshallese people, making it the largest concentration of Marshallese in the continental US; a high majority of that population resides in Northwest Arkansas with more than 12,000 Marshallese residents (Brown, MEI NGO, 2021).

Lastly, the examination of local teachers' perceptions of culturally relevant pedagogy is significant because NWA is home to the University of Arkansas, a large state university, that,

according to the University's field placement coordinator, Mr. JL Jennings, sends roughly 200 interns to local schools as part of its teacher preparation program. The more exposure preservice teachers get to culturally responsive practices and ideologies, the more likely they will be to create that same culture in their future classrooms. The cultural and linguistic diversity in the region makes it even more pertinent that educators and their leadership are promoting and supporting equitable educational practices.

Methods

This study investigated Northwest Arkansas secondary teachers' dispositions (values, attitudes, and beliefs) towards culturally responsive teaching. The region of NWA was selected due to its varying degrees of diversity across the school districts. To understand the experiences of classroom teachers and determine if more training or professional development in this area may be needed, this study was guided by one primary research question and three subquestions. My primary research question was, what are teachers' self-reported perceptions of values, attitudes, and beliefs relevant to culturally responsive pedagogy? My sub-questions were: 1) What possible factors could affect teachers' dispositions towards CRP? 2) What difficulties are teachers experiencing while incorporating CRP into their classrooms? 3) What support or resources could assist teachers in the incorporation of CRP?

Participants

Participants in this study were Northwest Arkansas high school (grades 9-12) teachers. The survey was sent out via email to local secondary teachers through a network of University faculty who assisted in survey distribution. This study was approved as exempt by the University's of Arkansas' Institutional Review Board as there were no identifying factors asked

of participants. The survey protected participants anonymity due to the sensitive nature of the topic and to help foster the most honest responses.

Subsequently, 131 teachers completed the survey. Because many teachers teach multiple subjects or identify with more than one race/ethnicity some questions allowed participants to select all applicable responses. There were 189 responses for the demographic question on subjects area(s) taught and 151 responses related to race/ethnicity. Tables 1-4 below provide an overview of the demographics of those who participated in this research study. The demographic factors collected were participants' subject areas, years of teaching experience, gender, and racial/ethnic identity. Later analysis elaborates on participants' subject areas and years of teaching experience alongside survey responses to explore possible factors affecting the teachers' dispositions toward CRP.

Table 1-4 Participant Demographics:

Table 1. Frequency of Participants' Responses Subject Area(s) Taught (n = 189)

Subject(s) Taught	N #	%
ELA	32	0.17
Social Studies	18	0.1
Math	25	0.13
Science	26	0.13
World Languages	8	0.04
ESL	7	0.03
Fine Arts	6	0.32
Physical Education/Coach	13	0.7
Special Education	25	0.13
Other	29	0.15
Total	189	100

Table 2. Frequency of Participants' Responses to Years of Teaching Experience (n = 131)

Years of Teaching Experience	N #	%
Less than 5	21	0.16
5-10 years	23	0.18
11-20 years	44	0.33
More than 20	38	0.29
0 or Pre-service Teachers (Interns)	5	0.03

Table 3. Frequency of Participants' Responses to Gender (n =131)

Gender	N #	%
Male	35	0.27
Female	92	0.70
Prefer not to say	2	0.15
Other	0	0.00
Non-binary/non-conforming	2	0.15

Table 4. Frequency of Participants' Responses to Race/Ethnicity (n = 151)

Race/Ethnicity	N #	%
Hispanic, Latinx, or Spanish origin	3	0.02
Black or African American	5	0.03
American Indian or Alaska Native	4	0.02
Native Hawaiian or other Pacific Islander	1	0.01
Asian	0	0.00
White	132	0.88
Prefer not to say	5	0.03
Other	1	0.01

Survey Instrument

This study examined teachers' beliefs, attitudes, and values relevant to culturally responsive pedagogy using a reliable and validated survey tool (Whitaker & Valtierra, 2018). As mentioned, the tool utilized was the Dispositions for Culturally Responsive Pedagogy Scale (DCRPS)(2018). Minor changes were made to the DCRPS by decreasing the question count to only include two of the three main factors, praxis, and community (Whitaker & Valtierra, 2018). Questions were limited to keep the survey under eleven questions to increase the likelihood of full survey completion, it took less than five minutes to complete.

The eleven survey statements were presented on a six-point Likert scale from "strongly agree" to "strongly disagree." The survey started with demographic questions: grade level(s) they teach, years of teaching experience, subject(s) they teach, racial/ethnic identity, and gender. Demographic responses were imperative to my secondary question addressing the potential factors affecting teacher dispositions.

Additionally, two open-ended questions were added. The first question asked what difficulties teachers have when using CRP in their classrooms, and the second question asked what support or resources might assist them in using CRP. The intention for asking these questions was to identify what issues NWA teachers were facing regarding CRP and identify what could be done to mitigate those barriers as well as to give participants a sense of agency as they were able to provide their lived experiences. After the responses were collected, they were exported from Qualtrics into a spreadsheet (a separate one for each question), then the responses were sorted by key words to help identify the main themes that were presented.

The survey instrument titled “Perceptions of Culturally Responsive Pedagogy: NWA Teachers,” is accessible [here](#) or in Appendix A.

Examination of the survey responses with the demographic categories was also performed to identify which factors may have contributed to positive or negative dispositions. Additionally, through an iterative process of reading the open responses, common themes were identified and used to categorize teachers' responses into themes. Through the analysis, the goal was to identify 1) Whether the majority of the sample population’s dispositions align with or against CRP, 2) Any connections that may exist between the survey statements and the demographic factors, and 3) What difficulties teachers encounter and what supports would assist them. The anticipation was that certain demographic groups would be more likely to have positive dispositions of CRP. For example, it was anticipated that certain subjects, such as World Language and Social Studies, would have more positive dispositions to CRP than other subjects (Martell, 2018).

Results

The survey findings were collected using Qualtrics software (Qualtrics, Provo, UT) and analyzed to better understand secondary teachers in NWA dispositions toward CRP. Subsequently, frequency tables and bar charts were created to show the distributions of responses. For the purpose of clarity, the following section of my paper is subdivided into sections based on the specific research questions.

RQ #1: NWA Secondary Teachers’ Dispositions (values, attitudes, and beliefs) Toward CRP?

To answer my primary research question, I used a survey that consisted of 11 Likert-scaled questions that asked teachers to evaluate their culturally responsive beliefs, attitudes, and

efficacy.² To make survey analysis more accessible, the 5-Likert scales were compressed into: agree, neutral, and disagree. Then descriptive statistics were used to create a frequency table of the participants' responses. See Table 5 for an overview of the responses. Additionally, a graph was created to show the frequency of the teachers' responses to each question. See Figure 1 below.

² Survey questions #2 and #8, which essentially as the same question, were both included initially to guage if participants were being intentional with their responses or selecting “agree” on all responses. The difference in response frequencies was not large enough to indicate that participants were providing the same answer for each question.

Table 5. Frequency of Participants' Responses to the CRP Survey (n = 131)

Question #	Survey Question	Agree	%	Neutral	%	Disagree	%
1	I value assessing my own teaching practices	124	0.95	6	0.05	1	0.01
2	I am aware of my cultural background	112	0.86	15	0.11	4	0.03
3	<i>I am willing to take advantage of professional development opportunities focused on issues of diversity</i>	98	0.75	27	0.21	6	0.05
4	I am open to feedback about my teaching practices	126	0.96	4	0.03	1	0.01
5	I am willing to examine my own identities	108	0.82	17	0.13	6	0.05
6	I am willing to be vulnerable in my classroom	110	0.84	17	0.13	4	0.03
7	I value dialogue as a way to learn about students' out-of-school lives	125	0.95	4	0.03	2	0.02
8	<i>I have an awareness of my cultural background</i>	90	0.69	31	0.24	10	0.08
9	I value student differences and incorporate them into my curriculum	105	0.80	24	0.18	2	0.02
10	I view myself as a member of the learning community along with students	127	0.97	3	0.02	1	0.01
11	<i>I am comfortable with conflict as an inevitable part of the teaching and learning processes</i>	84	0.64	42	0.32	5	0.04

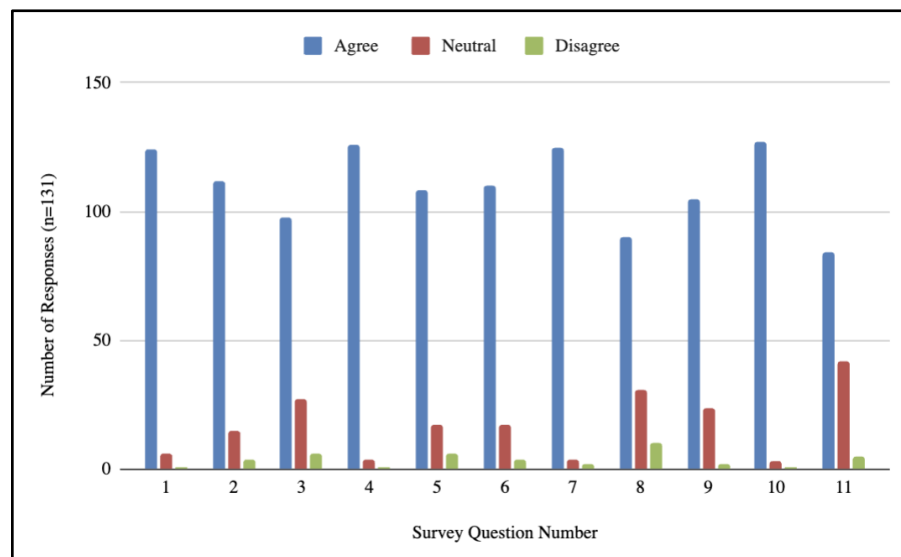


Figure 1. NW AR Teachers' Responses on the Culturally Relevant Teaching Survey

Overall, the teachers who responded to the survey clearly have positive dispositions toward their own CRP practices. This means that participants' values, attitudes, and beliefs, for

the most part, appear to align with those consistent with CRP. They also report having high self-efficacy when it comes to incorporating CRP in their classroom and lessons. Therefore, the data indicates that NWA secondary teachers have positive perceptions toward culturally responsive pedagogical practices.

Although the responses were overall positive, it was both interesting and prudent to explore the responses that revealed lower positive agreement with the survey questions asked. Questions 3, 8, and 11 as noted in italics (in Table 1 above), elicited 75% or less agreement with the survey questions.

RQ #2: Factors Affecting Teacher Dispositions

Participant demographics which included participants' subject area(s), years of teaching experience, race/ethnic identity, and gender are presented in Figures 2-5 below. A greater variance in the participants' subject areas (Figure 2) and their years of teaching experience (Figure 3) provided an opportunity to examine possible factors affecting a teacher's disposition towards culturally responsive pedagogy and practices. Other demographic information, racial/ethnic identity and gender, however, was more limited and less useful for analysis purposes.

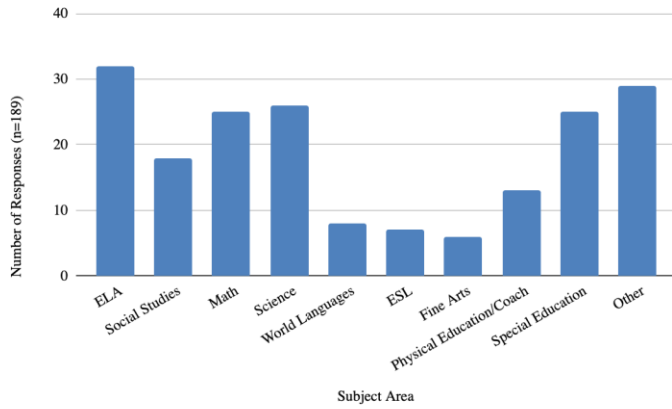


Figure 2. Participant Distribution by Subject Area

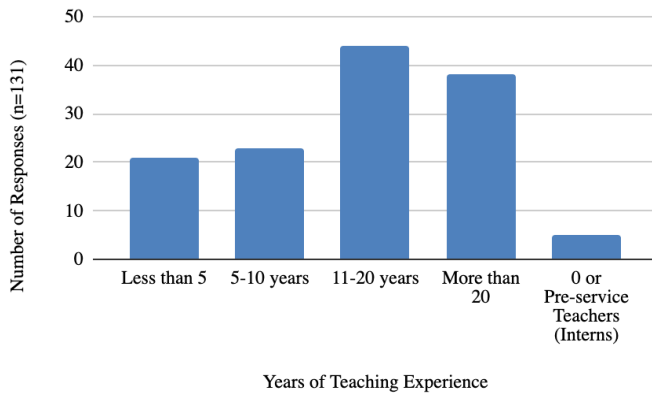


Figure 3. Participant Distribution by Years of Teaching Experience

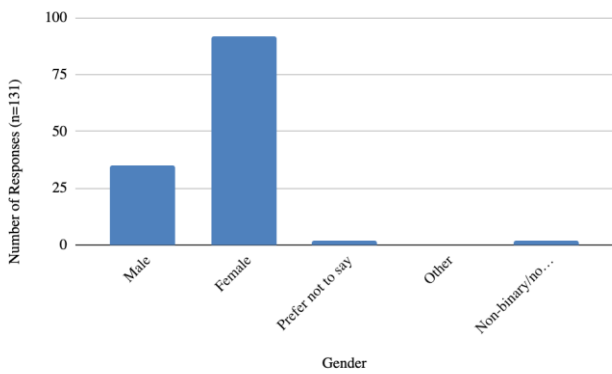


Figure 4. Participant Distribution by Gender

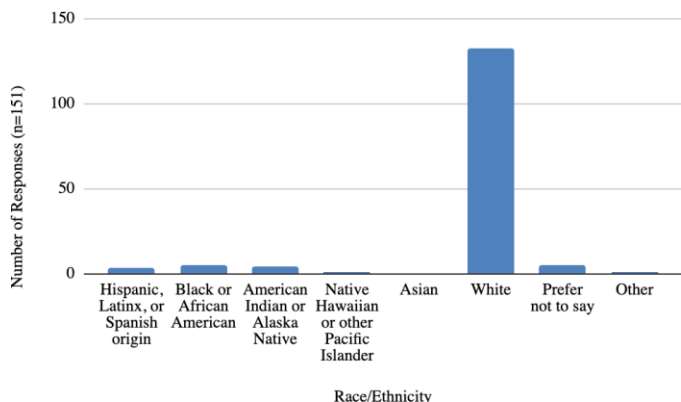


Figure 5. Participant Distribution by Race

Factor 1: Subject Area(s)

In response to survey question 3, “I am willing to take advantage of professional development (PD) opportunities focused on issues of diversity,” the majority of participants agreed. In examining the responses by subject area, none of the participants (0%) from Social Studies, ESL, Fine Arts, or Special Education disagreed. World Languages (WL) and ELA also had a low rate of disagreement. The group with the highest number of participants who disagreed with the statement was Math (.22), followed by Other (.13), and Science (.09). See Figure 6 below.

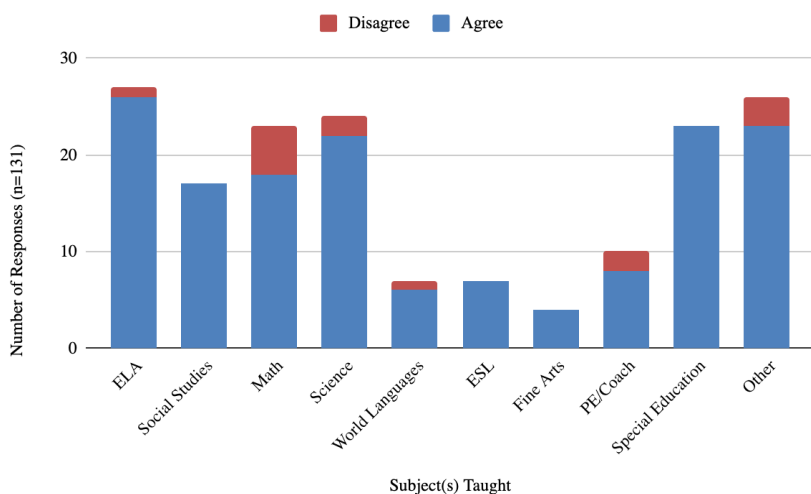


Figure 6. NWA Teachers' Responses to Survey Question 3 based on Subject Area(s)

In response to survey question 8, “I have awareness of my cultural background,” the majority of participants agreed, but there was a higher rate of disagreement than in the previous question. Math had the highest rate of disagreement (.30), followed closely by ELA (.26). However, all participants (100%) from WL and Fine Arts agreed. See Figure 7 below.

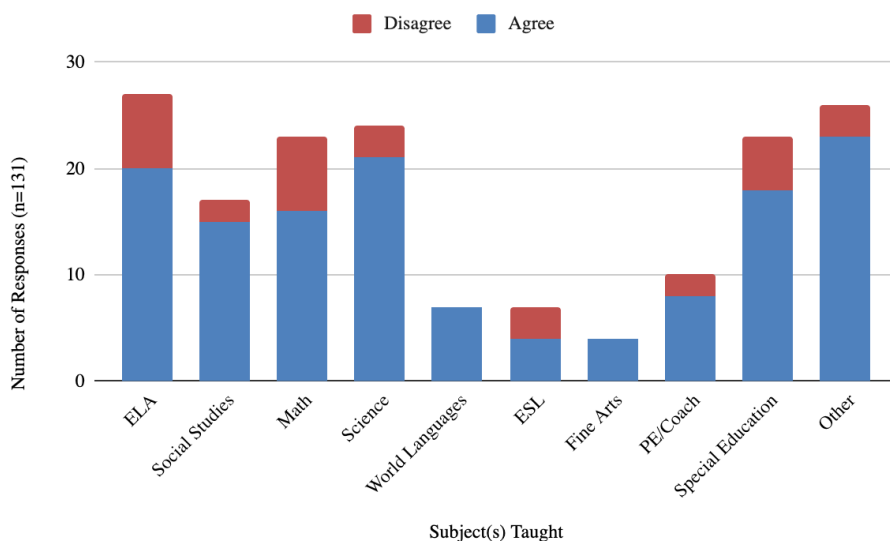


Figure 7. NWA Teachers’ Responses to Survey Question 8 based on Subject Area(s)

Lastly, in response to survey question 11, “I am comfortable with conflict as an inevitable part of the teaching and learning processes,” all (100%) participants from Fine Arts and PE agreed. Special Education (.04) and Social Studies (.06) also has low rates of disagreement, Math (.09) and Science (.08) had slightly higher rates. Followed by World Language (.14) and ESL (.14) with the same rates. ELA had the highest rate of disagreement (.19). See Figure 8 below.

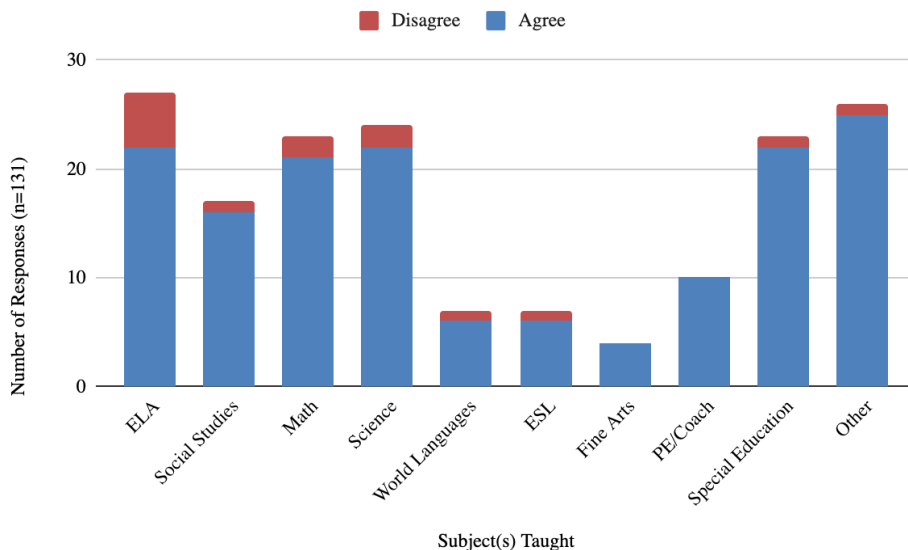


Figure 8. NWA Teachers' Responses to Question 11 based on Subject Area(s)

Factor 2: Years of Teaching

In response to survey question 3 “I am willing to take advantage of professional development opportunities focused on issues of diversity,” most participants agreed, however, the participants with more than 20 years of teaching experience had the highest rate (.16) of disagreement. 11-20 years had the second most disagreements (.06), followed by 5-10, then less than 5, who had zero participants disagree. The rate of disagreement with the statement gets higher as the years of teacher experience go up. See Figure 9 below.

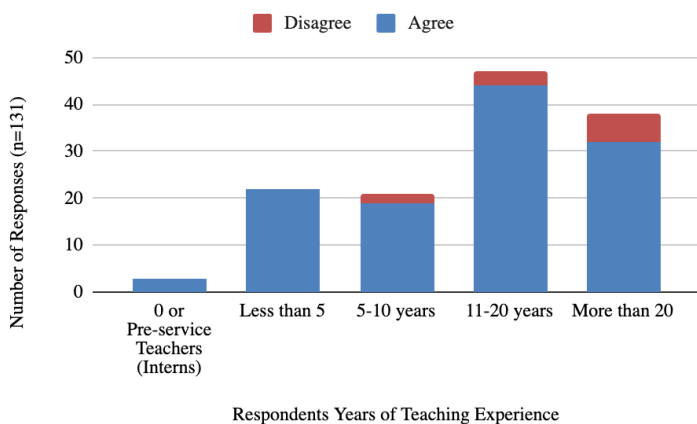


Figure 9. Survey Responses to Survey Question 3 Based on Teachers' Years of Experience

Responses to survey question 8, “I have awareness of my cultural background,” are consistent with the above question as the two groups with the highest rate of disagreement are the 11-20 years and more than 20 years of experience. The largest group of participants who disagreed with the statement was that with 11-20 years of experience (.23), and the succeeding group is teachers with more than 20 years of experience (.16). Additionally, teachers with less than 5 years (.18) had a slightly higher rate of disagreement than 5-10 years (.14). See Figure 10 below for a visual of this reporting pattern.

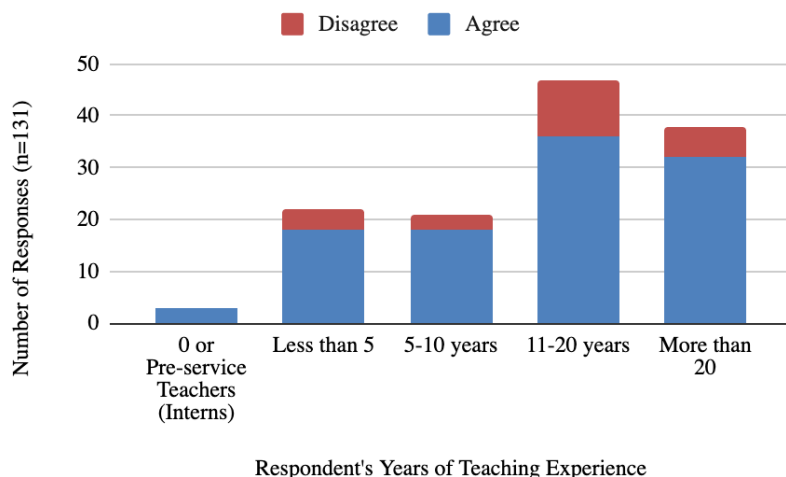


Figure 10. Survey Responses to Question #8 Based on Teachers' Years of Experience

Lastly, most of the responses to survey question 11 “I am comfortable with conflict as an inevitable part of the teaching and learning process,” were “agree.” However, the pattern noted in the preceding figures, is also present in Figure 11 below, “11-20 years” of experience has the highest rate of disagreement with the statement above (.12). It is noteworthy to mention that the “more than 20” years of experience (.05) category has very similar rates of disagreement with 5-10 (.10) and less than 5 years category (.09).

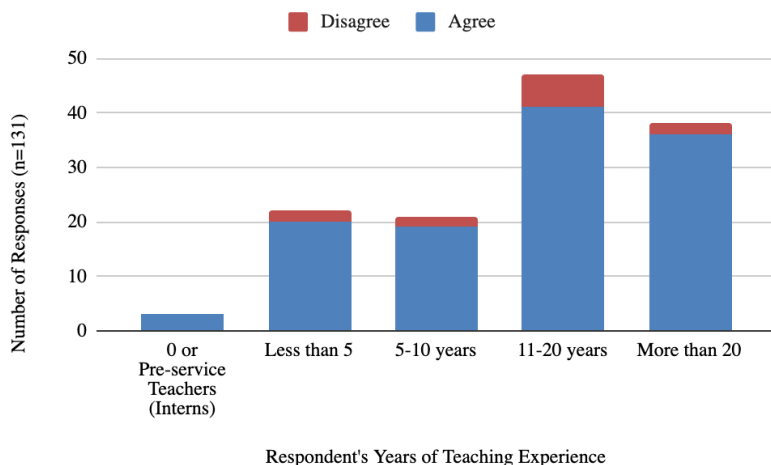


Figure 11. Survey Responses to Question #11 Based on Teachers' Years of Experience

As are many of the survey questions, this particular statement is very subjective to what the respondents view as “conflict.” For example, one teacher may imagine conflict as student frustration over their ability to understand the material, while others may see it as student disagreement with each other over a controversial issue. However, the frame of reference I am viewing this statement through is the one set up by the creators of the DCRPS, promoting community integration into student learning (Whitaker and Valtierra, 2018, p. 10). With that in mind, conflict in the teaching and learning process may be discussing difficult topics that impact students' lives such as - racism, poverty, and cultural differences - topics that may pertain to students' lived experiences, or offer them a new perspective.

RQ #3: What difficulties are NWA Secondary Teachers experiencing when incorporating CRP into their lessons?

The first open-response question (ORQ) in the survey addressed the third research question by asking “What difficulties have you encountered when incorporating culturally responsive practices into your lessons?” The themes for question one represent the overarching difficulty that teachers are reporting in their schools and classrooms. The themes identified from the responses were as follows: student engagement and understanding; resistance and lack of

support from community and others, policy pressures; lack of resources and time constraints; lack of personal efficacy with CRP and curricular challenges; do not use CRP; and no issues reported. It is important to mention that many of the responses overlap in their themes and fall into more than one of the categories, as all of these themes are interconnected in origin. Table 6 below shows some participant responses and their corresponding theme. For the full table with all of the responses, refer to Appendix B (see table B1).

11% of teachers reported not knowing how to incorporate CRP into the curriculum. 25% reported feeling worried or confused about how to use CRP under current legislation, afraid to upset students or parents, and are unsure if their administration will support them. To illustrate, below are some examples of teacher' responses that reflect these two themes:

- “With the recent Arkansas LEARNS Act, I feel a strong sense of fear when teaching anything that is REMOTELY controversial. I have to support my family. As it stands, I will no longer teach anything that can get me in trouble”.
- “A lack of support from my administration and parents of my students.”

While 11% of responses are indicative of either apathetic, uninformed teachers, or against CRP all together.

- “I don't incorporate culturally responsive practices into my lessons. I treat all students the same regardless of their backgrounds and believe all students can learn well regardless of their backgrounds.”
- “I do not worry about being culturally responsive in my lessons. $2 + 2 = 4$ in every culture.”

Table 6. Sample of Participants' Responses to Open Response Question #1 Sorted by Theme

Theme	Responses:
1) Student Engagement and Understanding:	Some of the kids don't want to learn these other cultures. Or they can't find their culture.
	Students are quick to make the leap to racism when it's just a discussion about different cultures.
	immaturity of students or lack of exposure in their own lives
	Students (and some parents) questioning its relevance to the course
	Students maybe uncomfortable sharing
	I'm always sadden by the lack of self-esteem and pride in different cultures. I wish more parents would celebrate their unique backgrounds and cultures.
	Sometimes students have charged responses to these teachings, especially in history. Answering charged or loaded questions in a professional and neutral way can be challenging at times.
2) Resistance and Lack of Support from Community and others, Policy Pressures:	Honestly, at this point, I am more worried about issues at the district and state level. Particularly state. As teaching about the world is bound to make someone uncomfortable, conflict is always a possibility, and the state has damaged a lot of confidence in incorporating culturally responsive practices.
	Concern about political attacks from community members
	Under the new law it sounds illegal.
	The pressure from state representatives, legislators, and some parents and stakeholders who openly criticize culturally responsive practices.
	a lack of support from my administration and parents of my students
	Outside pressure from certain groups to not include culturally responsive practices out of fear of being accused of teaching CRT.
	Some parts of the LEARNS Act now limit or forbid some of these practices.
	With the recent Arkansas LEARNS Act, I feel a strong sense of fear when teaching anything that is REMOTELY controversial. I have to support my family. As it stands, I will no longer teach anything that can get me in trouble.
	Racist attitudes and comments from other students.
3) Lack of Resource and Time Constraints:	I want to utilize resources from the cultures of our population, but there seem to be far less resources and also translation ability with the Marshallese community when compared to the Latine community
	limited time to develop and incorporate culturally responsive practices into classroom content
	teach physics and not a lot of resources, but more keep coming, like Step-UP
	Having enough time. We have a lot of frameworks already to cover

	<p>It can be difficult to find appropriate supplemental resources to use with Curriculum.</p> <p>I teach a subject where culture is not a major topic or even discussed. Knowing how to incorporate this is something I have never been taught or learned about in PD.</p> <p>I will admit that I am struggling to find the time to readjust my curriculum and activities to incorporate some culturally responsive practices.</p> <p>Knowing how to incorporate it with meaning the goals of standard/state testing. Having the time and pacing and scheduling to do community and culture practices.</p>
4) Lack of Personal Efficacy with CRP and Curricular Challenges:	<p>I have encountered anxiety about appropriation and hesitated to present certain topics that I don't understand fully.</p> <p>It is difficult for some people to understand other cultures</p> <p>I do not know what culturally responsive practices are.</p> <p>How to fit in culture into science practices</p> <p>I teach an objective subject that is not open to interpretation or subjective opinion. (My curriculum)</p> <p>Making it authentic instead of feeling forced.</p> <p>Not knowing about other culture's well enough</p> <p>I am sometimes worried that something I say or something I present will be taken out of context and reported to a parent who is against cultural inclusivity.</p> <p>It is difficult to know and understand the cultural backgrounds of all students. I try to get to know each students and incorporate cultural knowledge into the lessons.</p> <p>I try to be sensitive (as much as I can), but also my school isn't very diverse, so sometimes I worry that students will feel singled out.</p> <p>I don't always feel confident that I make all feel included, or that I am politically correct.</p>
5) Do not use CRP:	<p>I do not talk about culturally practices</p> <p>I do not worry about being culturally responsive in my lessons. $2 + 2 = 4$ in every culture.</p> <p>I don't incorporate culturally responsive practices into my lessons. I treat all students the same regardless of their backgrounds and believe all students can learn well regardless of their backgrounds.</p> <p>I don't necessary teach this so I don't have much conflict.</p> <p>I teach math. I try to stick to math. The most culturally incorporative thing I've done is have table names that were the names of minority mathematicians. The curriculum I use often uses names that would not be considered traditionally white protestant.</p>

6) No Issues:	I work in a very culturally diverse school and I have not encountered many issues. Many years ago, some of our cultures were apprehensive about sharing about their culture. Everyone is much more comfortable about sharing their values now.
	I teach film. Each student brings their own culture into their work. The culture that I'm trying to develop is creativity and a hard work ethic.
	Rarely have difficulty. Hospitality is very inclusive as an industry and diversity is prized.
	The majority of my students are very open minded. I work very hard at the beginning of the school year to create a positive and accepting learning environment.

RQ4: What support or resources might assist NWA teachers in incorporating CRP into their practices?

To address the final research question, the second ORQ asked “What support or resources would assist you in incorporating culturally responsive practices into your classroom?” The themes identified in participants' responses were as follows: professional development and training, resources and time, community engagement and understanding, administrative support and collective efforts, and responses that were not clearly aligned. Table 6 below shows some participant responses and their corresponding theme. For the full table with all of the responses, refer to Appendix B (see table B2).

13% of responses reflected a desire to learn more about cultures, languages, and how to enact CRP and other issues of diversity.

- “I have had students from different countries in my class. It would be good to know how to pronounce words such as mom and dad in their native language. It would also be good to have a knowledge of cultural expectations that the family may have while also making sure the rules and laws of our country are followed.”

Additionally, 15% of respondents wanted better, more engaging professional development.

- “A good PD session that is not just someone reading from a powerpoint slide.”

40% of responses indicate that teachers really just need a place to start. Many were unsure how to use CRP within their curriculum and standards, and they did not have the time to figure it out on their own. Further, 10% of participants said they have the awareness and resources, but instead of educational policies supporting them, they were hindering them.

- “I have the resources. I'm not sure I can legally without being sued.”
- “A reversal of recently passed legislation would be necessary to reach all cultures in my classrooms.”
- “The elimination of laws aimed at educators to keep curriculum white washed and history comfortable.”

Table 7. Sample of Participants' Responses to Open Response Question #2 Sorted by Theme

Theme	Responses:
1) Professional Development and Trainings	My initial response is to say that access to high-quality PD would help. We have many veteran teachers in our building who may be resistant to the idea of culturally responsive practices, so getting them on board would be necessary.
	I have had students from different countries in my class. It would be good to know how to pronounce words such as mom and dad in their native language. I would also be good to have a knowledge of cultural expectations that the family may have while also making sure the rules and laws of our country are followed.
	Better understanding of how culture and poverty affect student performance
	Understanding the background of diverse cultures in our area such as Indian & Polynesian peoples and understanding what culture/identity in being retained in the home.
	Professional Development with actual real life application
	A good PD session that is not just someone reading from a powerpoint slide.
	Being more educated on differences in culture
	Possibly a training to discuss cultural norms and expectations for the entire student body.
	I would love more PD sessions on different cultures so I can learn more. I do believe it would help me become a better teacher and improve my practices.
2) Resources and Time	TIME :). Also a database of artists from various cultures

	<p>Having a resource bank that has differentiated material so it is meaningful for students with a variety of different needs and ability levels.</p> <p>Good well rounded true resources. With this day and age it is hard to know what is a good resource on this idea and what is pushing a certain agenda.</p> <p>Ideas specific to a middle school science classroom - how do other science teachers incorporate these practices?</p> <p>If it was incorporated into our curriculum and we were provided with actual people that we could speak to to know if we are in line.</p> <p>Tie-ins to the curriculum. If there were any questioning by parents about our conversations, I don't feel like I could back it with my standards.</p> <p>Aligning to science standards</p> <p>For conflict, I wish I learned a way to steer conversation away from pointing fingers and hearing "You're wrong" or "You'll go to Hell for that". I would like a resource or support that helps me de-escalate situations.</p>
3) Community Engagement and Understanding	<p>Community members from my students' communities to educate me on what they wish teachers would know and to also preview my curriculum as needed.</p>
	<p>Political support for education and diversity in education as well as resources/lessons</p> <p>A reversal of recently passed legislation would be necessary to reach all cultures in my classrooms</p> <p>I have the resources. I'm not sure I can legally without being sued.</p> <p>The elimination of laws aimed at educators to keep curriculum white washed and history comfortable.</p> <p>Guests and experts visiting the classroom from diverse backgrounds</p>
4)Administrative Support and Collective Efforts	<p>A sense of security.</p>
	<p>Knowing my students' preferences culturally, but that would be deemed heresy by admin.</p> <p>I wish everybody in the school promoted cultural diversity. I also wish that more world languages were taught, and were seen as an enrichment, rather than just an elective class</p> <p>Admin support and assurances that teaching culturally responsive content will not be met with resistance from them or directives to stop.</p>
5) Not Clearly Aligned	<p>I am really not sure. You don't know what you don't know.</p>
	<p>I'm not sure; I really just try to treat them all like people knowing that they all come from different backgrounds.</p>

Discussion

This research aimed to examine teacher dispositions toward culturally responsive pedagogy in Northwest Arkansas high schools. More specifically, it investigated how NWA secondary teachers self-reported their dispositions (values, attitudes, and beliefs) toward CRP. Survey findings indicate that the NWA secondary teachers who participated have positive perceptions of CRP.

The study also had three secondary questions it sought to answer. The first sub-question asks what factors affect these teachers' dispositions about culturally relevant practices (i.e., years of teaching, subject matter, and ethnicities). The conjecture was that teachers who teach from the content-specific culturally related curriculum (i.e., World Language teachers) to have stronger dispositions toward CRP practices than non-world language teachers (e.g., science, math, history, etc.). This conjecture is backed by scholarship investigating the teacher training and necessary dispositions of WL teachers (Dion, 2020). Additionally, based on the instructional practices that scholars suggest are consistent with culturally responsive teaching, it was anticipated that teachers who explicitly teach English language learners (ELL) have stronger perceptions of CRP practices than single-subject teachers (Richards et al., 2007). The findings slightly diverge from these conjectures, as survey question 8 shows that WL and ESL teachers had a higher rate of disagreement than six of the other subject areas. Based on recent educational reform movements, an increase in multicultural education, and the dismantling of previous "colorblind" ideologies in education, the study predicted to find that novice teachers may have more positive dispositions toward CRP than veteran teachers. (Richards et al., 2007; Mette, 2016). This conjecture was affirmed by the responses from teachers in this study, which suggest that teachers with less than 5 years to 10 years of teaching experience are more likely to have positive perceptions of the

values, attitudes, and beliefs related to CRP, than teachers with 20 or more years of experience. However, the responses alone cannot confirm the nuances behind the findings.

Lastly, the study sought to examine classroom teachers' struggles in using CRP. The expectation was that responses would be mixed, some of which teachers were facing issues, and some who were not concerned with incorporating CRP. The findings were consistent with the expectation, however, another group appeared in the findings, those who do not have an understanding of the topic and, therefore do not use it.

Cultural Awareness

Overall, survey findings suggest that teachers who work with predominantly diverse students or topics are more likely to agree with the values, attitudes, and beliefs related to culturally responsive practices. Specifically, teachers in subjects who work with culturally related content or diverse students, were more likely to agree with the statement, “I have an awareness of my cultural background.” This is consistent with the expectation because literature suggests that experiences and exposure to diversity are the most impactful when it comes to multicultural or culturally responsive instruction (Kolano et al., 2014).

Conflict in the Classroom

Further, a key pillar of CRP is addressing students' lived experiences in tandem with experiences foreign to them to expand their worldview and help students move into a social justice mindset. With that, teachers and students may experience conflict as necessary part of the teaching and learning process. Many teachers may fear having conflict in their classrooms in a world that has become very polarized. Social Studies content, in particular, may be a point of contention. This is evident in recent years as different curricula, topics, and books are have been banned in Social Studies classrooms. For example, in 2022 the state of Florida banned AP

African American Studies courses and passed legislation that banned Critical Race Theory, this is known as the “Individual Freedom Act” (Hollingsworth, 2023; DeSantis, 2022). Similarly, in 2023, Arkansas passed the LEARNS Act (Arkansas’ Executive Order 23-05), which “prohibits indoctrination and Critical Race Theory in Schools,” (Sanders, 2023). These legislative actions alone present space for potential conflict in the classroom, and by banning discussion of America’s instructional racism, it has the potential to amplify those issues.

For those reasons, it is interesting that Social Studies teachers posed one the lowest rates of disagreement to the statement, “I am comfortable with conflict as an inevitable part of the teaching and learning processes,” when it comes to single-subject content areas because. These results may suggest that despite the legislative battles happening outside the classroom, Social Studies teachers are committed to teaching students how to critically examine the past and understand historical inequity, allowing potential conflict to spur discussion (Martell, 2018).

Professional Development on Diversity

The survey statement, “I am willing to take advantage of professional development opportunities focused on issues of diversity,” the results were consistent with what was expected; teachers who work with predominantly diverse students were more likely to agree with the statement. ESL teachers consistently work with culturally and linguistically diverse students and Special Education teachers work with students with diverse sets of needs and backgrounds. Research supports that teachers who have a connection or interest in issues of diversity in education will be more likely to continue learning about it or participating in further training (Kolano et al., 2014). Another consideration for these more positive perceptions is that these courses do not have the added pressures of standardized testing, therefore, they may have different perceptions of student achievement and instructional goals (Mette et al., 2016).

On the same survey question as above, it was anticipated that teachers who have had more teaching experience, but more importantly, teachers who went through their teacher education longer ago, would disagree with this statement more than newer teachers. The results confirmed my expectation. These findings are congruent with what other researchers suggest because teacher training programs have added coursework and prompted reflection on cultural awareness, that was not previously provided or mandated when veteran teachers completed their education (Jensen, 2021). Therefore, teachers who were more recently in teacher preparation programs were likely given a stronger understanding of cultural competency and its implications on the classroom (Jensen, 2021). Further, classrooms are becoming more diverse than ever before, so teachers who have been working longer may be accustomed to predominantly white environments, leading to less cultural awareness. Whereas newer teachers are more likely to begin their teaching experience in more diverse classrooms, requiring them to develop more cultural awareness from the start (Kolano et al., 2014).

Whitaker and Valtierra reported that white preservice teachers whose student teaching was in a diverse urban school realized the importance of connecting content to the students' community, making them more open to conflict and discussion (2018, p. 10). As schools are growing in diversity, that offers more opportunities for preservice teachers to get exposure to diverse classrooms earlier in their experiences, whereas teachers with more experience may not have had significant exposure (Kolano et al., 2014). An important consideration is that researchers note that there is not enough known about the level of acceptance of diversity training for veteran teachers, largely because they self-report higher CRP strategies than what is observed (Cox et al., 2017, p. 4).

Difficulties Using CRP

Lastly, this study sought to explore what difficulties teachers were having while incorporating culturally responsive practices into their lessons. Further, it aimed to explore potential avenues of support for teachers' implementation of CRP. According to survey findings, teachers reported lacking support, resources, time, and understanding of CRP. Likewise, when asked what support and resources would assist them, teachers reported wanting more tangible professional development, administrative support, and community understanding.

The sentiments that were seen in NWA teachers' responses to the difficulties they were facing in using CRP in the classroom and the support they needed are consistent with what scholarship reports. A case study of teachers' perceptions of CRP and its connection to leadership and preparation noted the importance of leadership which fostered a supportive environment for diversity and promoted effective training (Mette, 2016). Similarly, respondents in this study reported a lack of support from school administration and parents. Additionally, in the case study the two main themes the researchers identified for teachers' challenges when using CRP were, "lack of time and implementation apathy," (p. 14). Those themes were also attributed to little preparation and training on CRP during teacher preparation programs. Research often attributes teachers' apathy or even rejection of diversity initiatives in school to the lack of examination of race and racism in our society in traditional teacher preparation programs. Limited training about CRP means some educators are left with a limited understanding of racism and the importance of equitable practices. In many cases, it is up to the leaders of the school and community to foster an equitable environment and promote CRP practices within the school (Mette, 2016; Gay, 2018).

A common thread amongst research suggests that when teachers are offered support, resources, training, etc. that is relevant to CRP, it is not very effective (Jensen, 2021; Mette, 2016). This is consistent with studies on teacher diversity training and preparedness that report professional development opportunities on diversity were not actionable or effective (Jensen, 2021, p. 116). Regardless of the lack of competency or self-efficacy teachers have towards CRP, it is the responsibility of school districts and school leadership to enhance teachers' skills (Jensen, 2021, p. 49). Even with these considerations of cultural competency and awareness, there are still concerns about what is considered “too far,” by the law. While research has not yet been done to investigate Arkansas teachers' response to the recent legislation, there are reports of educators speaking against the LEARNS Act, expressing similar sentiments to those of the participants (Claybrook, 2023). Richards' work asserts that reform of school policies and procedures is one of the foremost ways to make the institution of education more culturally responsive. Educational policies have the power to determine the relationship the education system has with its diverse constituents and, therefore, have the power to shape what goes on inside the classroom (Richards et al., 2007, p. 64).

Limitations

Given the findings presented, it is imperative to note the limitations of this study. While the survey instrument was validated and likely to yield a good response rate due to the short amount of time necessary to respond, without other sources of data to triangulate with, the survey itself even with the open-ended questions, fails to capture the nuance of this topic. As scholars recognize, it is difficult to discern the accurate acceptance of CRP practices in a self-reported study (Cox et al., 2017). However, these results do suggest potential disparities that could be investigated further through the district's observations, evaluations, and feedback from

school staff and faculty. Additionally, as this study was completed through volunteer participation with a limited number of individuals (n=131) across the school districts, it is not intended to be used as a representative report of the secondary teachers in the region. Rather, this takes a glimpse into the pedagogical values, attitudes, and beliefs of a portion of the population, intending to encourage further research in this area. Further, to gain a better understanding of the current training and initiatives related to CRP in the school districts, it would have been beneficial to have asked participants what CRP-related training they have completed with their district.

Conclusion

This study contributes to a better understanding of teachers' perceptions of culturally responsive pedagogy. This is done by focusing on a specific region with varying degrees of racial/ethnic and socioeconomic diversity and has recently undergone state-wide educational policy change. The majority of participants reported positive dispositions toward the values, attitudes, and beliefs of culturally responsive pedagogy. This study further examines factors affecting teachers' dispositions: their subject areas and years of teaching experience. This study suggests that teachers who work with predominantly diverse students are more likely to have positive perceptions toward practices relevant to CRP. Additionally, results suggest that teachers who participated in teacher preparation more recently, specifically teachers with 5 to 10 years of experience, are more likely to have positive perceptions of CRP practices.

Lastly, and perhaps most relevant in understanding teachers' first-hand experience with CRP, this study examined teachers' difficulties when incorporating CRP into their classrooms. Findings indicate that teachers need more tangible, actionable CRP professional development and CRP curriculum scaffolding to minimize the time they spend building practices into their

lessons. Further, teachers need more support from their administration and/or policymakers to ensure that they can incorporate culturally relevant, equitable, and fair educational practices into their rooms.

These findings intend to inform school administrators of factors that may affect positive dispositions towards CRP and the barriers teachers are facing. Based on that information, districts should work to create and implement quality professional development that could support an increase in positive teacher dispositions towards CRP. Districts could initiate future studies investigating NWA teachers' dispositions to CRP to help analyze specific struggles in their area and, if done continuously, could be used to chart the effectiveness of their PD.

Furthermore, based on the findings of this study, additional future research is merited to build on this research with additional data sources or a qualitative component to explore some of the nuances this study was unable to capture.

As this region continues to diversify and the policies that shape our education system continue to change, school leadership needs to implement mandated professional development focused on culturally relevant pedagogy and practices. School districts should provide all teachers with professional development that gives them the tools and resources to implement a culturally relevant environment in their classrooms and by extension, in the school.

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Appendix A

Survey Instrument

Perceptions of Culturally Responsive Pedagogy: NWA Teachers

Dear NWA Secondary Teachers,

Thank you for agreeing to participate in this study to examine some of the perceptions held by local educators toward values associated with culturally responsive pedagogy. Your responses are anonymous.

This examination has the potential to both validate the effectiveness of teacher preparation and training programs in promoting equitable educational practices and uncover areas where additional support and resources are required to cultivate a more inclusive and culturally responsive learning environment.

In the 3-5 minute survey below, you will be asked to provide some demographic information and then rank a series of 11 Likert- style statements about your own teaching practices.

Participation in this survey is voluntary, and declining to participate will not adversely affect your relationship with the University or the researchers. Willingness to return the completed questionnaire indicates your consent to participate in this anonymous study. We greatly appreciate your participation and support, and we encourage you to share this with fellow Northwest Arkansas 7-12 teachers!

If you have questions about the research, please contact principal researcher, Rylie Ford at rnford@uark.edu or faculty supervisor, Dr. Peggy Ward at pdward@uark.edu.

If you have questions or concerns about your rights as a research participant, please contact Ro Windwalker, the University's IRB Coordinator, at 479-575-2208 or irb@uark.edu.

Click on the red arrow below to start the survey.

- 1) How many years of teaching experience do you have?
 - 0 or Pre-service Teachers (Interns)
 - Less than 5
 - 5-10 years
 - 11-20 years

- More than 20

2) What grade level(s) do you teach? Select all that apply.

- 7th
- 8th
- 9th
- 10th
- 11th
- 12th

3) What subject(s) do you teach? Select all that apply.

- ELA
- Social Studies
- Math
- Science
- World Languages
- ESL
- Fine Arts
- Physical Education/Coach
- Special Education
- Other ___

4) How would you describe yourself? Select all that apply

- Hispanic, Latinx, or Spanish origin
- Black or African American
- American Indian or Alaska Native
- Native Hawaiian or other Pacific Islander
- Asian
- White
- Prefer not to say
- Other ___

5) What is your gender?

- Male
- Female
- Non-binary/non-conforming
- Prefer not to say
- Other ___

How much do you agree with the statements below?

	Strongly Agree	Agree	Somewhat Agree	Somewhat Disagree	Disagree	Strongly Disagree
I value assessing my own teaching practices	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am aware of my cultural background	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am willing to take advantage of professional development opportunities focused on issues of diversity	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am open to feedback about my teaching practices	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am willing to examine my own identities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am willing to be vulnerable in my classroom	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I value dialogue as a way to learn about students' out of school lives	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have awareness of my cultural background	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I value student differences and incorporate it into my curriculum	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

I view myself as a member of the learning community along with students

-

I am comfortable with conflict as an inevitable part of the teaching and learning processes

-

Optional Open Response: Do you wish to elaborate, expand, or comment on any of your responses above?

What difficulties have you encountered when incorporating culturally responsive practices into your lessons?

What support or resources would assist you in incorporating culturally responsive practices into your classroom?

Will you consider participating in a subsequent virtual follow-up interview so I can validate my interpretations of the responses you provided? If yes, your identity will remain anonymous to everyone except me and my faculty advisor and used only for data analysis purposes.

- Yes -- include email below

- No

Do you have any additional comments you wish to provide?

Appendix B

Participant Responses to Open Response Questions 1 & 2

Table B1. Participants' Responses to Open Response Question #1 Sorted by Theme (n=88)

Theme:	Responses:
1) Student Engagement and Understanding:	<p>Resistance by a few students. Finding meaningful ways to make all students feel represented and heard. Some students do not have the life experience to believe what other students are saying about their lived experience.</p> <p>I think the biggest challenge in my classroom is finding things that will actively engage my students. When going over black history month, sometimes my non-POC students tend to not engage as much.</p> <p>Some of the kids don't want to learn these other cultures. Or they can't find their culture.</p> <p>Students willingness to engage in these conversations. Not dictating what "culture" means or having too narrow of a lens.</p> <p>Students are quick to make the leap to racism when it's just a discussion about different cultures.</p> <p>immaturity of students or lack of exposure in their own lives</p> <p>Students claim they do not have a culture. I see this more among my white students.</p> <p><i>Students (and some parents) questioning its relevance to the course</i></p> <p>Some students can be skeptical at first, but then they understand the value of what we are doing</p> <p>Many student who do not have a strong sense of culture at home have a hard time understanding different culture views and ways of living.</p> <p>some students don't want their culture focused on. We have a set curriculum and adding things can be a challenge</p> <p>Students maybe uncomfortable sharing</p> <p>I'm always sadden by the lack of self-esteem and pride in different cultures. I wish more parents would celebrate their unique backgrounds and cultures.</p> <p>Sometimes students have charged responses to these teachings, especially in history. Answering charged or loaded questions in a professional and neutral way can be challenging at times.</p> <p>Students may not know about their culture or they might not recognize their culture as a part of their identity</p> <p>I teach exceptional students and that brings a heightened sense of awareness to the words that we use to convey information about cultures that are not there own, because most take things very literally and don't have a lot of room for openness from their own unique experiences.</p>
2) Resistance and Lack of Support from Community and others,	<p>Attitudes of other educators</p>

Policy Pressures:	
	<p>Honestly, at this point, I am more worried about issues at the district and state level. Particularly state. As teaching about the world is bound to make someone uncomfortable, conflict is always a possibility, and the state has damaged a lot of confidence in incorporating culturally responsive practices.</p> <p>There is a general hesitancy surrounding anything that might be too "woke". I teach in a smaller, rural but rapidly growing district that has historically been resistant engaging in diversity initiatives or culturally responsive practices. We have also been under attack by Moms for Liberty, and I think that has caused fear and frustration among the faculty here.</p> <p>Concern about political attacks from community members</p> <p>Under the new law it sounds illegal.</p> <p>Fears of accusations to indoctrination.</p> <p>Some do not agree that we should do that an feel that we are pushing other cultures on them.</p> <p>The pressure from state representatives, legislators, and some parents and stakeholders who openly criticize culturally responsive practices.</p> <p>a lack of support from my administration and parents of my students</p> <p>Outside pressure from certain groups to not include culturally responsive practices out of fear of being accused of teaching CRT.</p> <p><i>Some parts of the LEARNS Act now limit or forbid some of these practices.</i></p> <p>Certain student prejudices or expressed parental responses concerned about a "lack of patriotism" in the classroom.</p> <p><i>With the recent Arkansas LEARNS Act, I feel a strong sense of fear when teaching anything that is REMOTELY controversial. I have to support my family. As it stands, I will no longer teach anything that can get me in trouble.</i></p> <p>Afraid I'm going to offend someone</p> <p>Racist attitudes and comments from other students.</p> <p>The tough questions students ask. I worry that they will ask something inappropriate and/or offend someone. Also the time, we have so much curriculum to cover as it is.</p> <p>Occasional comments or quips about different cultures.</p>
3) Lack of Resource and Time Constraints:	<p>I want to utilize resources from the cultures of our population, but there seem to be far less resources and also translation ability with the Marshallese community when compared to the Latine community</p>

	<p>I don't really have difficulty incorporating Hispanic culture into my teaching. I have classes where the major of students are not white and we talk about their traditions and we read stories that incorporate their culture. The only trouble I have is we don't incorporate all cultures that are represented in my classroom.</p> <p>limited time to develop and incorporate culturally responsive practices into classroom content</p> <p>teach physics and not a lot of resources, but more keep coming, like Step-UP</p> <p>Having enough time. We have a lot of frameworks already to cover</p> <p>Timing in class to differentiate and explore beyond the curriculum. The curriculum has broadened its horizons, however, moving away from Western Civilization to incorporating a Southernization element to begin World History that includes the ancient cultures/civilizations that eventually allow Europeans to sail the world.</p> <p>It can be difficult to find appropriate supplemental resources to use with Curriculum.</p> <p>I teach a subject where culture is not a major topic or even discussed. Knowing how to incorporate this is something I have never been taught or learned about in PD.</p> <p>Finding resources and effective implementation. To be honest, I have significant difficulty implementing any pedagogical practice that is created by someone who does not actually do the work that secondary school teachers do. My experience has led me to believe that there is too large a gap between theory and reality.</p> <p>I will admit that I am struggling to find the time to readjust my curriculum and activities to incorporate some culturally responsive practices.</p> <p>Knowing how to incorporate it with meeting the goals of standard/state testing. Having the time and pacing and scheduling to do community and culture practices.</p>
<p>4) Lack of Personal Efficacy with CRP and Curricular Challenges:</p>	<p>I have encountered anxiety about appropriation and hesitated to present certain topics that I don't understand fully.</p> <p>If the culture is different than your own, it can be very challenging to make sure that you are incorporating the practices fully and responsibly.</p> <p>It is difficult for some people to understand other cultures</p> <p>If you change education for one group then another can be left behind, so we must present the nuts and bolts of the subject matter.</p> <p>I do not know what culturally responsive practices are.</p> <p>How to fit in culture into science practices</p> <p>I teach an objective subject that is not open to interpretation or subjective opinion. (My curriculum)</p> <p>Making it authentic instead of feeling forced.</p> <p><i>Not knowing about other culture's well enough</i></p>

	<p>I am sometimes worried that something I say or something I present will be taken out of context and reported to a parent who is against cultural inclusivity.</p> <p>Its difficult to know how to approach the topic without inviting more conflict. I teach mostly STEM. I make sure to showcase Inventors, scientists, and engineers that are female or people from other cultures. Beyond that I don't feel I am competent enough to handle an open discussion.</p> <p>It is difficult to know and understand the cultural backgrounds of all students. I try to get to know each students and incorporate cultural knowledge into the lessons.</p> <p><i>I try to be sensitive (as much as I can), but also my school isn't very diverse, so sometimes I worry that students will feel singled out.</i></p> <p>I don't always feel confident that I make all feel included, or that I am politically correct.</p> <p>knowing how or what that even means, I feel like I build a valuable rapport with each of my students and adapt to their level</p>
5) Do not use CRP:	<p>I do not talk about culturally responsive practices</p> <p><i>I do not worry about being culturally responsive in my lessons. $2 + 2 = 4$ in every culture.</i></p> <p><i>I don't incorporate culturally responsive practices into my lessons. I treat all students the same regardless of their backgrounds and believe all students can learn well regardless of their backgrounds.</i></p> <p>I don't necessary teach this so I don't have much conflict.</p> <p>I haven't.</p> <p>I teach math. I try to stick to math. The most culturally incorporative thing I've done is have table names that were the names of minority mathematicians. The curriculum I use often uses names that would not be considered traditionally white protestant.</p> <p>The feeling that only certain cultures are receiving favoritism and there is clear bias when these subjects are addressed.</p>
6) No Issues:	<p>I work in a very culturally diverse school and I have not encountered many issues. Many years ago, some of our cultures were apprehensive about sharing about their culture. Everyone is much more comfortable about sharing their values now.</p> <p>I teach film. Each student brings their own culture into their work. The culture that I'm trying to develop is creativity and a hard work ethic.</p> <p>Rarely have difficulty. Hospitality is very inclusive as an industry and diversity is prized.</p> <p>I have not in my time really ran into many problems. I have had a handful of parents ask for their student to maybe do an alternate assignment but nothing crazy.</p> <p>none (x2)</p>

The majority of my students are very open minded. I work very hard at the beginning of the school year to create a positive and accepting learning environment.

Table B2. Participants' Responses to Open Response Question #2 Sorted by Theme (n=83)

Theme	Responses
1) Professional Development and Trainings	better education about our super small minority groups, (Karen speakers, Kiribati, Laos, etc)
	My initial response is to say that access to high-quality PD would help. We have many veteran teachers in our building who may be resistant to the idea of culturally responsive practices, so getting them on board would be necessary.
	More professional development and access to diverse texts that are approved to teach in the classroom
	We have Instructional coaches that can help us. I would be open to some professional development.
	I would best be supported initially by training in what constitutes culturally responsive training.
	I always love to learn about new cultures to help in my understanding.
	<i>Learning more, new things that may be better for how we personally do things</i>
	<i>I have had students from different countries in my class. It would be good to know how to pronounce words such as mom and dad in their native language. I would also be good to have a knowledge of cultural expectations that the family may have while also making sure the rules and laws of our country are followed.</i>
	<i>Better understanding of how culture and poverty affect student performance</i>
	Understanding the background of diverse cultures in our area such as Indian & Polynesian peoples and understanding what culture/identity in being retained in the home.
	Additional professional development to help teachers navigate the very muddy water we are in.
	professional development
	<i>training, practice, and teacher observations</i>
	Knowledge of cultural do's and don't's.
	Professional Development with actual real life application
	examples for specific content area. some sort of boundary guide. etc
	<i>A good PD session that is not just someone reading from a power point slide.</i>
	Being more educated on differences in culture

	<p>PD would be very helpful.</p> <p>Possibly a training to discuss cultural norms and expectations for the entire student body.</p> <p><i>I would love more PD sessions on different cultures so I can learn more. I do believe it would help me become a better teacher and improve my practices.</i></p>
2) Resources and Time	<p>Literacy embedded instructional materials with an emphasis on expressive language communication</p> <p>TIME :). Also a database of artists from various cultures</p> <p>guest speakers, videos, books etc</p> <p>Honestly, I think that the resources are out there for those who are willing to seek it. For everyone else, however, I think that teaching resources that present simple bellwork prompts highlighting important figures and dates/events for students and teachers alike to explore.</p> <p>more planning time or fewer subjects to prepare for</p> <p>more resources</p> <p>Texts by diverse authors</p> <p>Access to different resources that teachers could choose to take part in their classroom</p> <p>I personally would like a great book on the topic.</p> <p><i>Having a resource bank that has differentiated material so it is meaningful for students with a variety of different needs and ability levels.</i></p> <p>If there are certain words pertaining to math that I would need to explain in a different way due to a student's backgrounds, then that would be helpful, but otherwise I don't feel that any support or resources are needed.</p> <p>I plan with my PLC for our lessons and we review each one to make sure they are appropriate.</p> <p>Good well rounded true resources. With this day and age it is hard to know what is a good resource on this idea and what is pushing a certain agenda.</p> <p>If the school could provide information on students' backgrounds at beginning of school.</p> <p>Ideas specific to a middle school science classroom - how do other science teachers incorporate these practices?</p> <p>If it was incorporated into our curriculum and we were provided with actual people that we could speak to to know if we are in line.</p> <p>AR Course Frameworks/Components</p> <p>Ideas specific to a middle school science classroom - how do other science teachers incorporate these practices?</p> <p>Tie-ins to the curriculum. If there were any questioning by parents about our conversations, I don't feel like I could back it with my standards.</p>

	<p>It is important to understand where each of my students is from. In world history, I don't want to skip over something that a student would relate to or make to general of a summary of the topic at hand.</p> <p>Aligning to science standards</p> <p><i>For conflict, I wish I learned a way to steer conversation away from pointing fingers and hearing "You're wrong" or "You'll go to Hell for that". I would like a resource or support that helps me de-escalate situations.</i></p>
3) Community Engagement and Understanding	<p>Community members from my students' communities to educate me on what they wish teachers would know and to also preview my curriculum as needed.</p> <p>Political support for education and diversity in education as well as resources/lessons</p> <p>I am a Native Speaker from Colombia and being aware of cultural backgrounds is one of my strenghts.</p> <p><i>A reversal of recently passed legislation would be necessary to reach all cultures in my classrooms</i></p> <p><i>I have the resources. I'm not sure I can legally without being sued.</i></p> <p><i>The elimination of laws aimed at educators to keep curriculum white washed and history comfortable.</i></p> <p>Guests and experts visiting the classroom from diverse backgrounds</p> <p>How is culture determined? What are diverse backgrounds? What parts are race or religion based? What parts are income based? How do we understand and connect to cultures different than our own? How to we interact with biases on both sides? I'm more ignorant about the lives of wealthy families than I am other groups because I have not lived that life myself. Last, how do we expect people to be aware of others when so many of us are unaware of ourselves? Perhaps that is where the resources should begin? Examining our own experience and then finding ways to connect that to others? To answer your question, I believe that we are lacking knowledge that is not politicized in any way. I'm not necessarily answering this for myself, but I have seen colleagues and community members turn against responsive practices because of the political smearing that has occurred with DEI practices.</p> <p>These types of subjects are the very reason we are experiencing tension. Teaching the subject matter in an unbiased way and avoiding pushing an agenda is the most professional way to teach.</p> <p>Guest speakers that fit into the curriculum</p>
Administrative Support and Collective Efforts	<p><i>A sense of security.</i></p> <p>I would love to know what my legal boundry would be.</p> <p><i>Knowing my students' preferences culturally, but that would be deemed heresy by admin.</i></p> <p>I wish everybody in the school promoted cultural diversity. I also wish that more world languages were taught, and were seen as an enrichment, rather than just an elective class</p> <p>Admin support and assurances that teaching culturally responsive content will not be met with resistance from them or directives to stop.</p>
4) Not clearly aligned:	<p>I am really not sure. You don't know what you don't know.</p>

None you just need to be aware of all students and their needs.
All good here.
There aren't any. I use life experience and student experience.
NA
none.
I'm not sure; I really just try to treat them all like people knowing that they all come from different backgrounds.
not sure.
I allow my students of different background share about their cultures, if they are willing.
Anything that teaches students the value of a strong work ethic and a pursuit of creativity.
I'm not sure, and I wish there were specific examples of what you mean by culturally responsive practices.
We have most of the resources we need
n/a
<i>I just try not to bring it up</i>
Anything.
Not sure
<i>I don't know what I don't know.</i>

About the Author

Rylie Ford is a recent graduate of the University of Arkansas where she received a bachelor's degree in social studies education and history. This research, her undergraduate honors thesis, sparked her passion for equitable education and teaching for social justice. She will begin the history master's program at the University of Arkansas in Fall 2024, where she will also serve as a graduate assistant for the department. After completing her master's she plans to go back to the classroom and pursue a career in secondary Social Studies education.



Deciphering the Double-Edged Action of STING Pathway in Cancer

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Abstract

Cancer cells have unstable chromosomes and damaged DNA, which can activate the cellular alarm system cGAS-STING. This mechanism detects DNA in the incorrect location (the cytosol) and produces type I interferons, which can recruit immune cells to combat cancer. However, certain tumours can bypass or use this mechanism for their own benefit. This short article examines how cGAS-STING influences the different cells of the tumour microenvironment (TME), and how it can have both anti-tumour and pro-tumour effects. It also demonstrates how additional STING signals can cause inflammation and contribute to cancer growth. To employ cGAS-STING against cancer, it is critical to understand its complexities in various cell environments.

Keywords: cGAS-STING signalling, cancer, immune system, molecular biology, cancer immunotherapy

DNA Detection Mechanisms in Cancer

The immune system can recognize and destroy cancer cells, even though they originate from our own body. This is because these cells, especially those with many mutations, produce neo-antigens that are detected by the adaptive immune system [1]. However, for the immune system

to work effectively, it needs a favourable tumour microenvironment (TME), which should support the innate immune mechanisms that secrete interferons, cytokines and chemokines. These molecules attract and activate immune cells that fight cancer. One key innate immune mechanism is the STING (Stimulator of Interferon Genes) pathway, which is triggered by the cGAS (cyclic GMP-AMP synthase) sensor when it finds cytosolic DNA or DNA damage [3]. Pathogen-associated molecular patterns (PAMP) or the cell's own nuclear or mitochondrial DNA (DAMP) can both produce cytosolic DNA when damaged. Cancer cells frequently carry cytosolic DNA due to chronic DNA damage and chromosomal instability (CIN), which are hallmarks of cancer [4]. CIN and DNA damage can cause the creation of micronuclei, which contain damaged DNA or chromosomes. When these structures break, DNA is released into the cytosol [5]. CIN and DNA damage can also cause DNA fragments to leak from the nucleus or create chromatin bridges, which are detectable by cytosolic DNA sensors [6]. The cGAS-STING pathway is the primary method for sensing cytosolic dsDNA in a variety of cells, including during infection, malignancy, and DNA damage [4]. cGAS detects dsDNA with no sequence preference and produces ladder-like structures in the cytoplasm [7]. In the nucleus, where cGAS is also present, chromatin-bound nucleosomes impede its enzymatic activity [8]. However, cGAS may still interact with DNA replication forks, influencing genomic stability and homologous recombination [9]. When cGAS interacts with cytosolic dsDNA, it generates 2'3'-cyclic GMP-AMP (cGAMP), a second messenger that activates STING, an ER membrane protein [2, 10]. STING travels from the ER to the Golgi through the ER-Golgi intermediate compartment (ERGIC) and recruits TANK-binding kinase 1 (TBK1), which phosphorylates STING, interferon regulatory factor 3 (IRF3), and nuclear factor kappa-light-chain-enhancer of activated B cells (NF- κ B) [11]. These transcription factors activate interferon type I (IFN-I), cytokines, and

chemokines such C-X-C motif chemokine ligand 10 (CXCL10) and C-C motif chemokine ligand 5 (CCL5). STING can potentially cause autophagy, senescence, or cell death, depending on the signal amplitude and cell type [12]. The cGAS-STING pathway is controlled by a variety of post-translational changes, including ubiquitylation, ubiquitin-like proteins, and metabolites [13].

STING Pathway Dynamics in Carcinoma Cells

STING can be triggered by extracellular cGAMP, bacterial cyclic dinucleotides (CdNs), membrane fusion, nuclear DNA damage, and cGAS, which generates cGAMP as a second messenger [2, 14]. IFN-Is and chemokines are produced as a result of STING activation, and these molecules alter the TME and the adaptive immune response [15]. In animal models, STING signalling has anti-cancer properties that can be augmented by STING agonists or cancer treatments like radiation [16]. By detecting their own DNA or by transferring cGAMP to nearby cells like stromal or endothelial cells, cancer cells can activate STING [17]. Angiogenesis and vascular normalization in tumours are likewise regulated by STING activity in the endothelium (Figure 1) [18].

Extracellular DNA from tumours in the TME activates the DNA sensing pathway when it is absorbed by immune cells, particularly the dendritic cells (DCs) [19]. DNA-vesicle fusion or chromatin proteins like high mobility group box 1 (HMGB1) may be involved in the processes of DNA absorption [20, 21]. When cGAS enters the cytosol, it starts to produce IFN-I, which is mostly produced by CD11c⁺ DCs in mice [22]. Anti-tumour immunity is induced by IFN-Is by improving DCs and antigen presentation to CD8⁺ T cells [2, 23]. Mice lacking the IFN-I receptor or STING in DCs lose this immunity and are unable to reject tumours [23, 24]. In

addition, STING decreases myeloid suppressors, activates NK cells, polarizes macrophages to the M1 phenotype, and uses chemokines to draw in more immune cells [25, 26, 27].

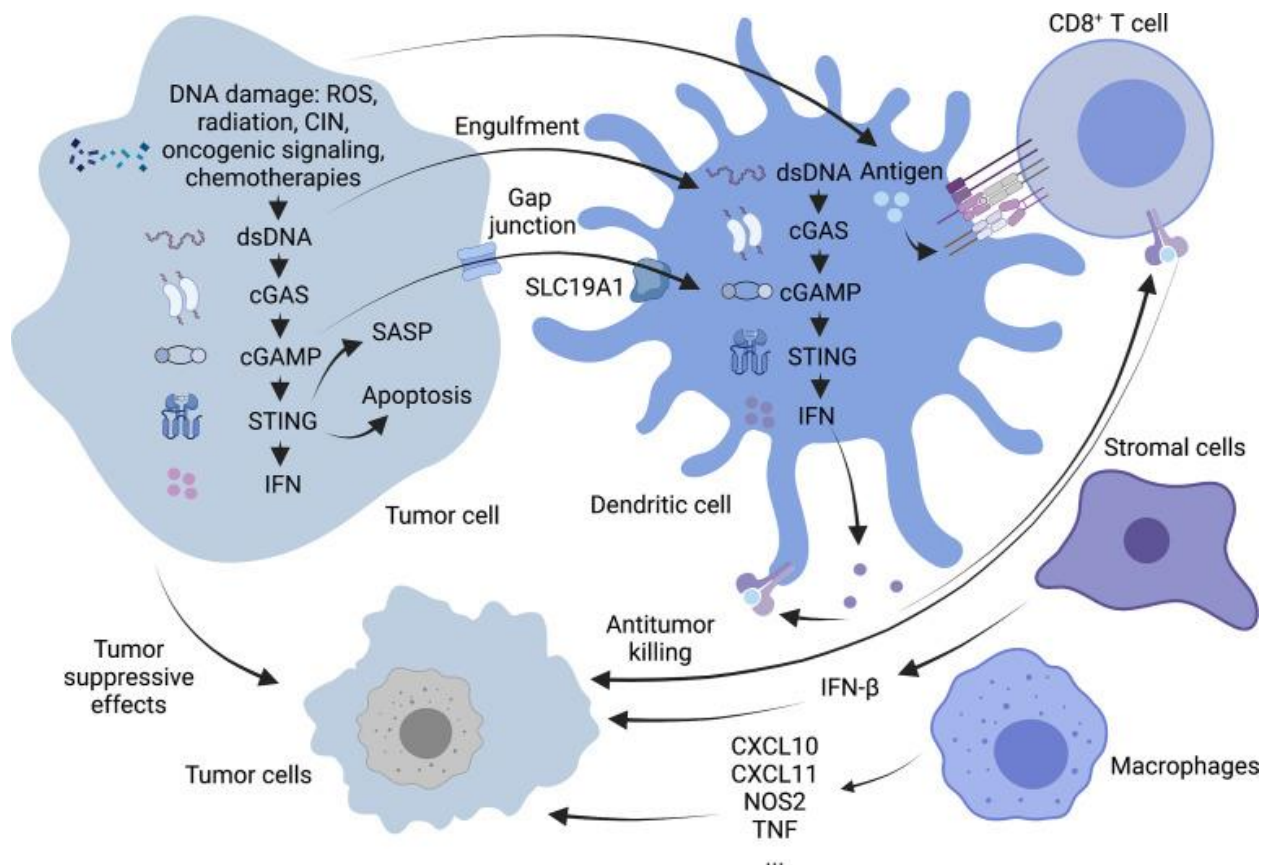


Figure 1: An Overview of Cellular Interactions in the Tumour Immune Microenvironment. The illustration portrays cellular interactions during an immune response against tumour cells. Various cell types, including tumour cells, dendritic cells, CD8+ T cells, stromal cells, and macrophages, participate in this complex process. Tumour cells experience DNA damage (due to factors like ROS and radiation) and undergo apoptosis. Dendritic cells engulf apoptotic tumour cells, while the cGAS-STING pathway activation leads to interferon (IFN) production. CD8+ T cells engage in antitumor killing activities, interacting with stromal cells. Key molecules like CXCL10, CXCL11, nitric oxide synthase 2 (NOS2), and tumour necrosis factor (TNF) play crucial roles in orchestrating this immune response. Image credits: Gan, Y, et al., (2022). [28]

Exploring STING Agonists as Soldiers in the Anti-Cancer Arsenal

STING signalling is a key feature of ‘hot’ tumours, which have DCs and cytotoxic T cells that can detect tumour antigens and respond to immunotherapy [2]. Thus, STING agonists have been investigated as potential anti-cancer therapies, including cGAMP, other cyclic di-nucleotides, and small compounds. They have shown impressive anti-tumour actions in mice models, which result in the removal of tumours and defence against recurrence [16]. Certain malignancies may produce enzymes that break down cytosolic DNA or cGAMP [30], or they may have malfunctioning or suppressed STING or cGAS genes [29], which would prevent immune recognition and activation. Tumour development is inhibited by IFN-I production and cell death that are triggered by acute STING activation [31]. On the other hand, persistent low-level IFN- β signalling stimulates the un-phosphorylated interferon stimulated gene factor 3 (U-ISGF3) complex, which in turn triggers pro-tumour genes [32]. Through the recruitment of myeloid-derived suppressor cells, the upregulation of programmed cell death ligand 1/2 (PD-L1/2), and the expression of indoleamine 2,3-dioxygenase (IDO), chronic IFN-I signalling also contributes to low-grade inflammation and immune suppression in the TME [32]. The anti-tumour responses mediated by T cells and STING are hindered by these factors [31]. Moreover, pro-inflammatory cytokines, particularly interleukin 6 (IL-6), are induced by STING signalling and improve cancer metastasis and survival [33]. Nuclear DNA damage triggers a cGAS-independent mechanism of STING signalling that activates NF- κ B p65, which drives the generation of IL-6 [34].

By changing cGAS–STING signalling, which typically recognizes DNA and initiates IFN responses, tumour cells might elude immune detection. Through non-canonical NF- κ B activation via p52 and RelB, tumour cells release pro-inflammatory cytokines instead of IFNs [2, 35]. This decreases the effectiveness of radiation treatment by blocking the traditional STING-TBK1-IFN

route [36]. IL-6 also inhibits STING signalling in prostate cancer cells. As a result, depending on the cell type and environment, STING signalling can have both pro- and anti-tumour effects. By causing T cells to undergo apoptosis or regulatory B cells to produce IL-35, STING signalling can also damage adaptive immune cells [2, 37, 38]. The results of STING signalling in T cells are modulated by T-cell receptor engagement [38]. Lower dosages or more targeted use of STING agonists are recommended to get around these obstacles.

STING Agonist and Anti-Vascular Therapy in Tumour Anticancer Effects

As stand-alone cancer therapies, vascular disrupting agents (VDAs) like combretastatin A4 phosphate (CA4P) have demonstrated a limited level of success [39]. According to preclinical research, CA4P efficiently disrupts the vasculature of tumours, especially in resistant tumour cores, but its effects are constrained by the tumour rim's ability to revascularize and stimulate regrowth [40]. Consequently, in order to enhance results, CA4P has been paired with various treatments in clinical trials, including radiation, chemotherapeutic drugs like paclitaxel and carboplatin, and the anti-vascular endothelial growth factor (anti-VEGF) antibody bevacizumab [41, 42, 43]. These mixtures have shown improved treatment outcomes and high levels of tolerance. Recent research has investigated the use of immunotherapy in conjunction with CA4P. In preclinical models, Deng et al. demonstrated that the combination of CA4P and chimeric antigen receptor-T cells (CAR-T cells) greatly increased antitumor activity [44]. Furthermore, in resistant mouse mammary cancer models, Oxi4503, an equivalent of CA4P, has been demonstrated to enhance responsiveness to immune checkpoint inhibitors [45]. The anticancer effects of combining CA4P with the immune-stimulating STING agonist cGAMP in order to lessen the side effects of STING agonists are discussed in a research by Czapla et al. [46]. Type I

interferons and other proinflammatory cytokines are released with activation of the cGAS-STING pathway, which stimulates a potent antitumor immune response [46]. While a number of STING agonists have been studied with varying degrees of success in preclinical and clinical settings, the Czapla et al. research is the first to look at the combined therapy of cGAMP and CA4P [46]. It was shown that while STING activation alone was adequate to prevent tumour development in B16-F10 tumours, there was no further advantage from CA4P, in the combination when it came to 4T1 cancers.

High STING expression in tumour and endothelial cells is expected to contribute to a successful antitumor response, as demonstrated by Demaria et al., who identified endothelial cells as the predominant source of type I interferon after cGAMP injection [47]. However, in 4T1 tumours, STING activation alone did not provide a significant immune response for long-term anticancer effects. Given the possibility of epigenetic silencing of cGAS or STING in many malignancies, combining CA4P with a vascular-disrupting drug was a sound strategy for highly vascularized 4T1 tumours [48]. This combination uses CA4P's vascular-disrupting capabilities to boost the antitumor response via cGAS-STING activation. STING agonists administered intra-tumourally stimulate innate immune pathways and counteract immunosuppressive settings, hence improving anticancer responses in non-immunogenic malignancies. The processes underlying the repolarization of the suppressive TME are still not well understood, despite the preclinical models' demonstrated effectiveness. Combination treatment successfully repolarizes macrophages from the immunosuppressive M2 phenotype to the immune-stimulatory M1 phenotype in both of the tumour models that have been investigated, as shown by Czapla et al. [46]. Tumour-associated macrophages (TAMs) of the M2-type predominate in the TME are

known as "cold" TAMs, whereas those of the M1-type are known as "hot" TAMs [49]. The anticancer effects of STING signalling depend on macrophages changing from an M2 to an M1 phenotype [50]. Additional research supports the idea that STING agonists might repolarize tumour-infiltrating macrophages, so transforming a "cold" TME into a "hot" one. Ohkuri et al., for example, have demonstrated that pro-inflammatory macrophages that are CD11b+Ly6C high, are recruited to the tumour in a STING-dependent manner [51], while Ager et al. have highlighted the role of STING agonists in repolarizing suppressive myeloid populations in both mice and humans, thereby enhancing immunotherapy efficacy [52].

Studies indicate that STING-activated and tumour-accumulating repolarized macrophages play an important role in the anticancer effects of STING-activating drugs. They further show that the use of STING agonists elicits a strong antitumor response in a variety of cancer models, which is predominantly mediated by natural killer cells (NK). Activation of the STING pathway overcomes immunotherapy hurdles such as immune exclusion and fatigue, making it a viable option for cancer eradication [53]. Consistent with these findings, Czaplak et al. revealed that STING agonist treatment efficiently induces NK cells to target and eliminate tumours, with the therapeutic benefit reduced when NK cells are depleted, emphasizing their crucial role in anticancer therapy [54]. TAMs are known to affect NK cell activity and phenotypic. Specifically, TAM M2 macrophages strongly limit NK cell activation and cytotoxicity against tumour cells. Modulating the TME with IL-12 and anti-TGF β increases the maturity and activation indicators of tumour-associated NK cells [46]. The process by which NK cells destroy cancer cells is reliant on the lack of major histocompatibility complex I (MHCI) molecules. NK cells recognize and kill cells missing MHC I molecules, successfully eradicating MHC I-deficient cancer cells in

B16-F10 tumours. In MHC I-positive 4T1 tumours, NK cells may destroy cancer cells by many mechanisms, including the overexpression of stress-associated chemicals that function as ligands for NK activation receptors. These increased ligands enable NK cell activation by bypassing MHC class I-dependent inhibition, resulting in the direct killing of tumour cells or the indirect release of pro-inflammatory cytokines [55].

The CD8+ T-cell response has long been thought to be responsible for STING therapy's antitumor effects. However, in the study conducted with the 4T1 breast cancer model by Czapla et al., an increase in tumour-infiltrating CD8+ T cells (TILs) following therapy was not observed. In contrast, melanoma models, particularly those with cGAMP injection, showed a considerable infiltration of CD8+ T cells. This resulted in melanoma tumours becoming "hot" infiltrated-inflamed tumours, with high amounts of TILs expressing the immune checkpoint receptor programmed cell death protein 1 (PD-1) [49]. Czapla et al. found that CD8+ T lymphocytes entering tumour tissues express CD69, which is associated with PD-1 expression [46]. CD69, an early activation marker for leukocytes, is known to be expressed on resident memory T cells, playing a vital role in the recruitment and retention of T cells in inflamed tissues. Several studies have highlighted CD69's role in producing tumour-infiltrating T cell fatigue. For example, Mita et al. found that tumour development and metastasis were reduced in Cd69^{-/-} mice, which was connected to enhanced T-cell infiltration and decreased CD8+ T-cell fatigue [56]. The tumour models studied were characterized as low immunogenic "cold" cancers, which are usually resistant to immune checkpoint inhibitors (ICI-resistant tumours) [57]. STING agonist therapy has been demonstrated to boost the inflow of tumour-infiltrating CD8+ T lymphocytes, transforming immunologically "cold" tumours into "hot" cancers that respond better to ICI

treatment. CD8⁺ T cells are critical for the efficiency of PD-1 inhibition; nevertheless, the presence of MHC I molecules on tumour cells is a required requirement for successful ICI treatment [58]. MHC I molecules are ligands for T-cell receptors (TCRs), and their recognition leads to T-cell activation.

The B16-F10 melanoma model, which lacks MHC I, showed a significant increase in CD8⁺ T cell infiltration into the tumour with exposure to cGAMP. An effective response to ICI therapy was seen when PD-1 blocking was explored in this setting, with some instances showing total tumour remission. This result might be explained by the overexpression of MHC I on B16-F10 tumour cells brought on by interferon γ (INF γ), which is generated by immune cells that have been activated by cGAMP, such as NK cells [46]. On the other hand, resistance to PD-1 treatment was shown in 4T1 MHC I-positive tumours. After STING activation, there was not a substantial inflow of CD8⁺ T cells, and these cells did not show higher levels of PD-1. Research has demonstrated that anti-PD-1 therapy is unable to produce antitumor effects in mice lacking cGAS or STING. This implies that before using STING agonists in conjunction with ICIs, patients may need to be screened for cGAS-STING signalling [59]. When ICIs are used in conjunction with cGAMP in tumour models where the cGAS-STING signalling pathway is functional, the effectiveness of the combination is markedly increased.

Conclusions

DNA sensing pathways, such as the cGAS–STING–interferon axis, are crucial for immune responses against infection, autoinflammation and cancer. However, STING signalling has

complex and contradictory effects on tumour growth and suppression. STING agonists have failed to show anti-tumour efficacy in clinical trials, despite their success in mouse models. Till date about 12 clinical trials have been focused on STING agonists, including compounds like ADU-S100, E7766, and GSK3745417 (Table 1) [60]. These agents hold promise for treating solid tumours and lymphoma. However, their cytosolic delivery remains a challenge due to inherent properties such as negative charge and hydrophilicity.

Table 1: The list of STING agonists tested for clinical trials [60]

Agonists	Treatment modality	Company	Administration method	Indications	Current status	NCT code
ADU-100	Combined with anti-CTLA4 mAb	Aduro Biotech; Novartis	Intratumoral injection (i.t.)	Advanced/metastatic solid tumours; lymphoma	Phase I (terminated)	NCT02675439
ADU-100	Combined with anti-PD-L1 mAb	Novartis	i.t.	Advanced solid tumours; lymphoma	Phase Ib (terminated)	NCT03172936
ADU-CL-20	Combined with anti-PD-L1 mAb	Aduro Biotech	i.t.	Metastatic/recurrent head and neck squamous cell	Phase II (ongoing)	NCT03937141

				carcinomas		
BMS-986301	Monotherapy/combined with anti-PD-L1 mAb or anti-CTLA4 mAb	Bristol-Myers Squibb	i.t.	Advanced solid tumours	Phase I (ongoing)	NCT03956680
DMXAA	Combined with carboplatin and Paclitaxel	Antisoma; Novartis	Intravenous injection (i.v.)	Non-small cell lung cancer	Phase III (terminated)	NCT00662597
E7766	Monotherapy	Eisai Inc.	i.t.	Advanced solid tumours; lymphoma	Phase Ia/Ib (ongoing)	NCT04144140
E7766	Monotherapy	Eisai Inc.	i.v.	Bladder cancer	Phase I (ongoing)	NCT04109092
GSK3745417	Monotherapy/combined with anti-PD-L1 mAb	GSK	i.t.	Advanced solid tumours	Phase I (ongoing)	NCT03843359

IMSA-101	Monotherapy/com- bined with anti-PD-L1 mAb	ImmuneSe- nsor Therapeuti- cs	i.t.	Advanced solid tumours	Phase I/IIa (ongoing)	NCT0402 0185
MK-1454	Monotherapy/com- bined with anti-PD-L1 mAb	Merck & Co	i.v.	Advanced/met- astatic solid tumours; lymphoma	Phase I (ongoing)	NCT0301 0176
MK-2118	Monotherapy/com- bined with anti-PD-L1 mAb	Merck & Co	i.v.	Advanced/met- astatic solid tumours; lymphoma	Phase I (ongoing)	NCT0324 9792
SB-11285	Monotherapy/com- bined with anti-PD-L1 mAb	Spring Bank Pharmaceu- ticals	i.v.	Advanced solid tumours	Phase Ia/Ib (ongoing)	NCT0409 6638

To address this, most clinical trials have opted for intra-tumoural administration. By directly targeting the tumour site, intra-tumoural injection achieves well-defined primary concentrations while minimizing systemic exposure and associated toxicities. In select cases, these STING agonists are also administered intravenously or subcutaneously. It is essential to understand how

DNA damage from different treatments affects STING signalling. By modulating the balance of STING signalling outputs, we may be able to enhance its anti-tumour functions and reduce its pro-tumour effects.

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About the Author



Neelabh Datta is a current biochemistry honors student, who exhibits a keen interest in exploring the domains of cell and molecular biology. His academic journey is marked by a quest to deepen the comprehension of life’s molecular fabric. An enthusiast of scientific history, Neelabh invests his leisure time in recounting various biological breakthroughs and the lives of eminent scientists. His fascination lies with nucleic acids—the very blueprint of life. Another of his interest lies in the various cell signalling pathways of our cells. Beyond the lab, Neelabh embraces the discipline of martial arts. He holds a black belt in Karate.

Honors College Corner

The University celebrated National Undergraduate Research Week April 15th through 19th. A combined effort of the Honors College, University Libraries, and the Office of Undergraduate Research, this week recognized the work of undergraduate students and provided extensive programming to help students develop their research initiatives. The feature event of the week was the Undergraduate Research Symposium. The first round, in which students submit a research abstract, almost doubled the previous year's applicants, with 105 submissions. Of those, 91 students moved on to the poster and presentation round which were judged by faculty panels. Students presented their posters at an in-person session on April 18th in the Union Ballroom. In addition to faculty and students, several university administrators attended the Symposium and heard from the student researchers.



Image 1 Visitors mingle with the student presenters. Photo by Chieko Hara

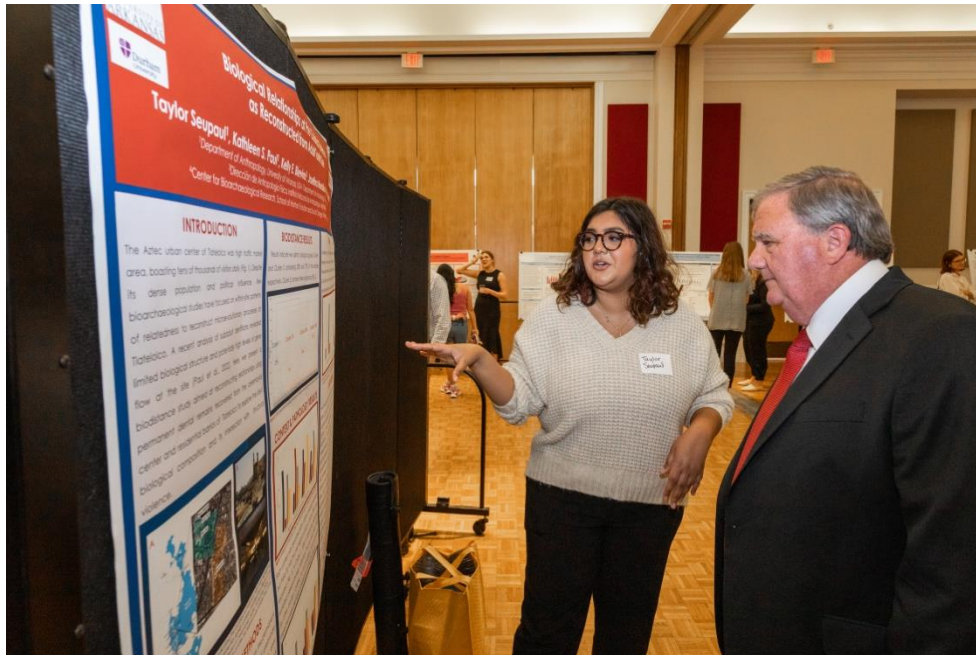


Image 2 Taylor Seupaul shares about her research with Provost Terry Martin. Photo by Chieko Hara

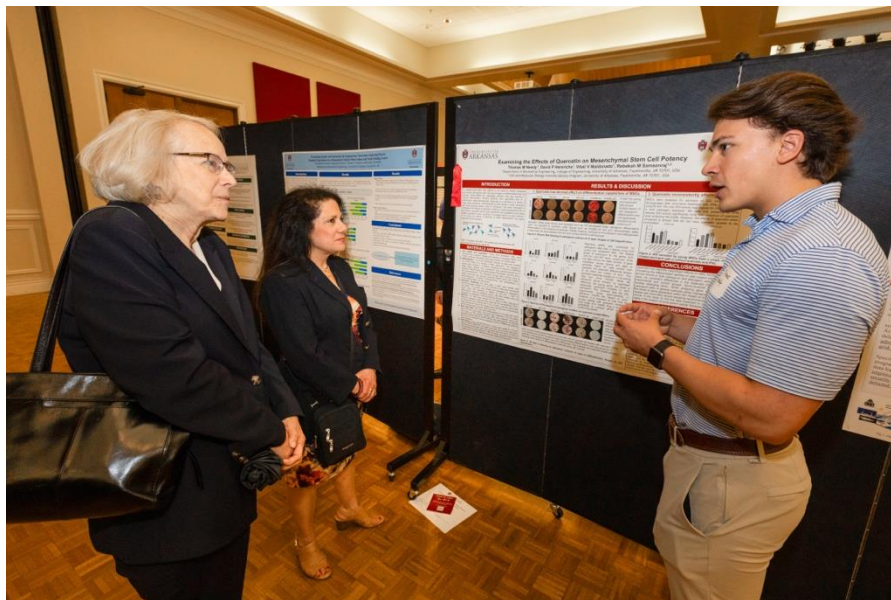


Image 3 Thomas Needy describes his project to Dr. Kim Needy, Dean of the College of Engineering, and Dr. Suzanne McCray, Vice Provost of Enrollment and Dean of Admissions. Photo by Chieko Hara

The students competed in six different discipline categories, one of which were divided into two competition groups due to the high number of submissions. The first place winners in each category provided a quote about the value of research to their academic experience:

Competition Winners

Category: Arts and Humanities

Name: Daisy Rehbock

Honors Affiliation: Honors Student

Major(s): International and Global Studies

Title: Gender Equality Threatened: A Digital Analysis of Spanish Right-Wing Political Parties

Quote: This research pushed me outside my comfort zone and

forced me to interact first-hand with hard truths about what social media is being used for in the modern day. However, I believe the impacts of this research are important and worth all the hours I spent scrolling right-wing Twitter and Facebook accounts. I want to thank my incredible mentor, Dr. Lisa Corrigan, for guiding me along this research process and giving me all the tools to be successful. I owe her the world. I feel excited and prepared for my post-grad journey as it takes me to Panama to serve in the Peace Corps and then to graduate school.



Category: Education

Name: Madison Price

Honors Affiliation: Honors Student

Major(s): Agricultural Business

Title: Understanding the Impact of Food Insecurity Among First-Generation College Students on the University of Arkansas Campus

Quote: My experience conducting research during my undergraduate career was transformative. It not only deepened my knowledge, but



also fostered a passion for discovery that motivates me to pursue a master's degree. The research experience itself equipped me with valuable skills in critical thinking, data analysis, and problem-solving, which will be instrumental for my success in graduate studies.

Category: Engineering

Name: Colton Gattis

Honors Affiliation: Honors College Fellow

Major(s): Biomedical Engineering

Title: Utilizing Spatial Transcriptomics to Compare Gene Expression in Volumetric Muscle Loss Injury Recovery



Quote: This experience allowed me to truly dive into the complexities of bioinformatics and discover my own strengths and weaknesses within it. I've since been able to enhance my skill set in a way that has been extremely attractive to employers, and I will continue to expand this skillset as I strive to expand my familiarity with this field. I plan to utilize what I've learned in this project along with advice from my mentor, Dr. Jeffrey Wolchok, to guide me as I transition to the next chapter of my life.

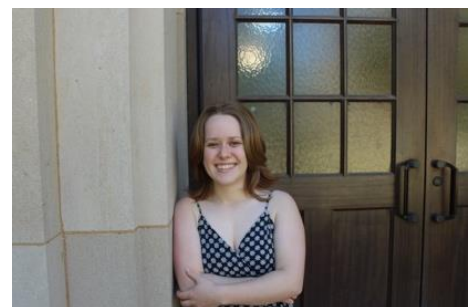
Category: Health

Name: Lucia Barraza

Honors Affiliation: Honors Student

Major(s): Exercise Science

Title: Perceptual Responses to Partial Water Immersion Body-Bag Cooling Following Exercise-Induced Hyperthermia



Quote: This project was an eye opening experience for me, and I am so grateful to have had the opportunity to be involved in research during my undergraduate career. I've been able to learn so much about the research process and all the work that goes into making important studies happen. I would like to thank my mentor, Dr. McDermott, for his advice and support, and for letting me be a part of such a cool project.

Category: Natural Sciences 1

Name: Gary Jackson

Honors Affiliation: Bodenhamer Fellow

Major(s): Biology and Chemistry

Title: Investigation of the Protein Dynamics Responsible for the Establishment and Maintenance of Compartmental Boundaries

Quote: I have been deeply grateful for the lessons that research has taught me," said Jackson. "It has led me to question the little things in life, and to see the beauty in scientific inquiry and

discovery. Through research, I've gained a deeper appreciation for the complexities of the world around me, igniting a passion for exploration and understanding that will continue to shape my identity.



Category: Natural Sciences 2

Name: Emilee Walden

Honors Affiliation: Honors Student

Major(s): Mathematics and Biology

Title: Mathematics-AI Based Phylogenetic Analysis of Influenza Mutation Data

Quote: Undergraduate research has been such a rewarding experience! I have had a lot of fun getting to contribute to research in infectious disease as well as develop new skills in preparation for graduate school."



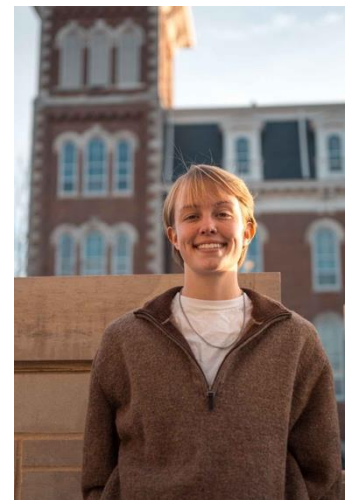
Category: Social Sciences

Name: Olivia "Olive" Kuester

Major(s): Political Science

Title: The Impact of Long-Term Partisan Monopolies on Voter Turnout

Quote: My experience as an undergraduate researcher at the University of Arkansas has ignited my passion for data, statistics, and political science. Being immersed in academic research has equipped me with an invaluable skill set that I'm excited to carry into my Ph.D. program at the University of Iowa in August. And of course a big thanks to Dr. Parry and the Office of Undergraduate Research for supporting both me and my project!

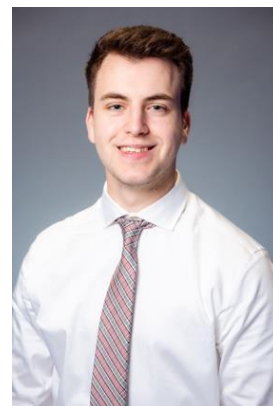


Office of Nationally Competitive Awards

2023-2024 Student Profiles

The Goldwater Scholarship (established by Congress in 1986) works to provide a continuing source of highly qualified scientists, mathematicians, and engineers by awarding scholarships to college sophomores and juniors who intend to pursue careers in these fields. Scholars receive up to \$7,500, and the award can be renewed for an additional year. To be competitive, students should have some experience with research at the time of application. 2024 is the second time in its history that the U of A has had four Goldwater Scholars in the same year.

- **ETHAN BATEY** – An honors chemistry and physics major, Batey plans to pursue a Ph.D. in physical chemistry or chemical physics followed by a postdoctoral position. He hopes to eventually work in academia either at a university or a national laboratory. Currently, he is conducting research with Bin Dong, assistant professor of chemistry, seeking to overcome traditional problems encountered in light-sheet fluorescence microscopy in cyto- and histological studies. Outside of his academic accomplishments, Batey has worked at Camp Kesem as a volunteer coordinator where he recruited, trained and managed other volunteers in support of children and parents suffering from cancer.
- **Joshua Mora Sanchez** – Mora Sanchez is a junior honors mechanical engineering major who plans to obtain a Ph.D. in mechanical engineering. He intends to conduct research on the electrification of aircrafts and work in the space industry. His interest in engineering and space took a meaningful turn when he met his role model, Franklin Chang Díaz, on a tour at the



AdAstra campus in Guanacaste, Costa Rica. Currently, he is conducting research with Han Hu, assistant professor of mechanical engineering, in the development of an advanced cold plate for the electrification of aircrafts.

- **Sam Sooter** – A sophomore honors physics and mathematics major, Sooter is interested in applying tools from statistical physics to biological systems with many interacting parts, like the brain or animal flocks. Currently, he is conducting research with Woodrow Shew, associate professor of physics, and Postdoctoral Research Fellow Antonio Fontenele, along with Shew Lab collaborators Andrea Barreiro, associate professor of mathematics at Southern Methodist University, and Cheng Ly, associate professor of mathematics at Virginia Commonwealth University. Using tools from statistical physics, Sooter is exploring the relationship between behavioral state and distance to criticality. After college, he will pursue a Ph.D. in physics, followed by postdoctoral work, and eventually start his own lab as a physics professor.



- **Emilee Walden** – Walden is a junior honors mathematics and biology major and plans to pursue a Ph.D. in bioinformatics and genomics with the intent of becoming a research professor. She aspires to do research focused on developing mathematical models and algorithms to interpret the evolution of genome sequences and evaluate how these sequences can provide insights into disease mutation patterns and prevention. Currently, Walden is conducting research with Jiahui Chen, assistant professor of mathematical sciences, that aims to enhance genome data



analysis for tracking flu virus mutations, potentially advancing real-time monitoring and vaccine development. Walden also serves as president for the Association for Women in Mathematics.

The Fulbright U.S. Student Program awards fellowships for U.S. graduating college seniors, graduate students, young professionals and artists to study, conduct research, and/or teach English abroad. Stipends and the length of stay in the selected country vary depending on the individual program. Recipients of the Fulbright U.S. Student fellowships are referred to as Finalists.

- **Katherine Chamberlin** – A 2024 honors graduate majoring in international business, Chamberlin is a Finalist for an English Teaching Assistantship to Germany. She was a Gilman Scholar and studied abroad in Ireland. On campus, Chamberlin served as a cross-cultural mentor and a conversation club leader for international students. She plans to pursue a master's degree in tourism and travel.



- **Sherjeel Naeem** – A 2024 honors graduate majoring in anthropology and biology, Naeem is a Finalist for an English Teaching Assistantship to Laos. He was a Governor's Distinguished Scholar, a mental health ambassador, president of Students with Refugees, and a cross cultural education mentor. He spent time in Greece working at a refugee organization as well.



When he returns from Laos, Naeem will enroll in a dual MD/MPH program in order to become a public health educator.

- **Rebekah Smith** – Smith holds a B.A. in German and history, '23 from the UofA. She is a Finalist for an English Teaching Assistantship to Germany. On campus, Smith was a culture team and IFriend intern with the International Students and Scholars Office and a peer ambassador for the Spring International Language Center. She also studied abroad in South Korea. Smith plans to teach at the high school level upon her return from Germany.



- **Gabrielle Vatthanatham** – Vatthanatham graduate with an M.A. in French in 2024. She is a Finalist for an English Teaching Assistantship to Belgium. Vatthanatham was a Governor's Distinguished Scholar and an Honors College Fellow. She taught French at the UofA as a graduate teaching assistant. She plans to continue her graduate education in a Ph.D. program in English and eventually teach English literature as a professor of English.



***The Truman Scholarship** (created by Congress in 1975 as a living memorial) awards \$30,000 for post-graduate study to students pursuing careers in public service. Students apply during their junior year. They are selected first as finalists, then after a rigorous interview process, may*

be selected as Scholars. Funds are awarded when a student enters graduate school. Amelia Southern Uribe was a 2024 Truman Finalist.

- **AMELIA SOUTHERN URIBE** – Southern Uribe was named a finalist for the prestigious 2024 Harry S. Truman Scholarship. Also a 2023 Udall Scholar, Southern Uribe is an honors political science and journalism major with a concentration in advertising and public relations. Southern Uribe has been extensively involved in campus and community events and groups, including founding the first Arkansas chapter of This is Zero Hour, interning with the city of Fayetteville’s Department of Sustainability, and sitting on a variety of statewide environmental boards. She plans to pursue a graduate degree in environmental management with a concentration in community engagement and environmental justice, as well as a career in public service focused on fighting climate change.



The NOAA Hollings Scholarship awards recipients an academic scholarship of \$9,500 per year for two years and a 10-week full-time paid summer internship at a NOAA facility. The internship between the first and second years of the award provides the scholars with hands-on practical experiences in NOAA-related science, research, technology, management and education activities.

- **Andie Forbes** – An honors environmental, soil and water science major, Forbes was named a NOAA Hollings Scholar. Active on campus and the community, Forbes plans to attend graduate school to pursue a master’s degree in marine resource management or environmental management.



Students wishing to apply for any of these or other competitive scholarships or postgraduate opportunities should contact the Office of Nationally Competitive Awards through awards@uark.edu and visit awards.uark.edu for more information.