Energy Literacy Infrastructure Study across Nebraska and Data-Driven Design of Energy-focused STEM Education and Virtual Outreach Activities for K-12 Students and Teachers

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Abstract.

Energy-related STEM literacy is essential for raising awareness about sustainable energy and developing the next-generation of STEM and energy workforce. For taking any practical, effective initiative to promote energy literacy, we recognized that the logical first step is to understand the current teaching and learning practices in K-12 classes on energy-related STEM topics. While similar efforts have been made in other states, this was lacking in Nebraska. To address this need, we conducted a 2-phase Energy Literacy Infrastructure study to create a state-level database detailing current teaching and learning practices in energy-related STEM education and to identify future educational needs across high schools of Nebraska. Phase 1 of this study involved qualitative, semi-structured phone interviews with teachers from select schools for a preliminary assessment of existing state of energy-related knowledge, skills, and attitudes among students and teachers. Phase 2 consisted of a web-based survey administered to all high school science teachers in Nebraska, using a list obtained from the Nebraska Department of Education's website. This phase aimed to gather more comprehensive data on current practices and future needs in energy-related STEM education. Analyzing the data from these two phases helped pinpoint key deficiencies, including a lack of resources, inadequate distribution of materials, insufficient guidance, gaps in expertise, and the absence of support networks. In fact, the findings revealed that more than half of the teachers feel unprepared to teach energy-related STEM topics and have expressed a need for additional support to overcome these challenges. Identifying these needs guided us through our next initiative: the data-driven design of STEM content and materials on energy-related topics for K-12 classrooms. As a test run, we conducted two virtual camps. The first one was a Young Nebraska Scientists (YNS) Summer Camp for middle and high school students. The second one was a session at the NanoSIMST Workshop to train middle and high school STEM teachers. This workshop provided essential engineering and nanoscience content knowledge, practical activities, and resources, equipping teachers to effectively deliver the new hands-on activities to complement their current curriculum and maximize student engagement. This paper summarizes our 5 years of effort to establish a streamlined, synchronized process for effective K-12 outreach, starting from the 2-phase energy literacy infrastructure study to designing K-12 education materials, training teachers and students, and conducting post-camp survey analysis. Overall, this sequential, need-driven design

of outreach can act as a scalable and impactful model for promoting K-12 energy literacy through broadening participation across Nebraska and beyond.

Keywords. Sustainable energy, energy literacy, K-12, STEM, Nebraska

Introduction.

There is a consensus among stakeholders that a well-educated and skilled STEM workforce is crucial for driving the U.S. economy and sustaining its global competitiveness.[1][2] The 2023 U.S. Energy and Employment Report[3] noted a rise in energy sector jobs from 7.8 million in 2021 to 8.1 million in 2022, with a 3.9% increase in clean energy jobs, outpacing the overall energy job growth of 3.1%. Employers anticipate a 6.4% increase in clean energy jobs by 2025[3] suggesting a steady increase in demand for skilled energy and STEM professionals nationwide as well as across Nebraska.[2] To develop skilled manpower for energy industries and to nurture innovation, energy literacy is thus the utmost need.

Energy literacy[4],[5],[6] helps us to understand the nature and role of energy significantly. It also enables a person to make decisions about how best to use energy while taking affects and consequences into consideration. Research,[7],[8],[9] however, suggests that the energy awareness and related education among U.S. K-12 students has a long way to go. For example, Dewaters and Powers[9] looked into the energy literacy of secondary students in New York State and reported that students are concerned about energy problems, but their low cognitive and behavioral scores suggested that the students may lack the knowledge and skills they need to effectively contribute toward solutions. Energy literacy thus calls for extensive studies, well-planned educational programs, and targeted actions at educational institutions at every level.[7] While these are essential, another significant challenge identified lately is the declining interest and participation of middle and high school students[10] especially in non-medical STEM fields, which poses a major hurdle in meeting the growing demand for a skilled energy STEM workforce. The school-level energy STEM education thus needs a complete reform to be more engaging and capable of addressing educational challenges in order to make a sustainable energy-STEM workforce pipeline.[1]

To tackle the observed shortfall, and to drive and propagate STEM literacy among middle- and high schoolers in Nebraska, meaningful outreach efforts have been made by various groups and organizations. These efforts target to improve knowledge over the broad umbrella of STEM disciplines where the major activities include STEM camps or outreach events for students, with a relatively smaller fraction of initiatives focusing on teachers' training/development. The assessment surveys and reports on these efforts unanimously indicate a positive change in student excitement and interest in STEM and increased knowledge gains as outcomes.[11],[12],[13],[14],[15] Since the inauguration of Nanomaterial Lab in 2016, led by PI Dishari from the Department of Chemical and Biomolecular Engineering at the University of Nebraska-Lincoln (UNL), we have established a strong reputation through extensive involvement in STEM outreach activities. Partnering with Nebraska EPSCoR, the Nebraska Center for Materials and Nanoscience (NCMN), the Nebraska State Museum, and other platforms, we have contributed to K-12 education and promoted STEM literacy. These activities have also helped us build valuable connections with middle- and high school STEM teachers, Lincoln Public Schools professionals, and broader audiences. However, in our early years (2016-2017), we noticed several trends and outcomes.

Firstly, the outreach activities often involved one-time interactions and one-way exchange with K-12 students, lacking long-term impact on sustaining STEM enthusiasm. Secondly, these activities were often designed without considering the prior knowledge, background, or specific needs of the students or teachers, resulting in a disconnect. Lastly, while working with middle- and high school students, especially prospective first-generation college students, and those from underrepresented and underserved communities, we noticed significant variations in the extent of knowledge in chemistry, engineering and sustainable energy across different schools. Even in some cases, middle school students demonstrated a better understanding of fundamental STEM concepts than high school students. Discussions with local K-12 STEM educators at that time revealed that the course contents and science activities included in the classroom learning vary significantly across schools. That was the time when we also discovered that there are reports available on the status of energy education at middle and high school levels in other states,[9],[16],[17],[18],[19] but not in Nebraska.

In the given context, we realized that an impactful way to bridge the disconnects could be identifying the needs of the students and teachers first, then addressing those in a well-informed manner. The best way to understand the needs will be to collect data and create a strong, state-level database on the current state of teaching and learning practices in energy-related STEM education to identify or predict the future educational needs across high schools of Nebraska. Such an informative database can help university-level educators understand the instructional infrastructure differences at schools, identify the barriers, and customize the outreach activities to cater to the needs of specific K-12 classes or groups. This will also aid schools in adhering to the "Nebraska College and Career-Ready Standards for Science" (NCCRS-S)[20],[21] which aligns well with the "Next Generation Science Standards" (NGSS).

Given the vastness of Nebraska, it is also crucial to implement a system that can enhance STEM literacy among demographics that are significantly underrepresented in STEM fields. However, the outreach activities and STEM camps organized at UNL primarily attracted students and teachers from nearby cities (Lincoln, Omaha), often missing those in remote areas due to travel and logistical challenges. Incorporating a dissemination system reaching students and teachers in both urban and remote locations would optimize the process and ensure a smoother transmission of knowledge on a wider scale, creating awareness of clean and sustainable energy at an early education stage and contributing to the development of the next-generation workforce.

With these realizations, leveraging our extensive expertise both in energy and sustainability research,[22],[23],[24],[25],[26],[27],[28],[29],[30] and in various STEM outreach, we took the following sequential action paths to address the energy literacy needs across Nebraska: First, to know the current state of energy literacy infrastructure across Nebraska, we performed a 2-phase energy literacy infrastructure study (data collected in 2019-2020, analyzed over 2020-2021) across high schools in Nebraska. While this was initially funded by the National Science Foundation (NSF) CAREER Award only, considering the scope and significance of this work, Nebraska Center for Energy Science Research (NCESR, funded by Nebraska Public Power District (NPPD)) and the UNL Department of Chemical and Biomolecular Engineering offered their kind support to this project. The next step was addressing the identified needs by designing data-driven STEM activities focused on sustainable energy. By the time we completed the energy literacy infrastructure study, COVID hit hard. We embraced the opportunities to organize virtual camps. In 2021, we conducted the Young Nebraska Scientists (YNS) camp virtually for middle and high school students.[31],[32] The outcome was very enthusiastic and through the process, we developed a framework and process of designing STEM kits and executing successful virtual STEM Camps. In 2024, we conducted another virtual STEM workshop through NanoSIMST for middle- and high school science teachers. The goal of this workshop was to equip science teachers with STEM knowledge, technical knowhow on specific hands-on activities that they can take to their classrooms. Due to the virtual nature of these workshops, we were able to reach out participants in remote locations of Nebraska and neighboring state (Iowa). A major fraction of these participants typically cannot avail themselves of these opportunities as they must travel to Lincoln where UNL is located. Thus, our efforts for virtual workshops/camps contributed to broadening participation and promoting energy literacy even in rural Nebraska and beyond. Surveys conducted after each workshop informed our subsequent outreach efforts. This paper summarizes our insights from the energy literacy infrastructure study to virtual camps for both students and teachers.

Energy Literacy Infrastructure Study Across Nebraska.

The purpose of this study was to gather information and feedback from high school science teachers in Nebraska to help better understand the teaching and learning practices of energy-related STEM education in Nebraska high schools. The whole project was executed in two phases. In **phase 1**, a small pool (16) of high school science teachers from select schools of Nebraska were phone interviewed (semi-structured, qualitative). In **phase 2**, a web-based survey was conducted among the science teachers of all the high schools of Nebraska. After institutional Review Board (IRB) approval received in 2019, the questionnaires for qualitative phone interview and web-based survey were prepared. Throughout both phases, engagement with stakeholders, including education specialists from the Nebraska Department of Education (NDE), Nebraska Green Schools Program, the local chapter of the U.S. Green Building Council, NPPD, and the Nebraska Energy Office was crucial for refining the interview process and obtaining feedback on the survey questionnaire. In the preparation of the questionnaire and administering the interviews and web surveys, we collaborated and sought services from the Bureau of Sociological Research (BOSR) at UNL.

Phase 1. For the limited phone interviews in phase 1, we prioritized schools and recruited teachers based on certain criteria (urban vs. rural, academic achievement, size, and student body demographics) to ensure collecting data from a diverse pool. The list of high school science teachers in Nebraska was obtained from the Nebraska Department of Education website. Each interview spanned between 15-20 minutes. The interviewers were given time to review the questions to familiarize themselves with the content. All interviews were audio-recorded, which allowed for monitoring. The audio recordings were transcribed by trained BOSR transcriptionists. Themes were then identified across the transcripts and coded by a BOSR staff member with expertise in qualitative data analysis. The 16 teachers interviewed had an average of 14.8 years of experience of being high school science teachers, with the shortest being 3 years and the longest being 40 years. Their experience in teaching energy-related curriculum or topics averaged 15-16 years, with the shortest being 1 year and the longest 40 years.

Key findings. The findings were analyzed across several categories, including current energy-related curriculum topics, teaching methods, course formats, and materials used. The analysis also covered teacher preparedness, needs for new courses, hands-on activities, outreach programs, student participation, barriers to STEM initiatives, and how university faculty can support interpreting and implementing the Nebraska College and Career Ready Science Standards (NCCRS-S).

In response to question on whether specific aspects of energy conversion and storage device are taught in their classrooms currently: 60% of teachers reported covering a range of topics, such as CO_2 generation and solar cars, while 20% said they do not cover energy-related topics, and another 20% said that they do not go into details. Most teachers indicated that materials- and nanotechnology-aspects related to renewable energy applications are not taught in their schools. In answer to the question whether courses or modules are used for energy education at their high school, half of the interviewees either denied their existence or lacked knowledge about them. Only 19% responded that they teach energy topics according to standards, but not like a formal course or module. In answer to another question, it was revealed that “Geoscience” (9^{th} grade) and “Physical and Earth Science” are the courses where energy topics are typically included. Typically, units on "Electricity,” “Waves,” “Sound,” and “Light” discuss energy in a relevant manner, while only 1 out of 16 respondents disclosed that they have a module named “Renewable Energy Resources.” Two others added that their modules are not an official product but more of a self-produced one.

One thing that came out distinctly is the **strong need for hands-on activities on energy-related topics**. Most teachers noted that their current energy-related teaching is primarily classroom-based. Energy-related outreach programs at the school level are scarce, with the vast majority reporting no such programs. When asked to specify topics of content respondents deem necessary to be included, if a new energy-related science course of module is developed, about half emphasized the importance of incorporating hands-on activities. Suggestions included integrating the concepts from textbooks to practical experiments such as making ethanol in laboratory, constructing fuel cells and solar energy models, and conducting small-scale energy simulations. Teachers also gave suggestions on some timely topics for new courses, like, pros and cons of new technologies vs traditional ones, fundamental differences in newer vs traditional batteries, and working principles of electric cars.

A wide spectrum of issues were raised in answer to question regarding barriers at their school to creating substantial STEM education initiatives focusing on energy, such as lack of priority on the energy-related topics in curriculum where they find it hard to devote much focus to this area of content, budget constraints, insufficient supplies and lab facilities, a shortage of experienced teachers, lack of direction/challenges in course design, and limited time and public support for energy education. Teachers expressed mixed confidence in their preparedness to teach advanced topics on energy and renewable energy. While some felt adequately prepared due to experience and training, others felt they lacked in-depth knowledge or practical experience, and a few felt underprepared at the school or district level.

In response to how university faculty can help the science teachers and schools in interpreting and implementing the Nebraska College and Career Ready Science Standards (NCCRS-S), respondents came up with several suggestions. Briefly, teachers need: (i) assistance in understanding and implementing various standards in the curriculum; (ii) **guidance in creating modules and conducting hands-on activities** in compliance with these standards in an organic way; and (iii) more professional development opportunities, such as **workshops for teachers**. They particularly emphasized the challenges of disentangling the standards and knowing where to start. Teachers also recommended that university faculty present a forward-looking vision of the energy field to students, increase awareness of industry opportunities and local jobs in energy sustainability, and tailor their contents for high school students. They suggested providing lessons, either in-person or remotely, on college life and careers in the sustainable energy field. Additionally, respondents proposed establishing state-wide consortiums, fostering close connections with science curriculum committees, offering new workshops or courses on energy topics at UNL, and building relationships with industry professionals to enhance educational materials and student motivation.

Phase 2. Phase 1 involved qualitative phone interviews with selected high school science teachers, serving as a pilot study to self-assess the direction of the study and ensure the relevance of the questions posed. In Phase 2, we expanded the assessment to a larger scale by conducting a web-based survey sent to all high school science teachers in Nebraska. This phase aimed to evaluate energy-related teaching and learning practices comprehensively and guide necessary improvements in energy-focused educational and outreach programs. The contact information of teachers was sourced from the Nebraska Department of Education and the survey was administered by BOSR. Initial survey invitations were sent on Sept 30, 2019, with multiple reminders sent from Oct 2019 to Jan 2020. Out of the 964 teachers sampled, 6.8% (n=66) did not receive the emails (emails bounced back), and 1.7% (n=16) were ineligible as they no longer teach high school science. Of the 948 eligible recipients, 150 teachers responded. Less than one-quarter of respondents (21.2%) reported having been high school teachers for 6-10 years, while over half (57.8%) have worked as high school teachers for 1-15 years. Survey data were recorded using Qualtrics and securely stored on a UNL Sociology Department server, with analysis conducted using Statistical Package for the Social Sciences (SPSS) software.

Key findings. The key findings from phase 2 are summarized in figures 1 and 2 (parts A & B). About 80% of teachers include the concepts of renewable energy in their own science curriculum, whereas nearly half of the teachers (49.3%) do not cover materials and nanotechnology related to renewable energy applications. Furthermore, more than half of the schools (64%) do not have any courses or modules whose main focus is energy or renewable energy education, while about 24.5% of respondents indicated that their schools offer such courses/modules under various names, including renewable energy sources, earth science, integrated science, physical science, or environmental science. Notably, over three-quarters of the teachers responded that these courses or modules were not provided by NISE network (96.7%), University Sources (87.5%), YouTube (78.1%), or other social media sources (90.3%), rather majority sourced from textbooks or other online resources (57.7%).

Classroom-based instruction predominates, with approximately 84% of the courses delivered in this format, and only about 15% offered online. A significant majority of teachers (91.5%) regard energy and renewable energy topics as equally important as other science topics, though a small fraction (4.6%) views them as less critical when compared to other science topics.

While 61% reported no substantial barriers at their schools to creating substantial STEM education initiatives focused on energy, 38% identified challenges in implementing so, such as lack of time to add new curriculum, funding, strict curriculum requirements, and insufficient equipment.

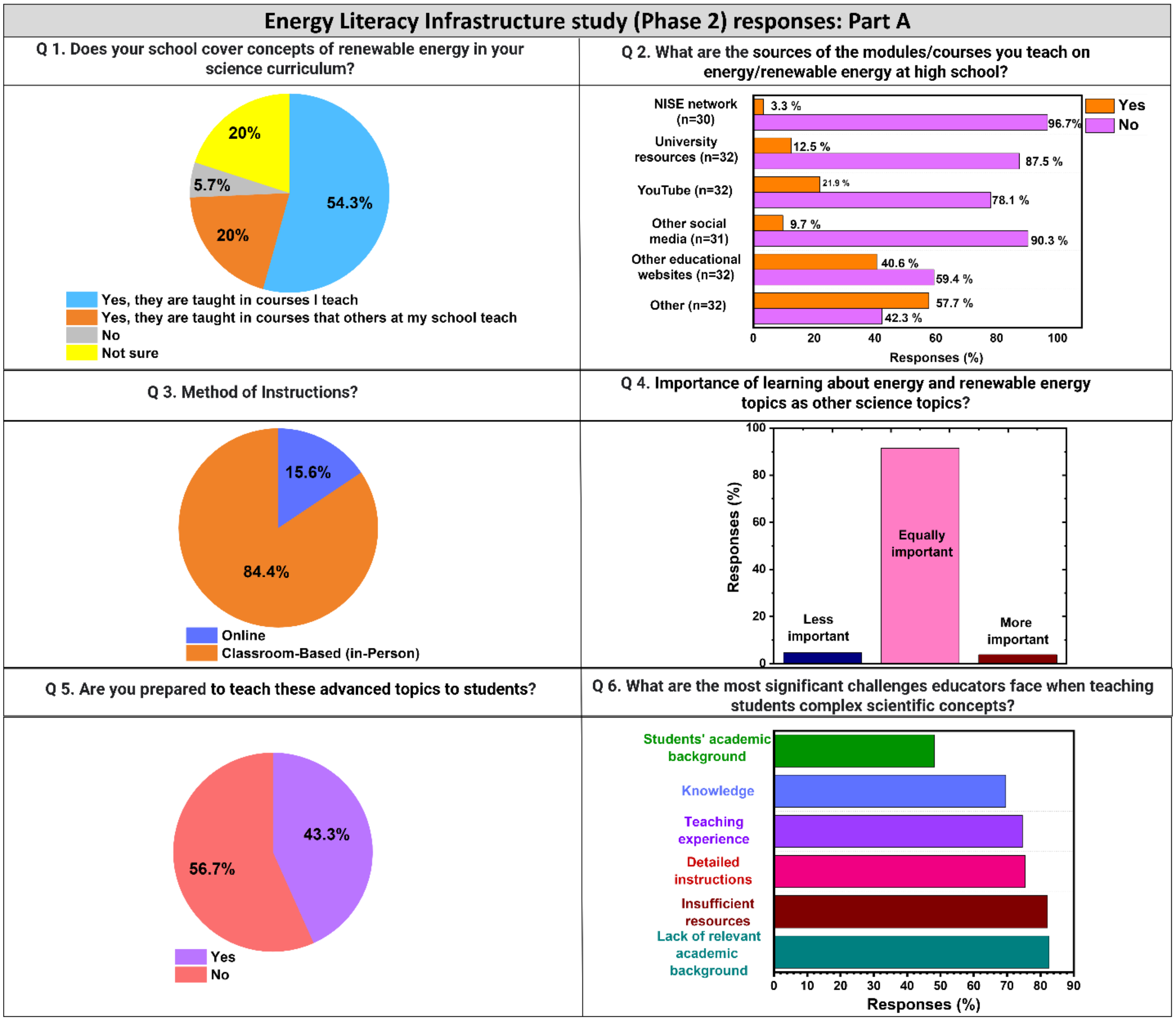

Figure 1. An overview of the analyzed survey responses from phase 2 of the energy literacy infrastructure study (Part A).

Most importantly, over half of the respondents (66.7%) mentioned that they need assistance in designing hands-on, energy-related STEM activities. Almost three-quarters of respondents (73.3%) said that they do not have any experience in developing curriculum on energy-related topics. **Over half of the teachers (56.7%) feel inadequately prepared to teach advanced energy topics**, citing a lack of relevant academic background (82.6%), experience (74.6%) and knowledge (69.6%) needed to teach these topics as primary concerns. They also reported insufficient resources (82.1%) and detailed instructions (75.4%) for implementing hands-on STEM activities, with nearly half (48.2%) noting students' insufficient academic background as an additional challenge. Other challenges they mentioned were time and financial constraints, further complicating the organization of such activities.

When probed the status of teachers' training, surprisingly, 92.9% of teachers said that they have not ever developed an energy-related curriculum through a summer research or internship position at a university.

More than half of the respondents (51.2%) also said that their schools are not well-equipped to support hands-on energy-related activities. Respondents said they have labs, 1-1 Chromebooks, and Vernier equipment to help support energy-related activities, but **they are in need of kits for renewable energy demonstration**, **lab equipment**, **time to prepare hands-on activities**, and **detailed curriculum for such activities**. Some also specified the need for **prepared lesson plans** that have been tested to help them better teach, and more staff to implement an energy focus into STEM education.

Nearly 70% of respondents also reported that there is not even any energy-related outreach program implemented at their schools. When teachers were asked if their students would attend a 3-day, renewable energy-related STEM summer camp at UNL, 60.3% said "Yes" and 39.7% said "No." Over three-quarters (88.6%) cited students' lack of time as the primary reason for not attending. Other concerns included financial feasibility (74.4%), travel constraints (67.4%), and conflicts with other camps (60.5%). Regarding interest in a summer course combining theory and interactive activities on renewable energy, 45.6% of teachers believed students would be interested, while 54.4% did not. The reasons for lack of interest were similar. Travel-related constraints are understandable as the survey was administered across Nebraska. For many students and teachers from remotely located schools in Nebraska, it would not be feasible to travel to attend activities organized at Lincoln, the capital and 2nd largest city of the state Nebraska. But this also highlighted the **need for alternate modes of support and infrastructure to implement energy literacy at remote schools in Nebraska**.

Respondents were asked how the University faculty could help implement the Nebraska College and Career Ready Science (NCCRS-S) standards. Respondents said they would benefit from **having the University faculty take some time to help implement and create lessons or activities for students**. In addition, **teachers suggested professional development or training opportunities from university faculty** to help them improve their STEM education teaching skills.

Teachers were asked if any energy-related science course or module was developed, what needs this new course or module would need to address. Teachers suggested that any new energy-related course or module should include comprehensive lesson plans and equipment. In addition, it would need to explain the advantages and disadvantages of each renewable energy topic and must meet the Nebraska curriculum standards. Some respondents also mentioned that there would be a need to trim down Nebraska's currently required curriculum in order to fit a new course or module in. Over three-quarters of the respondents favored an online course or learning materials on renewable energy, with 92.4% supporting a "stand-alone" online module and 91.3% endorsing a "stand-alone" offline module that could be integrated into existing lesson plans. Additionally, numerous respondents suggested that a semester-long dual credit course taught by UNL faculty would also work well if an online course or learning materials on renewable energy

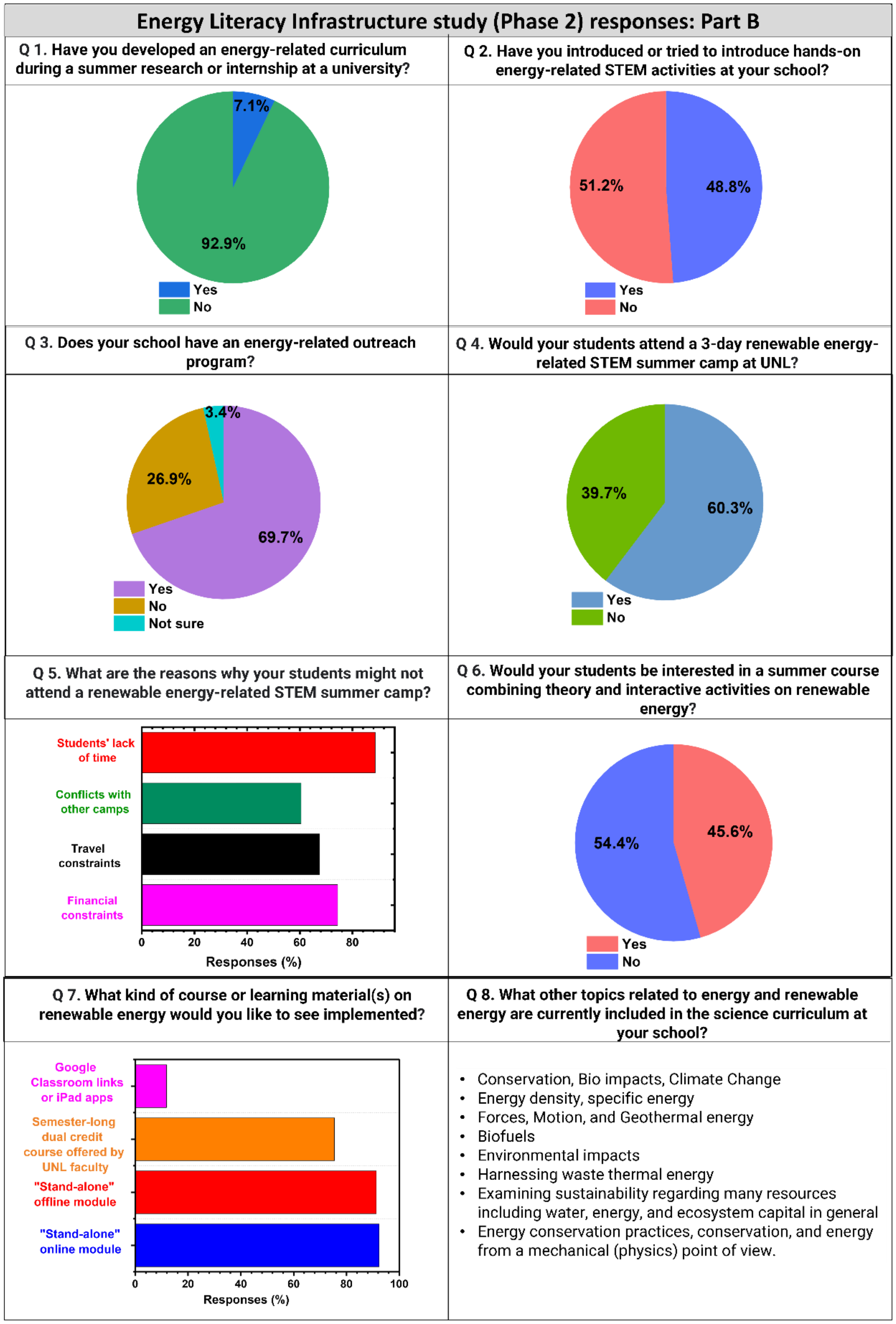

Figure 2. An overview of the analyzed survey responses from phase 2 of the energy literacy infrastructure study (Part B).

are designed. Some (11.8%) proposed alternative formats such as Google Classroom links or iPad apps for learning materials. Overall, the study again highlighted the importance of training high school science teachers in energy-related topics. Also, effective collaboration between high school and university-level educators is critical to understand the needs and address the needs to elevate energy literacy across high schools of Nebraska.

How the energy literacy infrastructure study shaped up the design of our STEM activities. The two-phase energy literacy infrastructure study and subsequent data analysis enabled us to uncover the existing teaching and learning practices and pinpoint the key challenges in implementing energy-related STEM literacy in Nebraska high schools. Here are the major takeaways in a nutshell: **(i) Teacher Preparedness and Resources**: Teachers struggle and feel unprepared to teach energy-related topics while adhering to NCCRS-S due to a lack of prior knowledge, training, time, resources, well-developed instruction materials/learning modules that combine theoretical concepts with engaging hands-on activities, and long-term support. **(ii) School Infrastructure**: Schools are not often equipped with the equipment, infrastructure, STEM kits critical for demonstrating sustainable energy technologies. **(iii) Geographical Disparities**: The struggle to implement energy literacy is more intense for students and teachers in remotely located schools in Nebraska as they are often unable to travel to Lincoln and avail themselves of the opportunities like summer camps, teacher workshop and internship in Lincoln. As a result, they miss the chance to collaborate with and receive guidance from university faculty, which is essential for developing engaging hands-on activities that can be integrated into their lessons in the classroom to effectively introduce and teach energy-related topics.

Recognizing these needs in 2019, we significantly shifted our focus to **data-driven design of outreach activities** and devised extensive plans to implement more effective remote outreach programs. By 2020, we were hit hard by COVID which further underscored the importance of these initiatives. Since then, we have organized several outreach activities prioritizing broad participation. Our group opted to design a range of engaging, easy-to-implement, hands-on STEM activity kits focused on working principles and science behind clean energy technologies. We boxed and shipped the kits to teachers and/or students participating in a camp/workshop, then guided them step-by-step through the experiments by instructing virtually (Zoom). This enabled the participants perform the experiments successfully while staying at their home, bypassing the need to travel to Lincoln for camps/workshops. While developing the kits and activities, we were mindful and tried to use easily accessible/available ingredients around us so that they can replicate these activities at home or in classroom as many times as they want. Finally, and very importantly, we dedicated extensive effort to creating very detailed experimental and instructional manuals for each camp/workshop. These manuals did not only include the list of ingredients and experimental methods, but also guided participants through observed phenomena by sequentially asking questions and providing detailed explanation of the underlying principles and their relevance to sustainable energy technologies at the very end. In many cases, we hinted toward relevant additional activities to satisfy the curiosity of eager learners.

Such efforts in data-driven design of outreach activities aimed for all over Nebraska (not just limited urban areas) can have a long-term, powerful impact in establishing a solid foundation of energy literacy across all Nebraska schools. This paper discusses two of our major efforts on energy-focused virtual outreach activities: (i) 2-day long, virtual Young Nebraska Scientists

(YNS) Summer Camp for Middle and High-School Students; (ii) NanoSIMST Workshop, a virtual Camp for Middle and High-School Science Teachers.

Data-driven Design of STEM Activities after Completion of Energy Literacy Infrastructure Study.

Young Nebraska Scientists (YNS) Summer Camp for Middle and High-School Students: A 2-day long, virtual Young Nebraska Scientist (YNS) summer camp was held in the summer of 2021 with the support from NSF and Nebraska EPSCoR. The theme of the camp was **chemistry, engineering and nanoscience behind renewable energy technologies**. The student participants (total 10) ranged from 9th to 11th grade, comprising of 6 girls and 4 boys. We remotely connected with high schoolers at more than 4-h driving distance from Lincoln, NE (Grand Island, Omaha, Amherst, and North Platte).

During the camp, through interactive, hands-on activities, the students were taught virtually how renewable energy technologies, such as fuel cells and electrolyzers are made, and how they work. They explored relevant chemistry and engineering concepts, like pH, polymers, ion transport, catalysis, and crystallization, and examined the behavior of the materials used to make energy technologies at nano- vs bulk/micron scale. All science kits, except for the crystallization kit, were developed from scratch by our lab (Figure 3). We also developed a detailed instructional guide on experimental set-up as well as relevant STEM concepts and shared it with the students before the camp. We also created an instructional video and shared it with the campers in advance. This allowed them to set up a table for experiments that would be visible to us over zoom, enabling us to provide customized instructions to individuals while they conducted experiments at their home on camp days. Figure 3 illustrates energy-focused hands-on activities conducted at the YNS camp, while Figure 3 shows a few zoom screenshots taken when students performed experiments successfully. Students used purple cabbage extract and fluorescent dyes to perform experiments demonstrating pH and ion transport concepts, which are essential for understanding energy conversion and storage devices such as batteries, electrolyzers, and fuel cells (Figure 3, 4a). Students used a pH indicator (phenolphthalein), carbon rods, a separator and a battery to demonstrate the concept of water electrolyzer (Figure 3, 4b). We also performed an elephant toothpaste experiment to understand the concept of catalysis, happening in electrochemical devices (Figure 3). A live demonstration of a hydrogen fuel cell toy car further engaged participants (Figure 3). We explored the roles of polymers in designing electrochemical technologies. Students conducted experiments to know about polymer properties (such as hydrophilicity/hydrophobicity and ion conduction) critical for these devices. We also showcased how common, everyday materials (e.g., table salt, cricket bugs, Christmas tree leaves, and sponges) appear under a digital microscope and compared these structures with nanoscale structures of ion-conducting polymers, visualized using scanning and transmission electron microscopy.

A virtual tour to the Nebraska Center for Materials and Nanoscience (NCMN) facilities introduced students to advanced nanoscale material characterization techniques. In addition to discussing and demonstrating energy technologies, we conducted brainstorming sessions where students proposed and presented electric car designs using renewable energy sources like hydrogen or solar power. They sketched their designs with glow-in-the-dark colors and black paper, making the activity both educational and enjoyable (Figure 3).

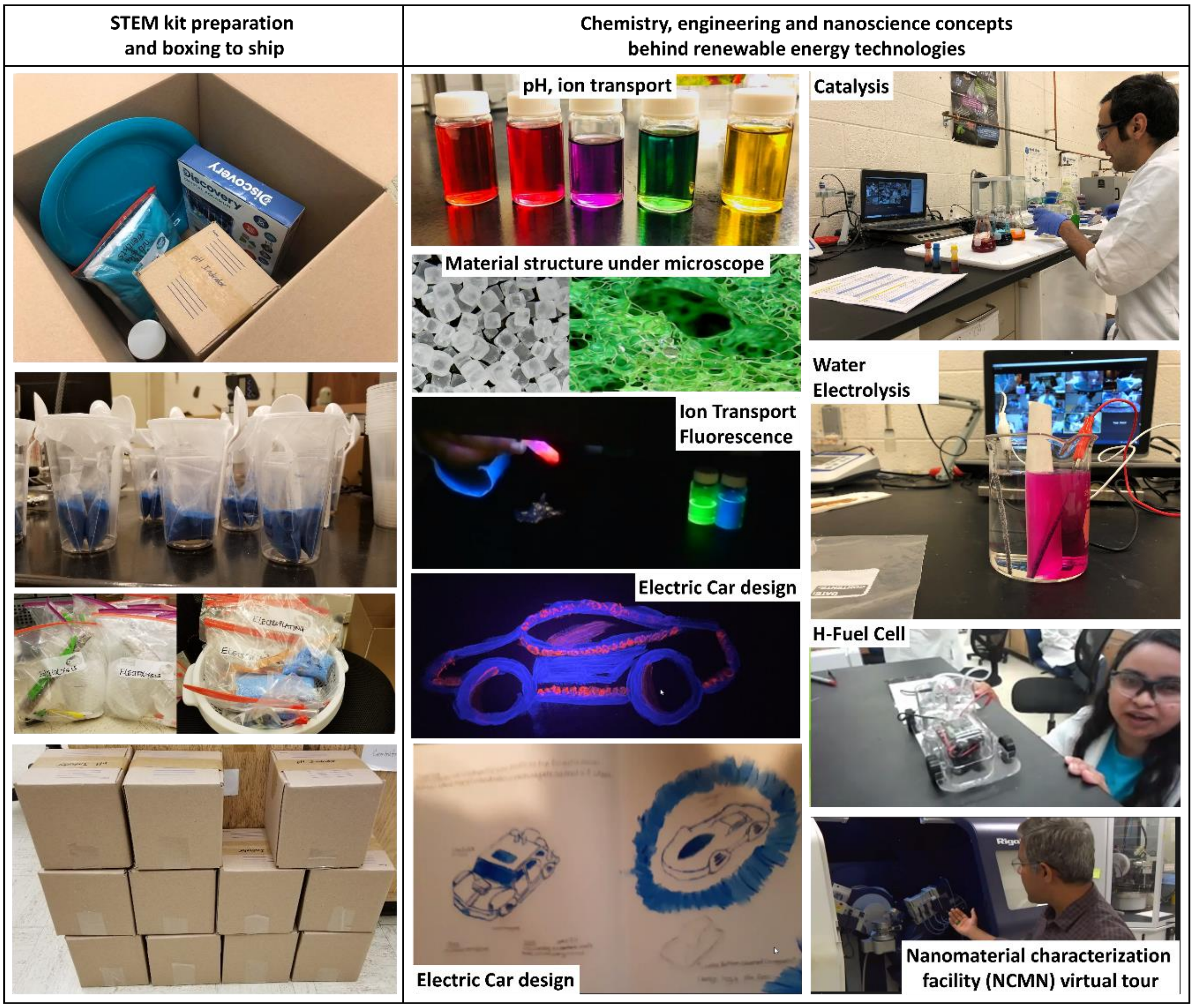

Figure 3. Left panel: Boxes ready to ship to the high school students participating in YNS camp. Each box included pH indicator, acid/base, crystallization, electrolysis, electroplating and a few other science kits. Image adapted from ref. [32]. © 2024 American Society for Engineering Education. Obewhere, O. A., & Cerda, K. A., & Keloth, R., & Dishari, S. K. , University of Nebraska-Lincoln, 2023 ASEE Midwest Section Conference, Lincoln. **Mid and Right panel:** Glimpse of energy-focused hands-on science activities performed at the YNS camp to teach chemistry, engineering and nanoscience concepts behind renewable energy technologies, such as electrolyzers, fuel cells, and batteries. We also included a video to give students a virtual tour to the Nebraska Center for Materials and Nanoscience (NCMN) having the state-of-the-art nanoscale materials characterization facilities at UNL.

Students also shared their career aspirations and how they would like to achieve their career goals leveraging training and resources in an informal set-up. We then discussed how the energy-related STEM knowledge and awareness can help them make environmentally conscious energy decisions and explore career opportunities in the energy sector. This comprehensive approach aimed to deepen their understanding of energy technologies while inspiring future careers in STEM.

Post-camp Survey Response. Organizing and executing the YNS camp required significant planning But the camp sustained a high level of engagement and achieved notable success, garnering appreciation from students (as detailed in our earlier paper[32]). The evaluation of the virtual YNS camp, including both pre- and post-camp perceptions, demonstrated that the camp was able to captivate and engage, and spike interest in sustainable energy, nanoscience and STEM effectively. 80-100% of students found the activities, such as learning about acids/bases, chemical reactions, electrolysis, and seeing science concepts in action to be extremely or very interesting. Students self-rated their knowledge, confidence, or interest in camp-related topics related to the camp. The ratings significantly improved after the camp. Before the camp, 100% of students felt only moderately or slightly knowledgeable about renewable energy, whereas after the camp, 60% felt very-to-extremely knowledgeable. Confidence in STEM fields rose from 70% feeling moderately knowledgeable before the camp to 70% feeling very-to-extremely knowledgeable after. Confidence in chemistry and nanoscience increased from 70% feeling slightly-to-not at all knowledgeable to 70% feeling moderate-to-very knowledgeable. 80% of campers strongly agreed that the YNS camp was well-organized and well-run, and 80% agreed (strongly or somewhat) that the camp provided valuable hands-on STEM experience. Interest in pursuing advanced education or careers in chemistry, nanoscience, and STEM significantly improved post-camp. 80% participants would recommend the camp to a friend.

Additional feedback spoke volumes about the effectiveness of the YNS camp, be it in-person or virtual:

"***Can't wait for the camp to be in person!***"

"***I actually enjoyed being able to do this online, it was very convenient for me because I live farther away. I think that you should consider continuing with more virtual camps so that more people can participate, even if they don't live nearby.***"

Especially the second comment aligns with the exact reason why we went virtual for 2021 YNS camp and highlights the potential of virtual camps to reach remote locations and spread STEM enthusiasm. This encouraging outcome inspired us to organize a virtual STEM workshop for high school science teachers recently (2024).

NanoSIMST Workshop - A virtual Camp for Middle and High-School Science Teachers: The energy literacy infrastructure study we conducted earlier indicated the clear need for training and resources for STEM teachers. Driven by this data collected, we organized a STEM workshop for middle and high school science teachers (Figure 5) in 2024, as a part of the NanoSIMST workshop. This event, sponsored by the National Nanotechnology Coordinated Infrastructure (NNCI) and organized in partnership with Stanford University, was hosted by the Nebraska Center for Materials and Nanoscience (NCMN). The NanoSIMST Workshop aimed to ***equip middle and high school teachers with engineering and nanoscience content knowledge, lessons, and hands-on- activities to bring back to their classrooms***. We conducted this workshop remotely. Like what we did for the YNS camp, for the NanoSIMST workshop we prepared (all except the squishy circuit kit) and shipped the kits to teachers, and they joined remotely from all over Nebraska (Omaha, Papillion, Kearney, Arcadia) and Iowa. Together, we engaged in various activities such as making electric circuits (Figure 5a), splitting water through

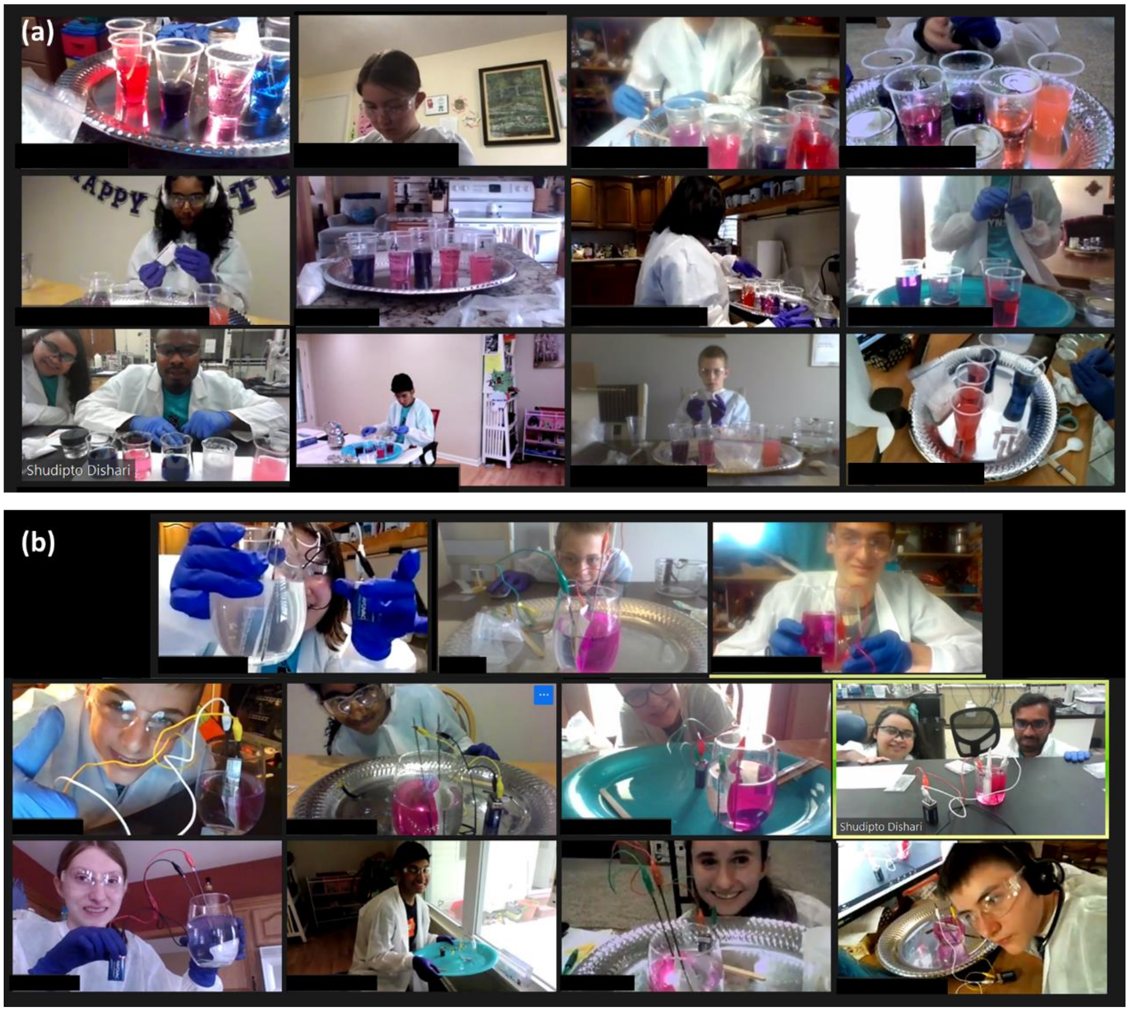

Figure 4. Screenshots taken during the virtual Young Nebraska Scientists (YNS) Summer Camp (2021) to show successful completion of experiments to understand concepts behind renewable energy technologies. (a) **Day 1:** Learning the concept of pH and proton (H^+) conduction in ionomeric materials using purple cabbage. (b) **Day 2:** Learning the concept of water electrolysis.

electrolysis (Figure 5b) and building batteries (Figure 5c). Initially, we explored the fundamentals of electric circuits using conductive clay and common household items like bananas, breads, and potatoes. As the workshop progressed, teachers started to proactively test conducting behavior of various random objects from their homes or workspaces to light up LEDs. This activity naturally revealed their child-like curiosity and showcased the fun side of STEM activities focused on energy. We prepared a thorough "instruction manual" detailing experimental procedures, interactive questions, the science behind the observed phenomena, and additional interactive ideas for extending the interactive activities further. The goal was to create it in a way that can aid the teachers to replicate the experiments with their students in the classroom.

Figure 5. 2024 NanoSIMST Workshop to train middle- and high school science teachers.

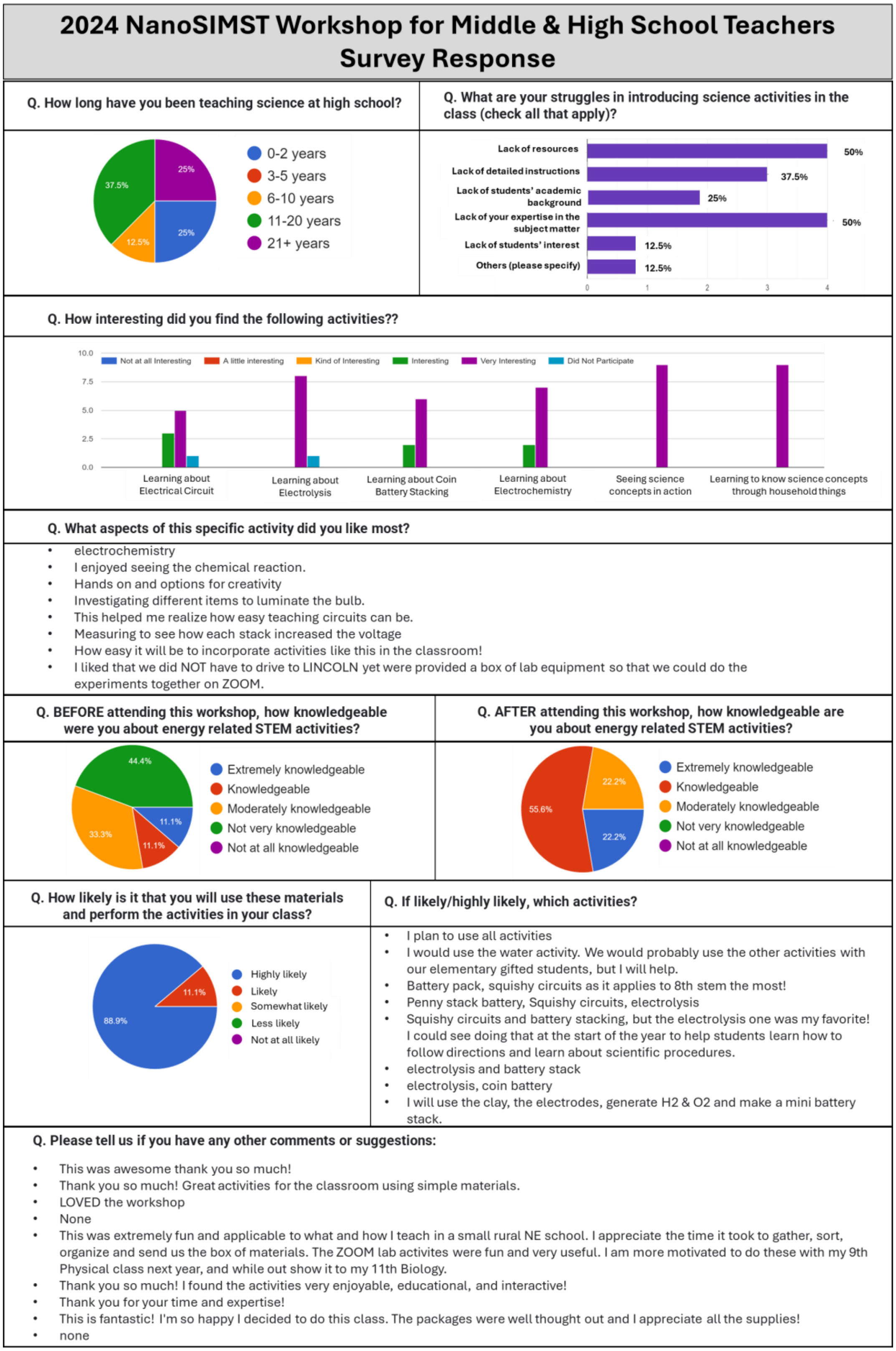

Figure 6. Glimpse of survey responses of our energy-focused STEM activities at the 2024 NanoSIMST Teachers' Workshop.

Post-camp Survey Response. The after-workshop survey responses are shown in Figure 5. Surprisingly, all participants were female teachers (100 %). Among them, 11% were Hispanic and 89% were not Hispanic or Latino. The high school teaching experience of the teachers was as follows: 25%: 21 yrs+; 37.5%: 11-20 yrs; 12.5%: 6-10 yrs; 25%: 0-2 yrs.

When asked why they struggle to introduce science activities in class, teachers cited lack of resources (50%), lack of expertise (50%), and lack of detailed instructions (37.5%) the most. The NanoSIMST workshop aimed to address all these issues. Overall, the survey responses were highly positive, as shown in detail in Figure 6. As per the survey, the percentage of teachers who felt knowledgeable or extremely knowledgeable about energy-related STEM activities increased from 22.2% before the workshop to 77.8% after. 100% of teachers responded that they are likely or highly likely to use the workshop materials and activities in their classes. This time, we had teachers participating from remote areas of Nebraska and Iowa, many of whom appreciated the opportunity to join the workshop over Zoom. Similar to the feedback we received from our virtual YNS student camps, the individual comments from teachers on appreciating the virtual workshop and energy-focused activities suggested that we are gradually making progress towards our goal of broadening participation in energy STEM.

Here are a few comments from the survey:

"This is extremely fun and applicable to what and how I teach in a small rural NE school. I appreciate the time it took to gather, sort, organize, and send us the box of materials. The ZOOM lab activities were fun and very useful. I am more motivated to do these with my 9th Physical class next year, and while out show it to my 11th Biology."

"I liked that we did NOT have to drive to LINCOLN yet were provided a box of lab equipment so that we could do the experiments together on ZOOM."

"This is fantastic! I'm so happy I decided to do this class. The packages were well thought out and I appreciate all the supplies!"

"How easy it will be to incorporate activities like this in the classroom!"

"This helped me realize how easy teaching circuits can be."

Based on the feedback, the following actionable steps are recommended:

Broader Impact and Future Directions.

Saul Griffith, an entrepreneur and renewable electricity advocate stated: "If we are to make a big change in the way energy is produced and consumed, we need an 'energy literacy' that gives people a tangible sense of their energy consumption, and of what it takes to meet that."[4] On the other hand, the UNL Engineering Dean Lance Perez stated: "It is in STEM areas where job growth and the future of the economy of the United States and Nebraska is. We either have to make the decisions necessary to participate in that growth, or we won't be able to participate in that growth and that would be bad for the future of Nebraska."[2] Both comments resonate with our approach to promote energy STEM literacy across Nebraska. Energy literacy at all educational levels is critical to build the energy workforce from the root level. To inspire and educate the next generation of innovators and problem solvers, we must reform the energy-focused STEM education and outreach activities, but the design must be need-driven, rather than random efforts often experienced.

We made the first effort to address a critical, unmet need in Nebraska by creating a comprehensive state-level database on teaching and learning practices related to energy topics in high schools. This 2-phase energy literacy infrastructure data helped us identify and address teachers' needs and guide them in developing renewable energy-focused curricula in a planned way. Subsequently, implementing virtual STEM camps and workshops allowed us to overcome the geographical barriers, enabling students/teachers from rural or underserved locations to participate. By training students and teachers, including those in remote areas, and finding effective ways to integrate the designed hands-on, inquiry-based activities into energy STEM modules, we are supporting and will continue to support the development of the next generation of skilled energy professionals in Nebraska and from Nebraska. We will continue to foster a sustainable future through these efforts. Our data-driven, multifaceted, and streamlined approach, tackling the energy literacy challenge from multiple angles, can serve as a replicable model for other groups, states, and countries, not just in the energy sector but across all STEM educational fields.

Our immediate focus will be on staying in touch with the teachers we have trained, asking for updates on how they have integrated our activities into their classrooms, and gathering student survey responses to assess their perceptions of learning energy-related STEM concepts. Using this feedback, we aim to refine our kits and continue this process, expanding support to more teachers across Nebraska and beyond through future funding opportunities. Long-term, we plan to collaborate with educators, experts, and non-profit organizations through structured partnerships, where we will co-develop new activities and share best practices to drive innovation in energy STEM education and foster a positive culture of energy-related problem solving at the K-12 level. We will also work on expanding the availability of science kits with detailed instructions at a wider scale to address the deficiency of resources pointed out by the teachers. To disseminate in areas with diverse populations, translating of the teaching materials and videos into other languages could broaden the scope of these activities. We will also establish mentorship programs and internships to address disparities in STEM access for underrepresented groups, such as women. Additionally, we will continue to mentor and support female students from middle school to graduate levels, inspiring them to pursue energy STEM careers through targeted initiatives and outreach activities.

Conclusions.

In conclusion, we successfully completed the Energy Literacy Infrastructure study, summarizing current teaching and learning practices on energy-related topics across high schools of Nebraska. This 2-phase study identified: (i) gaps in energy education, (ii) struggles of teachers in implementing energy-focused curricula due to lack of knowledge, experience and resources, and (iii) necessity for more virtual, yet effective energy STEM camps, workshops, and training for both students and teachers for broader participation in energy and STEM workforce. Informed by this database, we designed focused, hand-on STEM kits, activities, and instructional materials to enhance understanding of STEM concepts behind sustainable energy conversion and storage devices. Leveraging these materials, we organized virtual energy-focused STEM camps for middle and high school teachers (NanoSIMST workshop) and students (YNS camp), aiming to spread energy-focused STEM education even to remote areas of Nebraska and neighboring states. Post-activity surveys from YNS camp showed substantial gains in students' confidence to pursue STEM fields, with significant improvements in understanding renewable energy, chemistry, and nanoscience. Teacher evaluations from the NanoSIMST workshop also revealed that the percentage of teachers feeling knowledgeable or extremely knowledgeable about energy-related STEM activities increased from 22.2% to 77.8% after the workshop. These positive outcomes and feedback highlighted the success of this multifaceted, data-driven approach in improving the quality of energy-related STEM education and student engagement, thereby catalyzing the energy literacy at the grassroot level. Future efforts will focus on maintaining connection with trained teachers, refining educational kits based on feedback and classroom experiences, and expanding support through new initiatives and collaborations with educational experts in Nebraska and beyond. We believe this effective approach and study have the potential to be successfully adopted in other regions, fostering similar advancements in energy-related STEM education and student engagement.

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References.

[1] G. Athanasia, "The U.S. Should Strengthen STEM Education to Remain Globally Competitive," *Cent. Strateg. Int. Stud.*, 2022, [Online]. Available: https://www.csis.org/blogs/perspectives-innovation/us-should-strengthen-stem-education-remain-globally-competitive.

[2] M. Lee, "University of Nebraska working to address urgent STEM workforce needs." https://nebraska.edu/news-and-events/news/2019/university-of-nebraska-working-to-address-urgent-stem-workforce-needs#:~:text=University of Nebraska working to address

urgent STEM workforce needs,-April 15%2C 2019&text=Nebraska will have more than,those wi.

[3] US Department of Energy, "United States Energy & Employment Report 2023," 2023. [Online]. Available: https://www.energy.gov/policy/us-energy-employment-jobs-report-useer.

[4] J. DeWaters, B. Qaqish, M. Graham, and S. Powers, "Designing an energy literacy questionnaire for middle and high school youth," *J. Environ. Ed.*, vol. 44, pp. 56–78, 2013, doi: 10.1080/00958964.2012.682615.

[5] "Energy Literacy: Essential Principles and Fundamental Concepts for Energy Education," *DOE Office of Energy Efficiency & Renewable Energy*. https://www.energy.gov/energysaver/energy-literacy-essential-principles-energy-education.

[6] "Energy Literacy Framework: A Quick Start Guide for Educators," *Office of Energy Efficiency & Renewable Energy*, 2016. https://www.energy.gov/sites/default/files/2015/03/f20/EnergyLiteracy_QuickStartGuide.pdf.

[7] J. Dewaters, S. Powers, and F. Bilow, "An introductory energy course to promote broad energy education for undergraduate engineering students," *Sustainability*, vol. 13, pp. 1–22, 2021, doi: 10.3390/su13179693.

[8] L. S. Lee, Y. F. Lee, J. W. Altschuld, and Y. J. Pan, "Energy literacy: Evaluating knowledge, affect, and behavior of students in Taiwan," *Energy Policy*, vol. 76, pp. 98–106, 2015, doi: 10.1016/j.enpol.2014.11.012.

[9] J. E. DeWaters and S. E. Powers, "Energy literacy of secondary students in New York State (USA): A measure of knowledge, affect, and behavior," *Energy Policy*, vol. 39, pp. 1699–1710, 2011, doi: 10.1016/j.enpol.2010.12.049.

[10] K. Matzinger, "Stemming the STEM decline," *Junior Achievement USA*, 2024. https://jausa.ja.org/news/blog/stemming-the-stem-decline.

[11] Army Educational Outreach Program, "Programs for Students." https://www.usaeop.com/.

[12] EPSCOR NEBRASKA, "Young Nebraska Scientists." https://yns.nebraska.edu/.

[13] National Security Agency, "NSA's K-12 STEM Outreach activities are currently being re-evaluated to ensure alignment with our strategic objectives." https://www.nsa.gov/Academics/K12-Partnership/.

[14] National Science Teaching Association, "NSTA." https://www.nsta.org/.

[15] Strategic Air Command & Aerospace Museum, "SAC Museum Receives $20,000 Grant from the Peter Kiewit Foundation to Enhance STEM Education."

https://www.sacmuseum.org/news/sac-museum-receives-20000-grant-from-the-peter-kiewit-foundation-to-enhance-stem-education/.

[16] J. DeWaters and S. Powers, "Energy literacy among middle and high school youth," in *38th ASEE/IEEE Frontiers in Education Conference*, Oct. 2008, pp. T2F-6-T2F-11, doi: 10.1109/FIE.2008.4720280.

[17] A. Bodzin, "Investigating Urban Eighth-Grade Students' Knowledge of Energy Resources," *Int. J. Sci. Educ.*, vol. 34, no. 8, pp. 1255–1275, May 2012, doi: 10.1080/09500693.2012.661483.

[18] S. D. Kirby, A. G. Guin, and A. G. Chilcote, "Creating the next generation of residential energy stewards using the energy transformation curriculum," *Hous. Soc.*, vol. 42, no. 3, pp. 250–258, Dec. 2015, doi: 10.1080/08882746.2015.1121687.

[19] L. H. Barrow and J. T. Morrisey, "Energy Literacy of Ninth-Grade Students : A Comparison Between Maine and New Brunswick," *J. Env. Ed.*, vol. 20, no. 2, pp. 1–6, 2016.

[20] "Nebraska State Board of Education approves new science standards." https://newsroom.unl.edu/announce/nebraska-science/7152/40135#:~:text=NESS aligns well with the,specific references to climate change.

[21] Nebraska State Board of Education, "Nebraska's College and Career Ready Standards for Science," 2017. [Online]. Available: https://www.education.ne.gov/wp-content/uploads/2017/10/Nebraska_Science_Standards_Final_10_23.pdf.

[22] S. Chatterjee *et al.*, "Molecular-Level Control Over Ionic Conduction and Ionic Current Direction by Designing Macrocycle-based Ionomers," *JACS Au*, vol. 2, pp. 1144–1159, 2022, doi: 10.1021/jacsau.2c00143.

[23] S. Chatterjee *et al.*, "Advancing ionomer design to boost interfacial and thin-film proton conductivity via styrene-calix[4]arene-based ionomers," *Cell Rep. Phys. Sci.*, vol. 4, pp. 1–39, 2023, doi: 10.1016/j.xcrp.2023.101282.

[24] S. Farzin, E. Zamani, and S. K. Dishari, "Unraveling Depth-Specific Ionic Conduction and Stiffness Behavior across Ionomer Thin Films and Bulk Membranes," *ACS Macro Lett.*, vol. 10, pp. 791–798, 2021, doi: 10.1021/acsmacrolett.1c00110.

[25] S. Farzin, T. J. Johnson, S. Chatterjee, E. Zamani, and S. K. Dishari, "Ionomers From Kraft Lignin for Renewable Energy Applications," *Front. Chem.*, vol. 8, pp. 1–17, 2020, doi: 10.3389/fchem.2020.00690.

[26] O. A. Obewhere and S. K. Dishari, "Engineering Ionomer-Substrate Interface to Improve Thin-Film Proton Conductivity in Proton Exchange Membrane Fuel Cells," *ACS Appl. Polym. Mater.*, vol. 6, pp. 4535–4546, 2024, doi: 10.1021/acsapm.3c03218.

[27] S. Farzin, A. Sarella, M. A. Yandrasits, and S. K. Dishari, "Fluorocarbon-Based Ionomers

with Single Acid and Multiacid Side Chains at Nanothin Interfaces," *J. Phys. Chem. C*, vol. 123, pp. 30871–30884, 2019, doi: 10.1021/acs.jpcc.9b10015.

[28] S. Farzin, K. A. Cerda, O. A. Obewhere, and S. K. Dishari, "Lignin-based Materials for Energy Conversion and Storage Devices," in *Sustainability Engineering: Challenges, Technologies, and Applications*, E. C. Tan, Ed. 2023, pp. 1–60.

[29] K. Acurio Cerda *et al.*, "Cationic Lignin as an Efficient and Biorenewable Antimicrobial Material," *ACS Sustain. Chem. Eng.*, vol. 11, pp. 10364–10379, 2023, doi: 10.1021/acssuschemeng.3c01414.

[30] O. A. Obewhere, K. Acurio-Cerda, S. Suradhar, M. Dike, R. Keloth, and S. K. Dishari, "'Unravel-Engineer-Design' -A 3-Pronged Approach for Ionomers at Interfaces to Address Challenges of Proton Exchange Membrane Fuel Cells Oghenetega," *Chem. Commun.*, 2024.

[31] S. K. Dishari, "Young Nebraska Scientists (YNS) Camp, Chemistry and Nanoscience: Behind Renewable Energy Technologies," 2021. https://yns.nebraska.edu/gain-hands-on-experience-in-stem/summer-camps/renewable-energy.

[32] O. A. Obewhere, K. A. Cerda, R. Keloth, and S. K. Dishari, "Implementing a Virtual STEM Camp for Middle- and High Schoolers in a Post-COVID Climate Leveraging Prior Experience," *ASEE MidWest Conf.*, 2023.

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