Advancements in Agricultural Development
Volume 5, Issue 1, 2024
agdevresearch.org

Flowing Perceptions: Exploring Secondary Students' Perceptions of Water

C. J. Eck[1], K. Wagner[2]

Abstract

Adolescents' (i.e., high school students) opinions and preferences are important and less likely to be influenced by political and social norms, especially considering natural resource and climate related issues. Therefore, this study sought to identify and understand the perceptions of secondary students related to water issues and conservation practices utilizing a non-experimental survey research design. The majority (53.8%) of Oklahoma secondary students participating in this study believed water was of concern in the state. The primary water issues affecting Oklahoma according to secondary students (n = 93) were clean drinking water, water for agriculture, water for aquatic habitats, wastewater treatment improvement, and water quality monitoring to detect pollution improvement. Students' perceptions of water quantity and quality varied across groups based on their primary source of drinking water (i.e., Private Supply, Bottled Water, Municipal Public Supply, or Rural Public Supply). It is imperative for water-related curriculum to be developed for delivery in secondary classrooms across the state. Future research should consider the perceptions of students nationwide related to water and natural resource conservation.

Article History

Received: October 4, 2023
Accepted: March 14, 2024
Published: March 18, 2023

Keywords

Theory of Planned Behavior; water education; survey research design

1. Christopher J. Eck, Assistant Professor of Agricultural Education, Oklahoma State University, 457 Agricultural Hall, Stillwater, OK 74078, chris.eck@okstate.edu, https://orcid.org/0000-0002-1645-3632
2. Kevin Wagner, Professor of Plant and Soil Sciences and the Director or the Oklahoma Water Resources Center, 110 Noble Research Center, Stillwater, OK 74078, kevin.wagner@okstate.edu, https://orcid.org/0000-0001-9307-2799

Introduction and Problem Statement

Water is an essential resource which has an increasing demand (Wertz & Layden, 2013), making the conservation of water a pivotal issue (Chaudhary et al., 2019; Hurd, 2006). Eighty percent of state water managers in 2014 predicted shortages of freshwater in their respective states over the next decade (U.S. Government Accountability Office, 2014). These predictions were further projected by Warziniack et al. (2022) to continually increase across the U.S. by 2050 with both socioeconomic and climate-related changes playing primary roles. This concern is further exacerbated by only 3% of the water on earth being freshwater (U.S. Bureau of Reclamation, 2020). In addition, groundwater only accounts for 0.62% of Earth's water, some of which is beyond the reach of water extraction (U.S. Bureau of Reclamation, 2020). When considering water usage, agriculture alone utilizes nearly 80% of the water in the U.S. (National Institute of Food and Agriculture, 2023), increasing the need for public education and engagement related to water conservation (Mulki et al., 2018), especially considering the increasing impact of climate change on water availability (National Academies of Sciences, Engineering, and Medicine, 2023).

The public's perceptions of water and conservation efforts have been investigated over the years in many states. The opinions and preferences of these demographics were important, but adolescents (i.e., high school students) are less likely to be influenced by political and social norms, especially considering natural resource and climate related issues (Flora et al., 2014; Stevenson et al., 2014). Balundė et al. (2020) found adolescents value environmental and climate related concerns with minimal traditional social norms, yet Perry et al. (2021) found social media and online communities to play a key role in influencing adolescent perceptions. Therefore, this study sought to identify the perceptions of secondary students related to water issues and conservation practices to better inform formal and informal educational practices related to water and agriculture.

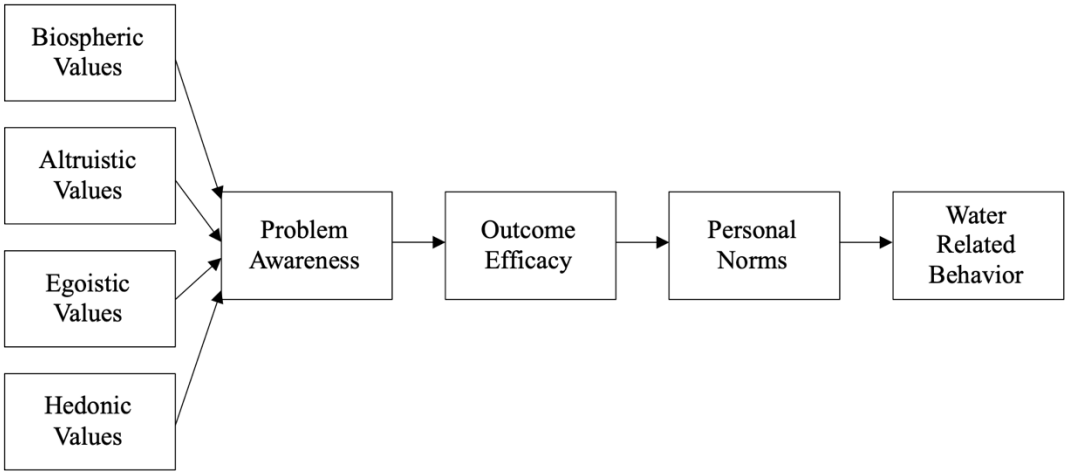
Theoretical and Conceptual Framework

This study was undergirded by the theory of planned behavior (TPB), identifying the attitudes, perceptions, and beliefs related to water in Oklahoma (Ajzen, 1991). The attitude (favorable or unfavorable) and intentions toward a behavior can help researchers predict one's actions (Ajzen, 1991), which in the case of this study relate to water usage and conservation efforts as the behavior. Although most secondary students are not at the age of decision making or voting yet, they are the future workforce and stewards of the United States; therefore, understanding their attitudes, intentions, and current behaviors is essential in considering the future needs of water related education and outreach. Ultimately, this study aligns with the United Nations (2015) goal of improving water quality, water use efficiency, and the integration of water management programs to achieve equitable access to safe drinking water for all by 2030, with an emphasis on understanding the perceptions and needs of primary consumers by 2030 (i.e., current secondary students). Within the context of this study, TPB can be further conceptualized with the value-belief-norm theory (Stern et al., 1999), which evaluates

normative considerations in relationship to an individual's awareness of an environmental problem (i.e., water), their perception of making an impact on the issue, and personal norms associated with the problem (see Figure 1).

Figure 1

Conceptual Model of The Value-Belief-Norm Theory for Water Related Behaviors



In addition to the theory and conceptual model presented, this study was framed by the National Water Survey Needs Assessment Program, which began in the Pacific Northwest in 2001 "to assess public aptitudes, attitudes, and actions relative to water issues" (Mahler et al., 2013, p. 99). The factors measured through the National Water Survey Needs Assessment Program align with TPB (Ajzen, 1991) and the conceptual model presented (see Figure 1), leading the program to conduct studies in the Northeast, North-Atlantic, Mid-Atlantic, Southeast, South-Central, and Midwest regions over time. The National Water Survey Needs Assessment Program focused on public perceptions, with the majority of respondents being over 50 years of age (Mahler et al., 2013). Considering future decisions regarding water needs, quality, and quantity will be heavily influenced by future generations, the perceptions of secondary students allow researchers to evaluate future water related behavior (Ajzen, 1991; Stern et al., 1999). Since the aim of the National Water Survey Needs Assessment is to establish a survey for baseline data collection on water issues on a state basis (Mahler et al., 2013), the survey was used for this study.

Purpose

This study aims to determine the perceptions of water issues in Oklahoma from the standpoint of students enrolled in secondary schools across the state. Four research objectives guided this inquiry:

1. Determine secondary students' perceptions of primary water issues affecting Oklahoma.
2. Identify the perceptions of water quantity and quality amongst Oklahoma secondary students.
3. Identify the water conservation efforts of secondary students and their families in Oklahoma.
4. Establish the primary areas of water related educational interest for secondary students in Oklahoma.

Methods

To evaluate secondary students' perceptions of water issues across Oklahoma, a 43-item survey was adapted from the National Water Needs Assessment Program (Mahler et al., 2013). The survey questionnaire included four sections addressing perceptions of environmental issues (27-items, e.g. perceptions of water related issues), water issues (10-items, e.g. sources of water, water quantity, water quality, and pollutants), water knowledge (4-items, e.g. water usage and conservation), and learning preferences (2-items, e.g. interest in water education). In addition, five demographic questions were asked, including, sex, age, grade level, class enrollment, and school classification. The survey was evaluated for face and content validity (Privitera, 2020) appropriate to a secondary student demographic by two faculty members in agricultural education teacher preparation.

There are roughly 257,000 eighth through twelfth grade students enrolled in Oklahoma public schools, although only about 60% of secondary schools have agricultural education programs in the state, reaching approximately 27,000 students (Oklahoma FFA Association, 2023). Two public school districts with agricultural education programs were randomly selected from each region of the state (i.e., Southeast, Southwest, Central, Northeast, and Northwest) with consideration given to school size classification (i.e., B, A, 2A, 3A, 4A, 5A, and 6A). Ten school superintendents were contacted to request participation from eighth through twelfth grade students in their district currently enrolled in agricultural education, environmental science, and/or earth science. Six of the superintendents responded to the request and agreed to distribute the survey questionnaire to their agricultural education, environmental science, and earth science teachers to request participation from their students using a Qualtrics survey questionnaire link.

Although 168 surveys were submitted, only 93 were received complete and used for data analysis. The participants were 48.4% female (n = 45), spanning from eighth through twelfth grade, with 43% only enrolled in either earth science or environmental science, while the remaining 57% were enrolled in both science and agriculture class at their respective schools.

Students from five of the school size classifications (i.e., B, A, 3A, 4A, and 6A) participated. Survey distribution was a limiting factor within this study as it relied on superintendent agreement, followed by distribution to teachers from the school site administrator, then the individual teachers requesting participation from their students. Considering this, the demographics align with the statewide average where 49% of eighth through twelfth grade students are female (Oklahoma Department of Education, 2023) and schools from the smallest (B) to the largest (6A) classification were represented.

Data were analyzed using SPSS Version 28 for this survey research design study (Privitera, 2020). Specifically, descriptive statistics (i.e., frequencies and percentages) were ran to answer the four research objectives.

Findings

The first research objective aimed to determine the primary water issues affecting Oklahoma as perceived by secondary students. Just over half (53.8%) of Oklahoma secondary students participating in this study believed water was of concern in the state and nearly 30% were unsure, while over 61% did not know what a watershed was.

When participants were asked to rate 27 water issues on a four-point scale of agreement based on their perceived importance (i.e., 1 = *not important*, 4 = *extremely important*), clean drinking water was by far the most important issue followed by water for agriculture. Water transfer/sale of water rights and hypoxia were the lowest rated issues. The 27 water issues are provided in Table 1 with their corresponding percentage of agreement at each level (i.e., 1 = *Not Important* [NI], 2 = *Somewhat Important* [SI], 3 = *Important* [I], 4 = *Extremely Important* [EI]).

Table 1

Importance of Water Issues to Secondary Students. (n = 93)

	%			
Identified Issue	***NI***	***SI***	***I***	***EI***
Clean drinking water	0.0	1.1	9.7	89.2
Water for agriculture	1.1	4.3	24.7	69.9
Water for aquatic habitat	1.1	9.7	24.7	64.5
Improving wastewater treatment	0.0	7.6	34.8	57.6
Improving water quality monitoring to detect pollution	0.0	12.9	31.2	55.9
Clean rivers and lakes	0.0	7.5	38.7	53.8
Improving agricultural practices	0.0	11.8	35.5	52.7
Preserving agricultural land & open space	0.0	7.8	41.6	50.6
Making water quality and quantity data available to public	1.1	16.1	33.3	49.5
Preserving & restoring buffer zones & wetlands	1.1	20.4	29.0	49.5
Residential water conservation	2.2	17.2	33.3	47.3
Improving municipal practices	3.3	18.5	32.6	45.6
Building new water storage structures (dams, reservoirs)	1.1	20.8	34.6	43.5
Water for recreation	5.5	20.8	30.8	42.9
Educating municipal officials	1.1	21.5	35.5	41.9
Clean groundwater	3.3	21.5	33.3	41.9
Water for household landscapes	12.9	21.5	25.8	39.8
Water for municipal use	0.0	25.8	35.5	38.7
Better management of shoreline access to prevent erosion	5.4	26.9	29.0	38.7
Better management of recreational activities (boating, fishing, ATVs)	6.5	24.7	31.2	37.6
Water for commerce/ industry/power	0.0	25.8	39.8	34.4
Improving home and garden practices	6.5	20.4	38.7	34.4
Involving citizens in collecting water quality information	8.6	19.4	37.6	34.4
Treating storm water runoff	8.7	14.1	43.5	33.7
Within state transfer/sale of water rights	7.5	25.8	34.4	32.3
Hypoxia (Gulf dead zone)	16.1	33.3	18.3	32.3
Interstate transfer/sale of water rights	6.5	30.4	37.0	26.1

Note. Perception Scale: 1 = *Not Important* (NI), 2 = *Somewhat Important* (SI), 3 = *Important* (I), 4 = *Extremely Important* (EI).

Identifying the perceptions of water quantity and quality amongst Oklahoma secondary students was the second research objective. A large percentage of participants reported purchasing bottled water as their primary source of drinking water (46.2%), followed by 28.0%

utilizing their municipal public water supply, 18.3% drinking from their rural public water supply, and the remaining 7.5% utilizing a private supply (i.e., private well, river, pond, or lake). Most participants on a private water supply felt their home tap water was safe to drink (see Table 2). Approximately one-third of students who used bottled water as their primary source of drinking water felt their tap water was safe to drink (see Table 2), while over half of those on all other water supplies felt tap water was safe to consume. Most secondary students (>75%) perceived the quality of Oklahoma ground water as normal or better. Perceptions of surface water quality was much lower with a quarter to half of the student's feeling quality was poor or worse (see Table 2). Water quantity was of concern by over half of the participants in three of the four groups, those on a private supply were not concerned with water quantity. Table 2 outlines the percentages of responses related to water quality and quantity by primary drinking water source (i.e., private supply, bottled water, municipal public supply, or rural public supply). Most participants felt climate change would not change or increase their water availability, yet most students felt drought impacts would stay the same or increase (see Table 2).

Table 2

Sources, Quality, and Quantity of Water

Item	%				
	PS (n = 7)	*BW (n =43)*	*MPS (n = 26)*	*RPS (n = 17)*	*Total*
Do you feel that your home tap water (water from the sink) is safe to drink?					
Yes	85.7	34.9	50.0	64.8	48.8
No	0.0	34.9	26.9	17.6	26.2
Unsure	14.3	30.2	23.1	17.6	25.0
In your opinion, what is the quality of groundwater (sources of well water) in Oklahoma?					
Excellent	0.0	0.0	3.8	0.0	1.2
Good	14.3	7.0	11.5	35.3	14.3
Normal	85.7	69.2	80.9	41.2	48.8
Poor	0.0	11.6	3.8	23.5	9.5
Unacceptable	0.0	4.7	0.0	0.0	1.2
Unsure	0.0	7.5	0.0	0.0	25.0
In your opinion, what is the quality of surface waters (rivers, streams, lakes, channels, and wetlands) in Oklahoma?					
Excellent	0.0	4.7	0.0	0.0	1.2
Good	14.3	14.0	11.5	41.2	16.7
Normal	28.6	41.9	46.2	35.3	40.5
Poor	57.1	25.6	38.5	17.6	31.0
Unacceptable	0.0	4.7	0.0	5.9	3.6
Unsure	0.0	9.1	3.8	0.0	7.1
Do you consider water quantity (having enough water) as a problem in Oklahoma?					
Definitely Not	0.0	4.7	7.7	0.0	3.6
Probably Not	71.4	23.3	23.1	35.3	30.1
Probably	14.3	25.6	38.4	35.3	26.5
Definitely Yes	0.0	38.9	23.1	23.5	26.5
Unsure	14.3	7.5	7.7	5.9	13.3
What is the likelihood of Oklahoma suffering from a prolonged drought?					
Increasing	28.6	53.4	15.4	53.0	51.2
Decreasing	0.0	4.7	3.8	17.6	6.0
Staying the same	57.1	23.3	57.7	11.8	20.2
Unsure	14.3	18.6	23.1	17.6	22.6
Do you think that the amount of water in your area will change as a result of climate change?					
Significant increase	14.3	25.6	26.9	5.9	18.3
Slight increase	28.6	27.9	38.5	47.0	29.3
No change	42.8	20.9	11.5	35.3	23.2
Slight decrease	14.3	16.3	19.3	11.8	22.0
Significant decrease	0.0	9.3	3.8	0.0	7.3

Note. Quality and quantity of water responses is broken down by primary drinking water supply: *Private Supply* (PS), *Bottled Water* (BW), *Municipal Public Supply* (MPS), or *Rural Public Supply* (RPS).

To further understand secondary student's perceptions of water quality, they were asked to identify pollutants impacting surface and/or groundwater across Oklahoma. While around half of the participants were unsure (see Table 3) of what containments impacted water quality, almost 50% felt pesticides were an issue and over 40% felt pathogens, fertilizers, metals, and turbidity were issues. Oil and gas production was by far the number one practice identified as impacting rivers and lakes with almost two-thirds agreeing (see Table 3).

Table 3

Pollutants Impacting Surface or Groundwater in Oklahoma (n = 93)

Item	*f*	*%*
Pathogens (bacteria, viruses, germs)		
Know it is not a problem	0	0.0
Suspect it is not a problem	7	7.5
Unsure	46	49.5
Suspect it is a problem	28	30.1
Know it is a problem	12	12.9
Fertilizers		
Know it is not a problem	0	0.0
Suspect it is not a problem	13	14.0
Unsure	40	43.0
Suspect it is a problem	28	30.1
Know it is a problem	12	12.9
Heavy Metals (lead, arsenic, mercury)		
Know it is not a problem	2	2.2
Suspect it is not a problem	5	5.4
Unsure	47	50.5
Suspect it is a problem	25	26.9
Know it is a problem	14	15.0
Minerals (iron, manganese, calcium)		
Know it is not a problem	7	7.5
Suspect it is not a problem	10	10.8
Unsure	49	52.7
Suspect it is a problem	19	20.4
Know it is a problem	8	8.6
Pesticides		
Know it is not a problem	2	2.2
Suspect it is not a problem	4	4.3
Unsure	41	44.1
Suspect it is a problem	34	36.5
Know it is a problem	12	12.9
Salinity (water too salty)		
Know it is not a problem	3	3.2
Suspect it is not a problem	16	17.2
Unsure	44	47.3
Suspect it is a problem	20	21.5
Know it is a problem	10	10.8

Item	*f*	%
Pharmaceuticals (antibiotics, personal care products)		
Know it is not a problem	5	5.4
Suspect it is not a problem	10	10.8
Unsure	47	50.5
Suspect it is a problem	20	21.5
Know it is a problem	11	11.8
Petroleum Products/Bi-Products		
Know it is not a problem	0	0.0
Suspect it is not a problem	6	6.5
Unsure	55	59.1
Suspect it is a problem	20	21.5
Know it is a problem	12	12.9
Algae		
Know it is not a problem	2	2.2
Suspect it is not a problem	14	15.1
Unsure	45	48.4
Suspect it is a problem	20	21.5
Know it is a problem	12	12.9
Sediment		
Know it is not a problem	1	1.1
Suspect it is not a problem	10	10.8
Unsure	57	61.3
Suspect it is a problem	15	16.1
Know it is a problem	10	10.8
Turbidity (muddy water)		
Know it is not a problem	4	4.3
Suspect it is not a problem	6	6.5
Unsure	42	45.2
Suspect it is a problem	20	21.5
Know it is a problem	21	22.6
Practices Impacting River and Lake Pollution in Oklahoma[a]		
Oil and gas production	58	62.4
Industrial practices	33	35.5
Erosion from roads/construction	31	33.3
Landfills	30	33.3
Agriculture – Crops	24	25.8
Septic systems	21	22.6
Agriculture - Animals	17	18.3
Wastewater treatment plants	17	18.3
Mining	17	18.3
New suburban development	16	17.2
Storm water runoff	15	16.1
Forestry (wood harvesting)	13	14.0
Runoff from home landscapes	12	12.9
Military bases	7	7.5

Note. [a]Participants could select all issues of interest.

The third research objective aimed to understand the water conservation efforts of secondary students and their families in Oklahoma. Specifically, students were asked to identify behavioral changes either they or their family did to conserve/preserve water. Changes in yard watering habits was the top conservation effort; however only one-third had made these changes. Less than 25% of students indicated a change in the use of pesticides, fertilizers, or other chemicals, or had adopted new technologies. Table 4 provides five potential behavioral changes and the corresponding responses. Additionally, participants were asked to identify where they stood on environmental issues, where zero was total natural resource use, and 10 was total environmental protection. Over half (55.5%) of the students identified themselves in the middle (i.e., 4 to 6 on the 10-point scale), trying to find balance between usage of natural resources and environmental protection.

Table 4

Water Conservation Efforts (n = 93)

Behavioral Change	*f*	*%*
Changed how often you water your yard	33	35.5
Changed your use of pesticides, fertilizers, or other chemicals	22	23.7
Adopted new technologies (low flow showerheads, high efficiency washing machines or dishwashers)	21	22.6
Changed the way your yard is landscaped	16	17.2
Pumped your septic system	14	15.1

Note. Participants could select all issues of interest.

To provide a new water source, research is investigating the treatment of produced water from oil and gas production. Secondary students' most supported the reuse of produced water for agricultural production and to enhance stream flows; however, less than 50% supported these uses (see Table 5). Approximately one-third of students supported the use of produced water for drinking water or food production uses.

Table 5

Perceptions of Treatment and Reuse of Produced Water (n = 93)

Item	*f*	*%*
Support use for agricultural production (non-human use)	43	46.2
Support discharge to rivers and streams to improve stream flow	37	39.8
Use for drinking water	33	35.5
Support use for industrial purposes	32	34.4
Consume food produced with this water	29	31.2

Note. Participants could select all issues of interest.

The final research objective evaluated water related educational interests of secondary students across Oklahoma. Sixty-three percent have not participated in water related education, and the 37% percent who had, identified environmental science or oceanography

classes as the education received. Table 6 depicts interest in 18 water-related topics. Students were by far the most interested in fish and wildlife water needs, while less than one-third were interested in other water related topics (see Table 6).

Table 6

Learning Interest Related to Water Issues. (n = 93)

Identified Issue	*f*	*%*
Fish and wildlife water needs	41	44.1
Beach/shoreline clean-up	28	30.1
Restoring fish and aquatic habitat	27	29.0
Protecting public drinking water supplies	27	29.0
Home and garden landscaping	26	28.0
Animal waste management	25	26.9
Forest management and water issues	25	26.9
Community actions concerning water issues	22	23.7
Watershed management	21	22.6
Produced water from oil production	21	22.6
Irrigation management	20	21.5
Stream restoration	20	21.5
Grazing management	19	20.4
Nutrient and pesticide management	19	20.4
Water policy and economics	18	19.4
Private well protection	16	17.2
Septic system management	15	16.1
Landscape buffers	11	11.8

Note. Participants could select all issues of interest.

Conclusions, Discussion, and Recommendations

Essential water issues were clean drinking water, water for agriculture, wastewater treatment improvement, clean rivers and lakes, and the preservation of agricultural land and open spaces, with more than 90% of participating secondary students feeling these were important or extremely important. Clean drinking water was the primary concern, aligning with previous research on other groups (Eck et al., 2020). Similarly, water for agriculture was also the second priority for college students in Oklahoma, while the public perceived it as the fourth most important issue (Chapagain et al., 2020). Considering the impact of agriculture in the state, the need to consider water for agriculture is imperative.

Secondary students were generally unsure of the impacts of pollutants on surface and groundwater in the state. Perhaps this is a result of the lack of education related to water that participants reported, as 63% of students reported not receiving water education. Addressing this lack of knowledge is pivotal considering the necessity of water and its increasing demand

(Chaudhary et al., 2019; Hurd, 2006; Wertz & Layden, 2013). Awareness of the problems associated with water, coupled with the identified impact students' personal decisions make on water quantity and quality (Stern et al., 1999) become driving forces in future water related behavioral changes (Ajzen, 1991; Stern et al., 1999). Considering the expressed interest in fish and wildlife water needs, water education programming could use this to generate engagement and establish awareness of water-related problems impacting rivers, lakes, and streams along with water sources and associated issues. Providing access to educational content could impact the future behaviors of students (Ajzen, 1991), especially considering their intention to find balance between natural resources and environmental protection, where problem awareness and outcome efficacy (see Figure 1) have been key predictors of behavioral change (Stern et al., 1999).

Perceptions of water quantity and quality varied across groups based on their source of drinking water (see Table 2). Perhaps these perceptions result from subjective norms (Ajzen, 1991) established at home regarding water quantity and quality, or could it be that awareness of the problem and efficacy to impact the problem is lacking (Stern et al., 1999). Considering the age of most participants, the ability to implement water conservation efforts are limited (i.e., perceived behavioral control) as they are not the homeowner or decision maker. Although interest in the beneficial uses of produced water existed, significant differences between students and the public were observed, with the public primarily supporting the industrial use of produced water (Chapagain et al., 2020). Perhaps students feel their potential impact is limited (i.e., outcome efficacy) due to personal norms or moral obligations they feel from authoritative sources (Stern et al., 1999; van der Werff & Steg, 2016).

Overall, students' responses indicate a general care for the environment and water-related issues (i.e., biospheric values), yet awareness of the water related problems is lacking (Stern et al., 1999) considering water quality and quantity concerns in Oklahoma. Therefore, it is imperative for water-related curriculum to be developed for delivery across the state by agricultural teachers, science teachers, and Extension educators. Specifically, topics aligning with content standards in earth science, environmental science, and agricultural courses should be developed to further water education across content areas. To further the potential behavioral change, the curriculum should be grounded in agriculture as a context given its impact on the water supply and its clear connection to science, providing a concrete example to real-world problems (Ricketts et al., 2006; Swafford, 2018). Considering adolescent development, curriculum should also be scaffolded for different age brackets, as content related to career opportunities should be developed for seventh and eighth grade students given the impact of career related decisions at that point in adolescence (Reynolds, 1991; Steinberg, 2014). In addition, STEM enhanced curriculum is critical in grades five through eight to promote continual achievement and interest in science and math (Singh et al., 2002). Finally, curriculum focused on behavioral change (Ajzen, 1991) is ideal during the developmental period between adolescence and adulthood (Rice & Dolgin, 2008). Water resource centers, water associations, and the National Water Survey Needs Assessment Program should consider the findings of this study to help inform programming and educational outreach materials. Considering the target audience, social media networks and online outreach should be

prioritized to better align with the values and norms of adolescents, ultimately impacting behavioral change (Perry et al., 2021).

Future research should consider the perceptions of students nationwide related to water and natural resource conservation. Additionally, research should evaluate the change in perceptions following the delivery of water-related curriculum and investigate the long-term impact of those perceptions and intentions on behaviors and career-related decisions.

Acknowledgements

C. J. Eck – conceptualization, methodology, investigation, writing – original draft; **K. Wagner** – validation, resources, writing – review and editing.

References

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Balundė, A., Perlaviciute, G., & Truskauskaitė-Kunevičienė, I. (2020). Sustainability in youth: Environmental considerations in adolescence and their relationships to pro-environmental behavior. *Frontiers in Psychology, 11*(1), 1-13. https://doi.org/10.3389/fpsyg.2020.582920

Chapagain, B. P., Wagner, K. L., Joshi, O., & Eck, C. J. (2020). Perceived importance of water issue and factors affecting learning opportunities in Oklahoma. *Journal of Water, 12*(2), 1–16. https://doi.org/10.3390/w12020395

Chaudhary, A. K., Warner, L. A., & Ali, A. D. (2019). Using perceived benefits to segment residential landscape irrigation users. *Urban Forestry & Urban Greening*, *38*, 318–329. https://doi.org/10.1016/j.ufug.2018.12.008

Eck, C. J., Wagner, K., Chapagain, B., & Joshi, O. (2020). Post-secondary students' perceptions of water issues and water-related educational interests. *Journal of Extension, 58*(3). https://doi.org/10.34068/joe.58.03.15

Flora, J. A., Saphir, M., Lappé, M., Roser-Renouf, C., Maibach, E. W., & Leiserowitz, A. A. (2014). Evaluation of a national high school entertainment education program: The alliance for climate education. *Climatic Change, 127*, 419–434. https://doi.org/10.1007/s10584-014-1274-1

Hurd, B. H. (2006). Water conservation and residential landscapes: Household preferences, household choices. *Journal of Agricultural and Resource Economics*, *31*(2), 173–192. https://www.jstor.org/stable/40987314

Mahler, R. L., Smolen, M. D., Borisova, T., Boellstorff, D. E., Adams, D. C., & Sochacka N. W. (2013). The national water survey needs assessment program. *Natural Sciences Education, 42*, 98–103. https://doi.org/10.4195/nse.2012.0025

Mulki, S., Rubinstein, C., & Saletta, J. (2018) Texas' water quality challenge and the need for better communication in an era of increasing water quality contamination events. *Texas Water Journal, 9*(1), 108–119. https://doi.org/10.21423/twj.v9i1

National Academies of Sciences, Engineering, and Medicine. (2023). *Communities, climate change, and health equity: Lessons learned in addressing inequities in heat-related climate change impacts: Proceedings of a workshop–in brief*. The National Academies Press. https://doi.org/10.17226/27204

National Institute of Food and Agriculture. (2023, July 19). *Water*. U.S. Department of Agriculture. https://www.nifa.usda.gov/topics/water

Oklahoma Department of Education. (2023). *State public enrollment totals*. https://sde.ok.gov/documents/state-student-public-enrollment

Oklahoma FFA Association. (2023). *About Oklahoma FFA foundation*. https://www.okffa.org/about-foundation

Perry, G. L., Richardson, S. J., Harré, N., Hodges, D., Lyver, P. O., Maseyk, F. J., Taylor, R., Todd, J. H., Tylianakis, J. M., Yletyinen, J., & Brower, A. (2021). Evaluating the role of social norms in fostering pro-environmental behaviors. *Frontiers in Environmental Science, 9*(1), 1–7. https://doi.org/10.3389/fenvs.2021.620125

Privitera, G. J. (2020). *Research methods for the behavioral sciences* (3rd ed.). Sage.

Reynolds, A. J. (1991). The middle schooling process: Influences on science and mathematics achievement from the longitudinal study of American youth. *Adolescence, 26*(101), 132–157. https://pubmed.ncbi.nlm.nih.gov/2048469/

Rice, F. P., & Dolgin, K. G. (2008). *The adolescent: Development, relationships, and culture* (12th ed.). Allyn & Bacon.

Ricketts, J. C., Duncan, D. W., & Peake, J. B. (2006). Science achievement of high school students in complete programs of agriscience education. *Journal of Agricultural Education, 47*(2), 48–55. https://doi/org/10.5032/jae.2006.02048

Singh, K., Granville, M., & Dika, S. (2002). Mathematics and science achievement: Effects of motivation, interest, and academic engagement. *The Journal of Educational Research, 95*(6), 323–332. https://doi.org/10.1080/00220670209596607

Steinberg, L. (2014). *Adolescence* (10th ed.). McGraw-Hill.

Stern, P. C., Dietz, T., Abel, T., Guagnano, G. A., & Kalof, L. (1999). A value-belief-norm theory of support for social movements: The case of environmentalism. *Human Ecology Review*, *6*(2), 81–97. https://www.jstor.org/stable/24707060

Stevenson, K. T., Peterson, M. N., Bondell, H. D., Moore, S. E., & Carrier, S. J. (2014). Overcoming skepticism with education: Interacting influences of worldview and climate change knowledge on perceived climate change risk among adolescents. *Climatic Change, 126*, 293–304. https://doi.org/10.1007/s10584-014-1228-7

Swafford, M. (2018). STEM education at the nexus of the 3-circle model. *Journal of Agricultural Education, 59*(1), 297–315. https://doi.org/10.5032/jae.2018.01297

United Nations. (2015). *Transforming our world: The 2030 agenda for sustainable development*. https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf

U.S. Bureau of Reclamation. (2020). *Water facts: Worldwide water supply*. Central California Area Office. https://www.usbr.gov/mp/arwec/water-facts-ww-water-sup.html

U.S. Government Accountability Office. (2014). *Freshwater: Supply concerns continue, and uncertainties complicate planning*. https://www.gao.gov/products/gao-14-430

Wagner, K. L., Eck, C. J., King, A. E. H., Joshi, O. (2021). Oklahoma's perceptions, attitudes, and beliefs related to water resources and their management: A decade long look. *Natural Sciences Education, 50*(1). http://dx.doi.org/10.1002/nse2.20054

van der Werff, E., & Steg, L. (2016). The psychology of participation and interest in smart energy systems: Comparing the value-belief-norm theory and the value-identity-personal norm model. *Energy Research and Social Science, 22*(1), 107–114. https://doi.org/10.1016/j.erss.2016.08.022

Warziniack, T., Arabi, M., Brown, T. C., Froemke, P., Ghosh, R., Rasmussen, S., & Swartzentruber, R. (2022). Projections of freshwater use in the United States under climate change. *Earth's Future*, *10*(2), 1–20. https://doi.org/10.1029/2021EF002222

Wertz, J., & Layden, L. (2013). *Troubled water: A deep dive into Oklahoma's most precious resource*. https://stateimpact.npr.org/oklahoma/2013/02/27/troubled-water-a-deep-dive-into-oklahomas-most-precious-resource/