FINDINGS FROM MACROINVERTEBRATES.ORG SUMMER 2021 EDUCATOR TRAININGS

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ACKNOWLEDGEMENTS

Evaluation & Report Credits

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Project Credits

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About Rockman et al Cooperative, Inc.

Rockman et al Cooperative, Inc. is an employee-owned, innovative research, evaluation, and consulting company that specializes in examining critical issues in formal and informal education. The Rockman team includes evaluators with diverse backgrounds and skillsets who help clients answer critical questions in clear, direct, and honest ways. Rockman et al has served as the lead evaluator for numerous projects funded by the National Science Foundation, as well as several other public and private funding agencies. Learn more at www.rockman.com.

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EXECUTIVE SUMMARY

PocketMacro is a mobile app designed by The Human-Computer Interaction Institute at Carnegie Mellon University to help users better identify benthic macroinvertebrates commonly found in streams and other waterways. In Summer 2021, the app and other supplemental materials were highlighted during trainings for educators held at the Stroud Water Research Center. Participants filled out a survey after the training, and a subset were interviewed by a member of the evaluation team from Rockman et al Cooperative (REA). Key findings have been synthesized below.

KEY FINDINGS

ABOUT THE TRAININGS

- After the trainings, educators reported a significant increase in their knowledge about macroinvertebrate identification

> "I'm still beginner level, but **I feel comfortable now** going and working with my students."

- Educators thought that the trainings were impactful on their ability to:
  - Use the PocketMacro app to identify aquatic macroinvertebrates
  - Access tools and resources to teach about aquatic macroinvertebrates
  - Prepare their students or volunteers to identify aquatic macroinvertebrates

- Aspects of the trainings that were most helpful to educators included:
  - Exploring the features of the PocketMacro app
  - Sharing ideas with other educators about possible applications of PocketMacro and other highlighted resources in their own learning contexts

> "I will be able to learn about the creatures living in my stream and be able to **better assess stream health** as a result."

- Attendees at the shorter Mini-Walkthrough training sought more time for group discussion and practice using the app

ABOUT THE POCKETMACRO APP

"I think it's an **empowering tool.** I think it's easy for folks to use and would **increase confidence and identification skills** and things like that."

- Educators felt that the app:
  - Looked professional and was easy to use
  - Was more accessible and user-friendly than printed reference materials
  - Provided the right amount and level of information for novices

- Educators thought that the app was most effective at helping them:
  - View macroinvertebrates closely
  - See relevant features to conduct an identification
  - Differentiate between insect groups
  - Confirm an ID

"It's **really hard to find stuff like this** that gives the kids good, solid information that **doesn't dumb it down** or baby it for them."

- Educators thought that the app would help students:
  - Feel more confident in their IDs
  - Focus on an organism's diagnostic characteristics
  - Increase their interest in related topics
- The app was viewed as less impactful on educators' ability to address standards

"The **photographs are pretty amazing** and being able to **zoom in and out** on both sides of the organism, like the ventral and the dorsal are pretty cool.

- Educators found the three app sections (Field Guide, ID Help, Flashcards) to be useful overall. They liked:
  - The Field Guide and its zoomable images
  - The guided questions in the ID Key
  - Ability to practice with the Flashcards

- Possible applications of the PocketMacro app most frequently mentioned by educators included:
    - To increase students' or volunteers' interest in aquatic macroinvertebrates, environmental stewardship, and waterways
    - To increase students' or volunteers accuracy around macroinvertebrate ID
    - To review their own knowledge and develop their own identification skills
    - To figure out what was in their own local streams
    - To utilize with individuals or organizations for water quality biomonitoring efforts
    - To prepare students for streamside specimen collection and identification
    - To provide lab-based experiences when outdoor collection is not possible

- Potential features to add to the PocketMacro app included:
    - Crowdsourced educator resources and networking opportunities
    - Information about the macroinvertebrates' location, lifecycle, movements, differences in adult versus larval forms, and invasive species
    - Ability to compare specimen images (two Orders or with users' photos)
    - Ability to track decisions and review or change choices made in ID Key to better understand how selecting different features leads to Order identification

In sum, the trainings using the PocketMacro app provided educators with valuable resources to engage students and volunteers with aquatic macroinvertebrates and to support their developing identification practices.

"The Field Guide and the Flashcards will be very useful in ***increasing my own confidence in identifying/discriminating between similar-looking organisms.***"

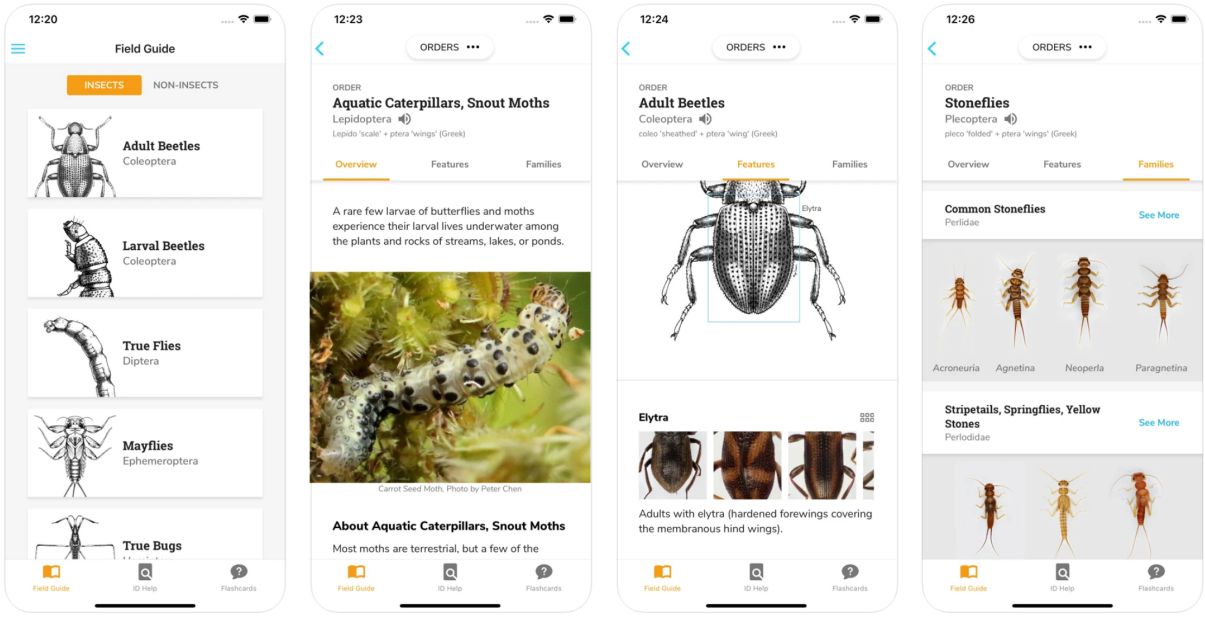
"It is a great tool to zoom in and **see the different features** like tarsal claws."

"It sounds really dorky, but I have found myself - Like when I was in a doctor's office waiting room, I was **playing with the Flashcard feature**."

PROJECT DESCRIPTION

As part of a National Science Foundation-funded effort, The Human-Computer Interaction Institute at Carnegie Mellon University, alongside the Carnegie Museum of Natural History, Stroud Water Research Center, and Clemson University, developed PocketMacro, a mobile app version of The Atlas of Common Freshwater Macroinvertebrates of Eastern North America (www.macroinvertebrates.org). The app features nine Orders of aquatic insects and other benthic macroinvertebrates commonly used in water quality biomonitoring and environmental education (see Figure 1).

FIGURE 1: SCREENSHOTS FROM THE FIELD GUIDE SECTION OF THE POCKETMACRO APP



In late July 2021, Stroud Water Research Center hosted two training events for informal and formal educators that both highlighted several digital and print resources for teaching and learning about aquatic macroinvertebrates, including the PocketMacro app, flashcards, handouts, posters, videos, and texture rubbings. The first event, a Mini-Walkthrough, was held in the evening and introduced participants to the PocketMacro app's features and functionality. The second event, a half-day Educator Training, also

introduced the PocketMacro app and gave attendees the opportunity to collect aquatic macroinvertebrates streamside and practice using the app to identify them (see Figure 2).

To examine the impacts of the training events and the PocketMacro app, independent evaluators from Rockman et al Cooperative (REA) worked with the app's developers to create a survey to gather information from event attendees regarding their opinions of the overall experience and the resources highlighted during the trainings (*See Appendix A for instrumentation*). Survey questions focused on what attendees found valuable about the trainings and app, as well as suggestions they had for future improvement. The survey prompted respondents to reflect on how the trainings and app supported attendees' development of their own aquatic macroinvertebrate identification skills, as well as their confidence in their ability to teach or train students and volunteers.

FIGURE 2: PHOTOGRAPHS FROM THE EDUCATOR TRAINING

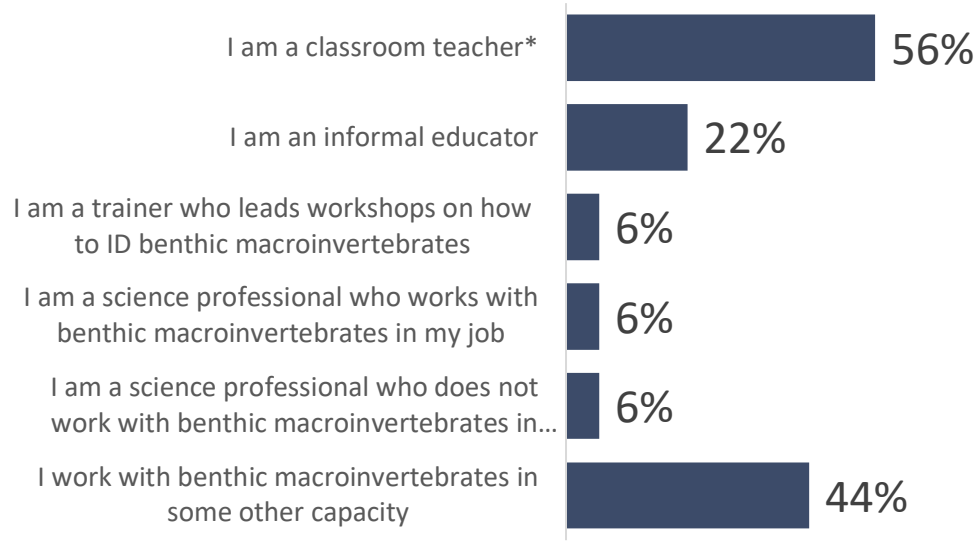
METHODS

Attendees either took a paper-based survey immediately after the Educator Training or Mini-Walkthrough (depending on which event they attended), or utilized an online link to take the survey at a later date. Almost all attendees at the Educator Training (18 out of 19) and the Mini-Walkthrough (16 out of 17) completed the survey. Survey respondents received a $25 online gift card. In addition, respondents who indicated a willingness to provide further feedback were contacted via email to participate in an interview via the Zoom videoconference platform. Interviews lasted approximately 45 minutes, and interviewees received a $25 online gift card for their participation. Five individuals from the Educator Training and two individuals from the Mini-Walkthrough were interviewed.

SURVEY SAMPLE: EDUCATOR TRAINING

The majority of Educator Training attendees (61%) were female. The average age of Educator Training attendees was 50 years of age (Range = 28-73). One attendee was African American, the rest were White/Caucasian. Over half of the Educator Training attendees were classroom teachers (see Figure 3).

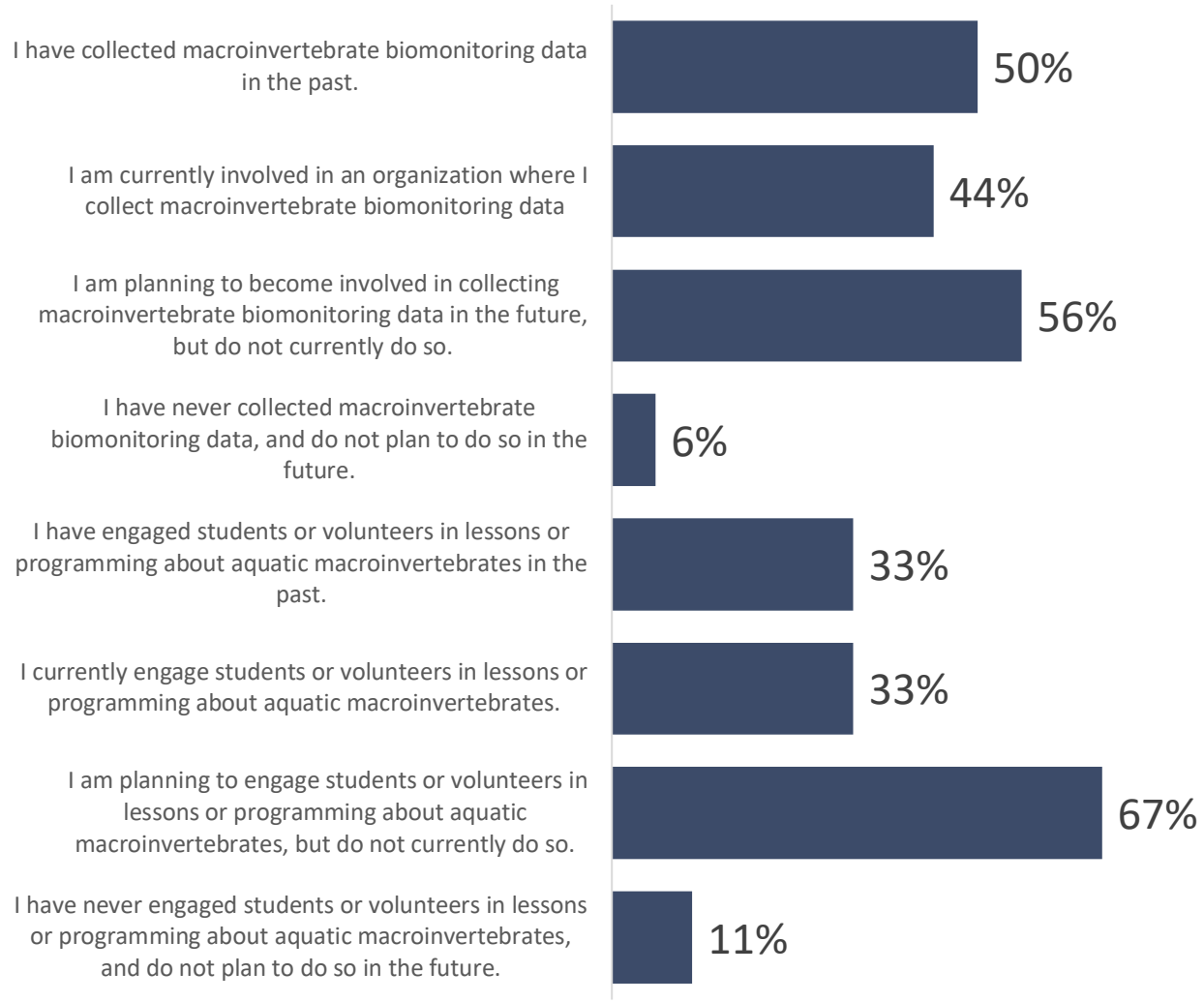
FIGURE 3: EDUCATOR TRAINING ATTENDEES' OCCUPATION (N=18)



** Of those who indicated they were classroom teachers, two taught middle schoolers, four taught high schoolers, one taught PreK & Kindergarteners, one taught undergraduates, one taught outdoor education for PreK-12th graders, and one did not specify.*

The majority of Educator Training attendees (67%) had participated in some kind of training in aquatic macroinvertebrate identification before. These trainings tended to be with Stroud (42%) or another environmental center (8%), through attendees' local watershed or Master Naturalist groups (25%), or via college courses (17%). Over half of the participants did not currently collect macroinvertebrates biomonitoring data or engage students or volunteers in lessons or programming about aquatic macroinvertebrates, but planned to do so in the future (see Figure 4). Very few attendees had never done these activities nor planned to do so in the future.

FIGURE 4: EDUCATOR TRAINING ATTENDEES' PRIOR EXPERIENCES (N=18)*

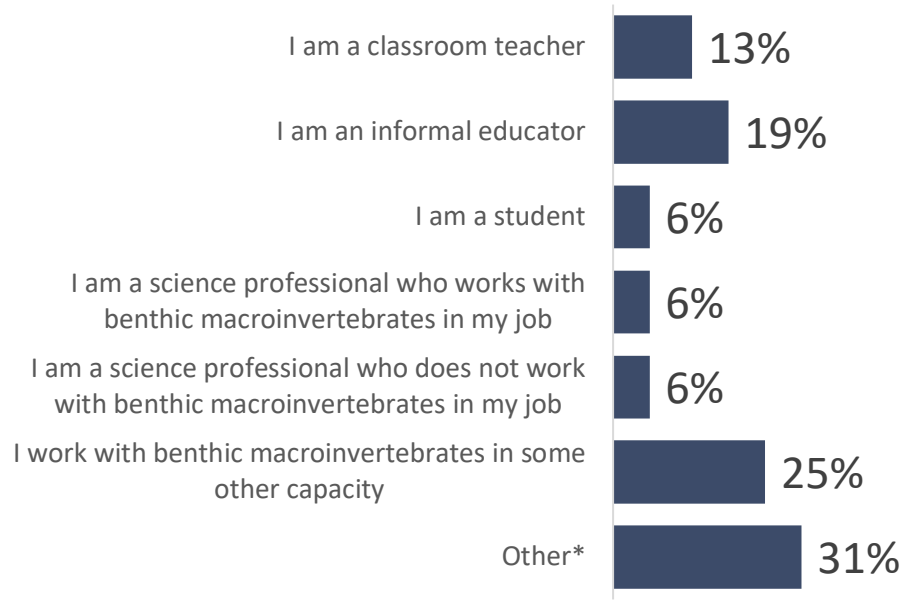


** Respondents could select more than one option.*

SURVEY SAMPLE: MINI-WALKTHROUGH

The majority of Mini-Walkthrough attendees (69%) were female. The average age of respondents was 51 years of age (Range = 13-78). Two respondents were Asian, one did not specify, and the remaining thirteen were White/Caucasian. Most attendees were either water quality biomonitoring volunteers or hoped to conduct aquatic macroinvertebrate identification in the future (see Figure 5).

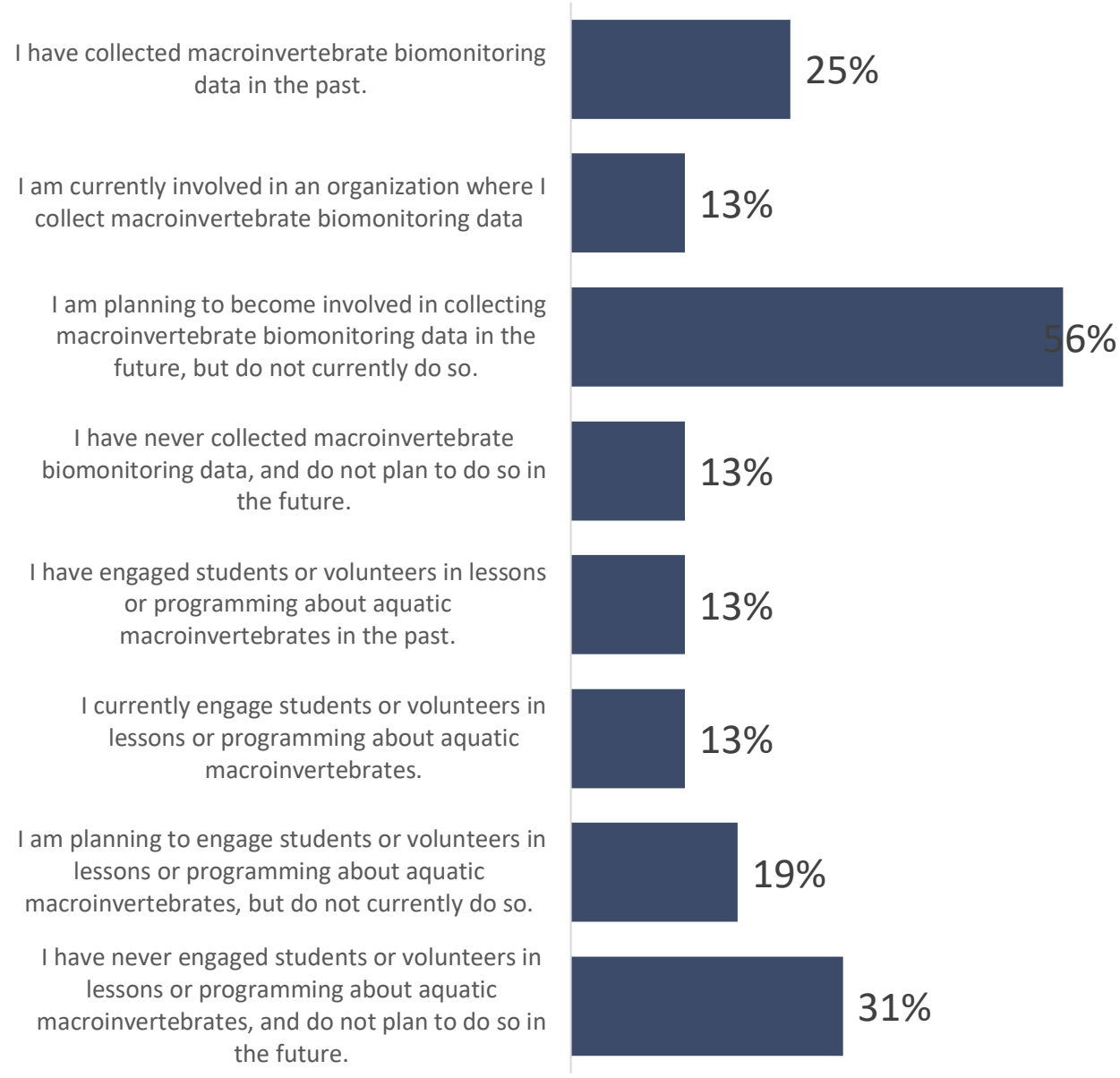
FIGURE 5: RESPONDENTS' OCCUPATION (N=16)



** "Other" consisted of individuals interested in participating in citizen science in the future: "I am interested in being able to ID what is in my backyard stream."*

Overall, the Mini-Walkthrough attendees were less experienced than those who had attended the Educator Training. The majority of Mini-Walkthrough attendees (60%) had never participated in an aquatic macroinvertebrate identification training before. Over half of the participants planned on becoming involved in collecting macroinvertebrates biomonitoring data, but had not previously done so (see Figure 6). Mini-Walkthrough attendees also tended not to engage students or volunteers in aquatic macroinvertebrate programming, and most did not plan to do so in the future.

FIGURE 6: MINI WALK-THROUGH ATTENDEES' PRIOR EXPERIENCES (N=16)*



** Respondents could select more than one option.*

FINDINGS

THOUGHTS ABOUT THE EDUCATOR TRAINING

Most Useful Aspects of the Educator Training

Survey respondents (n=18) felt that the overall training was useful with most stating that it was "very helpful" (83%) and the remainder finding it to be "helpful" (17%):

> *"This was like a foundational experience for me because I didn't have this training before. So it was helpful to have the presenters that were there, all of the helpers that were there just guiding us through what we needed to do, how we could use the website, and then using the app as well, taking us out into the water, you know, getting some macros coming back and using the app...if you're not very comfortable with it as an educator, this is a prime opportunity for someone to help you out."*

> *"I think there's a lot of people who are very knowledgeable about things and I came away from - like I'll definitely go back to Stroud. I'll definitely use the app again. I think those were like my biggest lessons that I learned were I should just really go back to those resources like all the time...and I thought the workshop was actually pretty well structured from the idea of an orientation, going to the stream, getting the specimens' identification, and then implementation within the classroom."*

In terms of specific aspects of the training, *"Identifying preserved specimens using the app"* and *"Observing the organisms from the stream"* were deemed to be most useful to training participants (see Figure 7): *"Well, I liked the fact that they got us out and into a real stream, and actually have us, you know, do a nice survey. I really enjoyed the water quality survey spreadsheet that they gave us in terms of determining just how healthy a stream is and things like that. That's going to come in very handy."* Several participants liked that the training emulated the kind of hands-on engagement they hoped to provide to students:

“Having them, I guess, model for us basically sort of what a lesson would look like and then us going to do it. So that when you would want to go do it with students, you had a pretty good understanding and could adapt it as you see fit based on your class.”

“As you start to go through the taxonomy, started going through like the different decisions of the apps guiding you in real time with a specimen, you're kind of trying to figure out, ‘If I was a student, how am I using this?’ I think that was the most useful part. Practice followed by the secondary brainstorming - like how would you implement this within your educational space?”

Attendees also appreciated the collaborative nature of the activities:

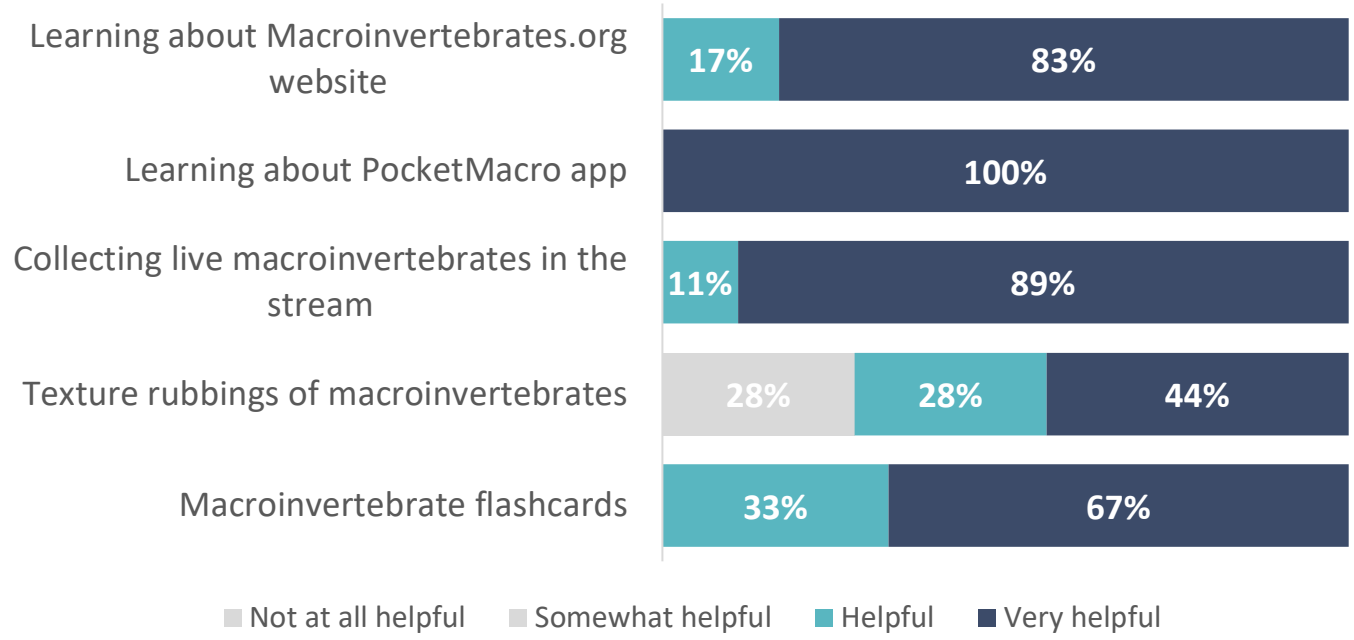
“*Working with other teachers to learn how to creatively use these resources with students!”*

“Meeting your fellow professionals is always a plus because you always get ideas off of them. I think collaboration in terms of between schools and within schools, between teachers and then also between schools can be very helpful.”

“I did feel like there was a lot of value in just getting together with other educators and talking about - you know, I had to pick their brains, and then the experience of collecting specimens with a number of other educators, and kind of getting tips on like how you do it: ‘What are you looking for? Where would you look for it? How would you collect them?’ was all really valuable and then the identification process.”

One participant said that if the training had been longer, she would want to know how to pair the app with the website *“because I know that they're companion pieces, but I know that they work very differently.”*

FIGURE 7: MOST USEFUL ASPECTS OF EDUCATOR TRAINING (N=18)



PLANNED APPLICATIONS OF THE EDUCATOR TRAINING

Attendees had several ideas about ways to utilize the tools they had encountered during the Educator Training. Some planned to use the resources from the training to increase students' or volunteers' interest in and/or accuracy around macroinvertebrate identification:

> *"Get students interested in stream health."*
>
> *"Get students interested in identifying macros to Order level."*
>
> *"I will use the tools with a group of citizen scientists to improve their ID accuracy and confidence."*

One attendee noted that although the subject matter of macroinvertebrates is specific, the topic relates more broadly to discussions of water and the water cycle, ecosystems, or pollution and environmental stewardship. Another attendee agreed: *"I'm going to be*

doing ecology and it's going to help me explain to them how even the smallest things play a role in keeping this stream going and keeping that environment healthy."

Others noted that they would use the tools from the Educator Training for their own learning: *"Review my understanding and ability to identify macroinvertebrates, so I feel more comfortable using this/teaching this to students."*

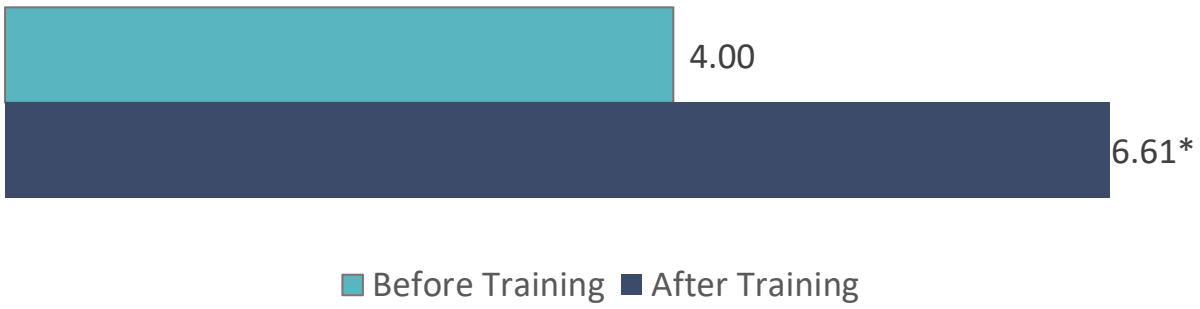
Impacts of the Educator Training

Attendees self-reported a significant increase in their knowledge about aquatic macroinvertebrates identification after the Educator Training (see Figure 8):

> *"I definitely felt like I learned a lot more content knowledge, which was another thing that the app helped me with, but also because there were experts there. I could ask questions that I needed to ask using the app that I wouldn't necessarily have been able to do just playing with the app on my own related to the actual organisms...Some of the taxonomical information that had to do with, you know, so if you find these critters, like these ones are in the same Family as these ones and this is what the larval phase looks like. This is what the adult looks like and when you're seeing them all kind of in the same location. I feel like it kind of having all those threads to tie together was something that maybe I didn't necessarily have before."*

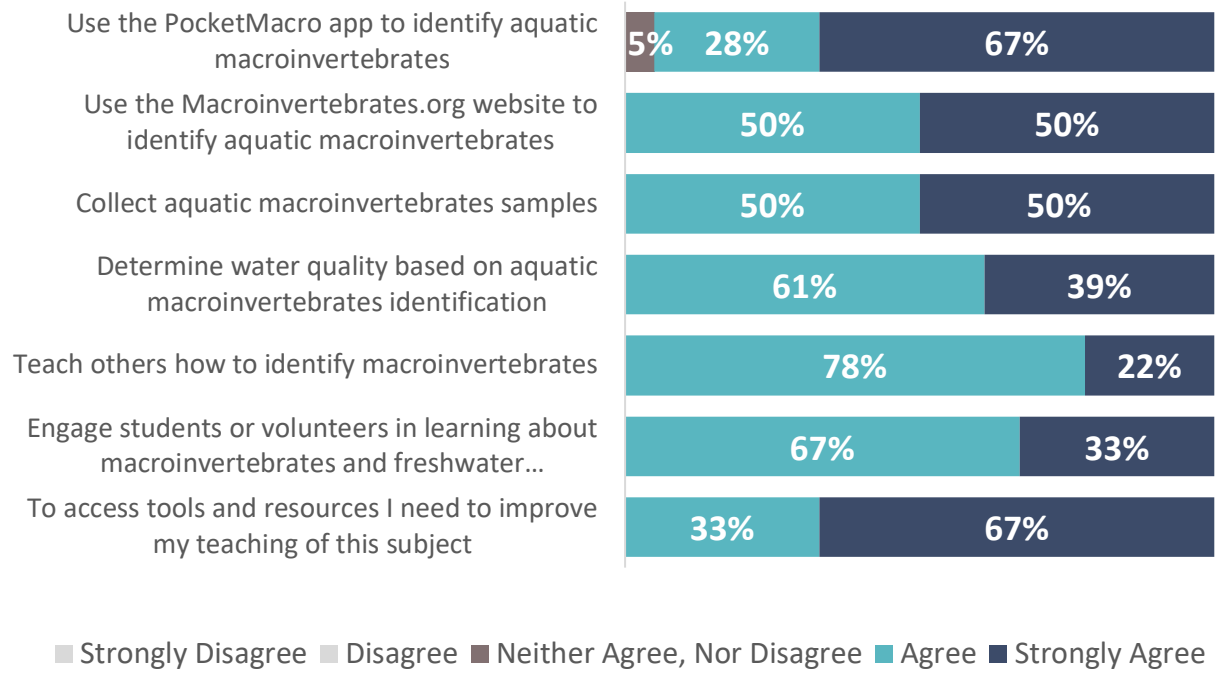
In terms of their confidence, attendees felt that the training had most impacted their ability to use the PocketMacro app to identify aquatic macroinvertebrates and access tools and resources to teach about the subject (see Figure 9). Attendees also felt that the training provided them with tools to prepare their students or volunteers to identify aquatic macroinvertebrates (M=4.22, on a scale from 1 to 5 with 1 being "Not at all" and 5 being "To a large extent."): *"I feel more confident because people helped me understand where my mistakes were coming in. It makes me much more ready to help other students."*

FIGURE 8: CHANGES IN RESPONDENTS' KNOWLEDGE AFTER THE EDUCATOR TRAINING (N=18)**



** Indicates a statistically significant difference at the p<.05 level.*
*** On a scale from 1 to 10, with 1 being, "I have no familiarity at all with aquatic macroinvertebrates," and 10 being, "I am an aquatic macroinvertebrate expert."*

FIGURE 9: CHANGES IN RESPONDENTS' CONFIDENCE AFTER THE EDUCATOR TRAINING



One attendee summarized their experience thusly:

> *"I'm still beginner level, but I feel comfortable now going and working with my students, and how to use the app, how to use the website. When I go out and collect specimens, I also feel comfortable helping other teachers maneuver the app, you know, work with the website, go collect them just because I've had that exposure and I practiced using it, and I have connections to other people that have helped me as well."*

THOUGHTS ABOUT THE MINI-WALKTHROUGH

MOST USEFUL ASPECTS OF THE MINI-WALKTHROUGH

Survey respondents (n=15) felt that their overall experience at the Mini-Walkthrough was useful, with most stating that it was "helpful" (60%) and the remainder finding it to be "very helpful" (40%). In terms of specific aspects of the Mini-Walkthrough, *"Learning about the PocketMacro App"* was thought to be most useful to training participants (see Figure 10):

> *"Exploring the app via 'assignments.' Searching for specific features in app."*

> *"Getting familiar with the app and its features. There were things I would have probably missed on my own."*

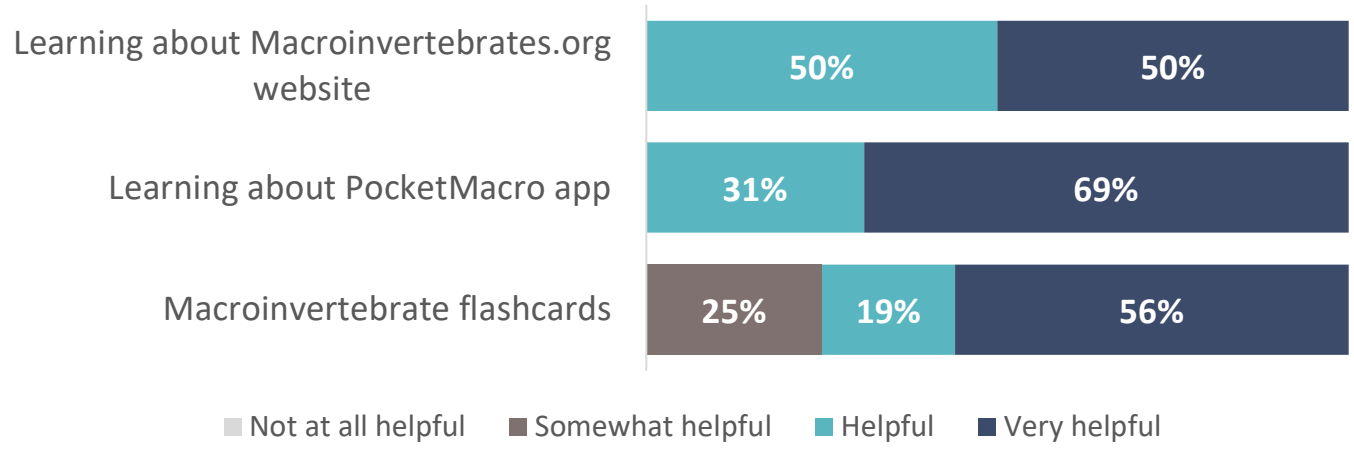
> *"Learning about the PocketMacro app, as it will be the easiest thing to use while in the field."*

> *"Introduction to the high-definition zoom photos and photo decks to scroll through."*

In terms of improvements to the Mini-Walkthrough event itself, one attendee appreciated exploring the functionality of the PocketMacro app, but was *"interested in learning more how this tool can be used by organizations like mine."* In addition to its applications, this individual also wanted to gain more clarity around *"reporting our*

community science data to organizations like the DP or the EPA to support advocacy efforts...I'm very unclear on what exactly can be used, what is considered Tier 1 and Tier 2 data, and the standards for that." Another attendee wanted to see how the app could be used in conjunction with a dichotomous key. In general, Mini-Walkthrough attendees sought more time for group discussion around ways to utilize the app to conclude the event: *"It felt like once we got into the app, I feel like we maybe never like left it and came back together."*

FIGURE 10: MOST USEFUL ASPECTS OF THE MINI-WALKTHROUGH (N=16)



PLANNED APPLICATIONS OF THE MINI-WALKTHROUGH

Although they did not have as much time to discuss their thoughts as a group, attendees had several ideas about ways to utilize the tools they had encountered during the Mini-Walkthrough. Some wanted to share the resources with other interested parties:

> *"Teaching my grandchildren and other family members about the wonderful (hidden) world of Macroinvertebrates!!!"*

> *"I will definitely use them to ID aquatic inverts in my local streams, and definitely share it with anyone who voices interest in learning about them."*

Several had specific groups in mind that would benefit from incorporating the resources highlighted in the Mini-Walkthrough into their programming:

> *"For my daughter's Girl Scout troop who were part of the Stream Girls, the app would be cool to use when we do stream activities. We recently cleaned up a stream and this app would have been fun to use to identify insects. The flashcards are neat. The illustrations and info blurbs can be used for games with the girls during camps."*

> *"The tools on the website and app seem like an amazing resource for community scientist volunteers to take their stream assessments to the next level."*

> *"Informational programs for the general public with watershed steward groups."*

> *"This tool would very much enable us to add macro sampling and identification to our existing program...We do public programs where we say, 'Meet a macroinvertebrate,' and I think that this tool could be used by someone who just walks up off the street and we give them, you know, a ten-minute intro and then they catch the stream critters...But it's also like advanced enough that someone who has maybe the next level up of knowledge could also use it."*

Others noted that they would use the tools they were exposed to during the Mini-Walkthrough for their own learning:

> *"I will be able to learn about the creatures living in my stream and be able to better assess stream health as a result."*

> *"I would use this to participate in possible citizen scientist projects."*

A few attendees came to the training for all of the reasons above:

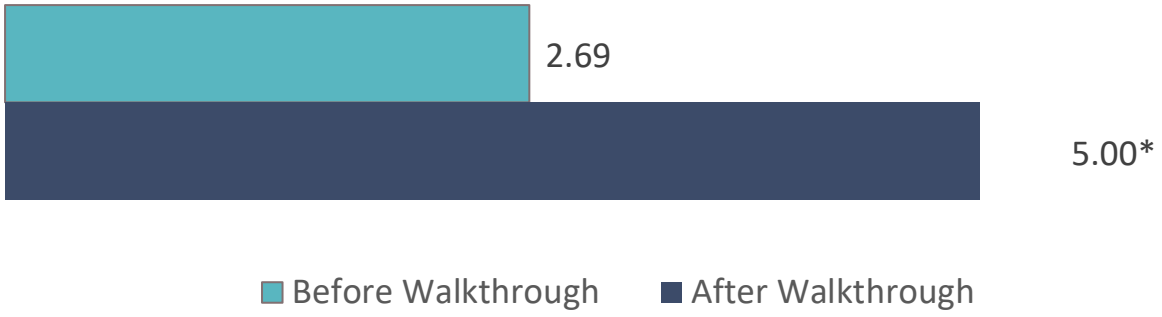
> "*I feel like [Stroud is] really good at creating tools that can be connecting the research to the community and what regular people can use. So I wanted to*

explore this tool and see if there would be any potential uses for, I mean me personally, but also for our volunteers and the community that we engage."

IMPACTS OF THE MINI-WALKTHROUGH

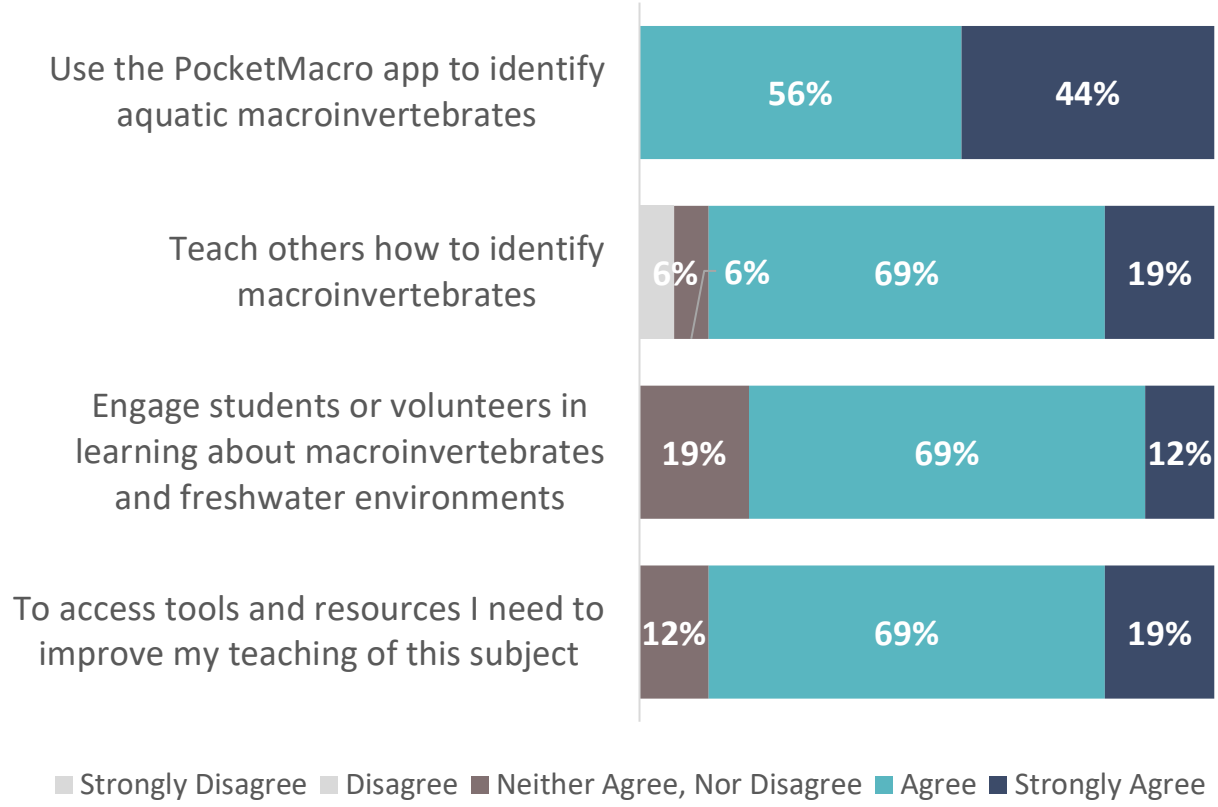
Attendees self-reported a significant increase in their knowledge about aquatic macroinvertebrates identification after the Mini-Walkthrough (see Figure 11). In terms of their confidence, attendees felt that the training had most impacted their ability to use the PocketMacro app to identify aquatic macroinvertebrates (see Figure 12). Attendees (N=13) also felt that the training provided them with tools to prepare their students or volunteers to identify aquatic macroinvertebrates (M=4.07, on a scale from 1 to 5 with 1 being "Not at all" and 5 being "To a large extent.").

FIGURE 11: CHANGES IN RESPONDENTS' KNOWLEDGE AFTER THE MINI-WALKTHROUGH (N=16)**



** Indicates a statistically significant difference at the p<.05 level.*
*** On a scale from 1 to 10, with 1 being, "I have no familiarity at all with aquatic macroinvertebrates," and 10 being, "I am an aquatic macroinvertebrate expert."*

FIGURE 12: CHANGES IN RESPONDENTS' CONFIDENCE AFTER THE MINI-WALKTHROUGH



THOUGHTS ABOUT THE POCKETMACRO APP

OPINIONS ABOUT THE POCKETMACRO APP

Attendees at both the Educator Training and the Mini-Walkthrough found the overall app to be intuitive and liked its look and feel:

> *"It just looks very slick. It's very user-friendly. It looks like a lot of experts in different fields worked on it."*

> *"That seemed very professional-looking graphic designwise and also functionalitywise."*

Some attendees thought that the app was easier and more accessible to use than printed materials:

> *"As far as like a field guide for these things, I just feel like that would be overwhelming...I think it would be really difficult as a lay person to use a paper book. It's not sort of pared down...I feel like the app makes it so much quicker and so much easier*."

> *"I think people use their phones nowadays for everything, and this will be right there with you. You can start scrolling through these at your leisure. So yeah, I think people will use it. It's convenient. There's a tremendous amount of information there in the app."*

> *"It's much quicker for me to go back and change my choice, walk through it again and just see if that answer matches up more with what I'm actually really seeing. So you still have a lot easier access to the images, whether you want to use the Field Guide or whether you just want an ID Help. So I do think there's an improvement here over the big thick field guide that you might have to carry to do that."*

> *"Having a portable ID tool to use in the field. My last experience with macro ID was a black and white ID poster from the PA Fish & Boat Commission. This rocks!"*

Only one participant indicated that apps were hard for him to use in general: *"I prefer to snap photos and do IDs at home with better light, a bigger screen, and better Internet."* One individual felt more comfortable using the app in conjunction with a printed dichotomous key. He thought that the app was better for Family level IDs, but that many water sampling programs do not require that level of detail. He shared that a dichotomous key allowed him to *"see all the different groups at once,"* whereas the ID Key in the app only focused on one answer. But he also acknowledged that more familiarity with the app would be useful for focusing in on relevant features: *"I think using*

that PocketMacro will force me to practice knowing what the gill filaments are and the different mouth parts. I think it's gonna make me practice those and I'll get better at those and be able to use the PocketMacro app more efficiently, and again get a more specific ID than what I could do with, a hard copy, a dichotomous key."

Event attendees liked the amount and level of information provided, especially when thinking about their students:

> *"It's really hard to find stuff like this that gives the kids good, solid information that doesn't dumb it down or baby it for them. It isn't so high level that they're getting caught up in a thousand words they don't understand."*
>
> *"The overview and a little bit of a background on each taxonomic group, I think that's helpful."*
>
> *"I think I would recommend it because it does seem very comprehensive...From talking to other educators, you know, they kind of shared the same opinion that this is a great place to kind of like start to practice. And, you know, while there may be bumps along the way, these are the best training wheels you can get...I still think there's the value in you need to put in the time to just practice and practice and practice. I think that it has the information. It has a lot of pictures. It guides you through the process and I think all those things are what I was looking for and something that can be extremely mobile, and easy for young people to navigate."*
>
> *"If I think that I've identified some sort of caddisflies, I can then look at the different types and look at a bunch of different photos that I think if I brought my field notebook out, I wouldn't necessarily have all those resources in one spot...The app has a lot of information and capacity stored in it. So I think being able to use the identifying feature and then being able to like flip over and saying, 'Okay, let me look at a bunch of different caddisflies and make sure that I really think I have what I've identified.'"*

Impacts of the PocketMacro App

Attendees at both the Educator Training and the Mini-Walkthrough were asked whether the PocketMacro app impacted their accuracy or confidence in their ability to identify aquatic macroinvertebrates, as well as their ability to engage or train others to do so (if applicable). Attendees felt that the app was most effective at helping them see relevant features to conduct an identification (see Figure 13): *"It is a great tool to zoom in and see the different features like tarsal claws."* Many thought that the app's features would help them to differentiate between insect groups: *"The Field Guide and the Flashcards will be very useful in increasing my own confidence in identifying/discriminating between similar-looking organisms."* One attendee shared that the app had increased his *"general knowledge of macroinvertebrates"* and provided *"observation confirmation."*

Some felt that the app would help their students feel more confident in their identifications as well by providing detailed visuals and focusing them on diagnostic characteristics:

> *"A lot of times the student will be like, 'I'm not sure.' You know, they're almost like hesitant about relying on their own memory of what something is, and then if they have the crutch to say, 'All right, what is it I got? I see that you see the three tails. I clicked in. It's got six legs. I got three tails. All right. I know that this is a mayfly."*
>
> *"I think it's streamlined. It narrowed down what the student will have to look for. I think that's very helpful for the students because then they're like, 'All right. I just need to find this,' instead of, you know, being overwhelmed with the idea of the totality of the organism."*
>
> *"The app helps to demystify all of that, helps to show them what these organisms look like."*
>
> *"I think that if folks are already interested in macros, [the PocketMacro app] makes it more accessible, easier to identify them. I think it's an empowering tool.*

I think it's easy for folks to use and would increase confidence and identification skills and things like that."

"When the app presents taxonomy features and anatomy features, then they're like, 'Well, I don't know it. I don't know what a wing pad is. Like what's it doing there? I definitely think it will increase their knowledge of the vocabulary within the field. I think that it will help them just kind of get this idea of decision-making tree flow chart, taxonomy piece."

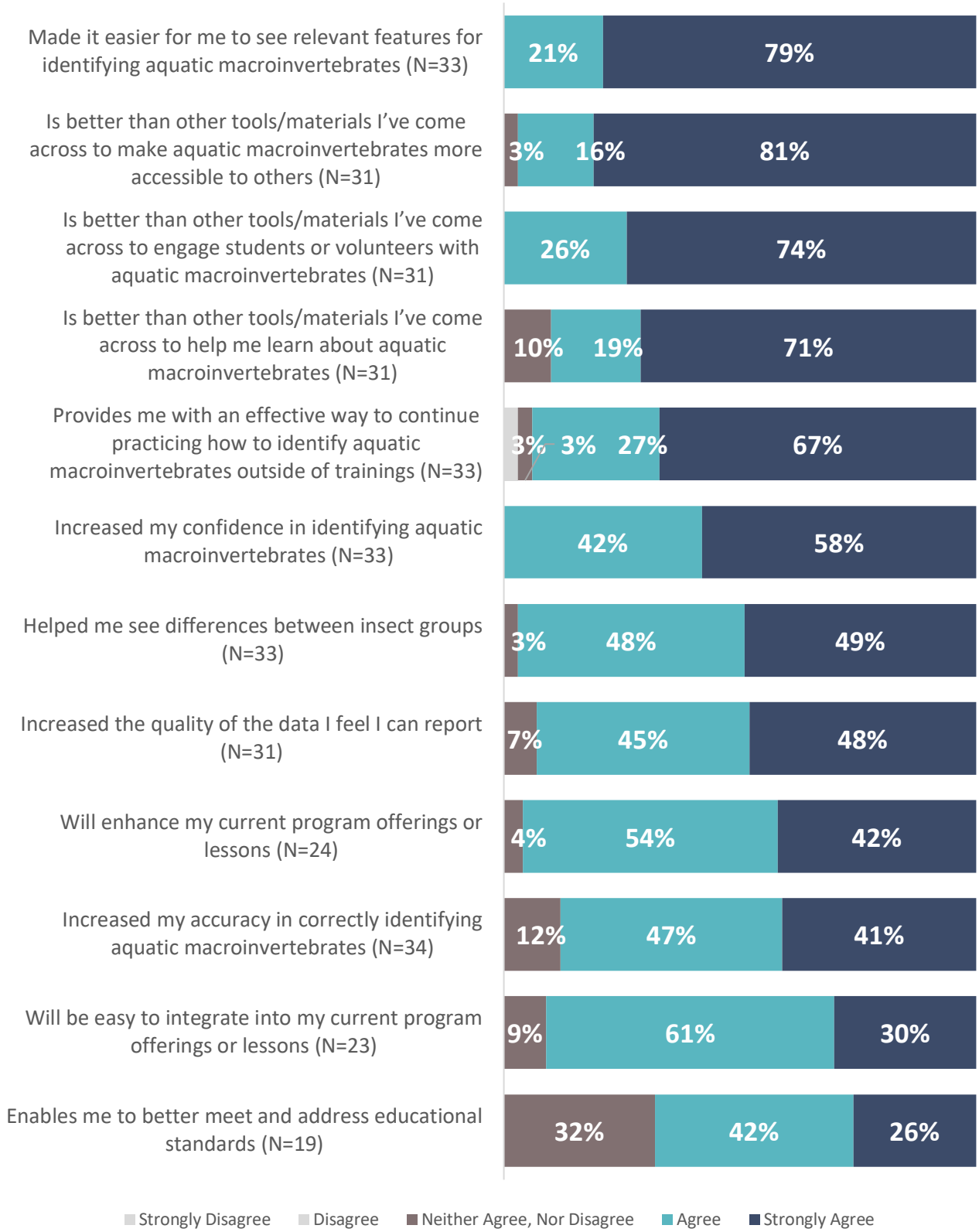
Participants also thought that the app would increase students' interest in the topic and processes of macroinvertebrate identification:

"I think it would increase the engagement and excitement for it because it's real. Like we're not just looking at it on a piece of paper...These are real pictures. These are real organisms and we can go out and we can go in the water and we can collect these samples. and this is what you're finding. And you're going through a process where you're trying to figure out what are they, you know, what are the features of these macros? And what does that mean? How are they connected to one another?"

"Everything in the environmental science world starts with the smallest things, and so it was basically saying to them that things that you're going to see around you every day start somewhere, and most of them spend the vast majority of their time in that macroinvertebrate stage... Just simply giving them a way to investigate the world around them when I'm not standing there helping would be big for me."

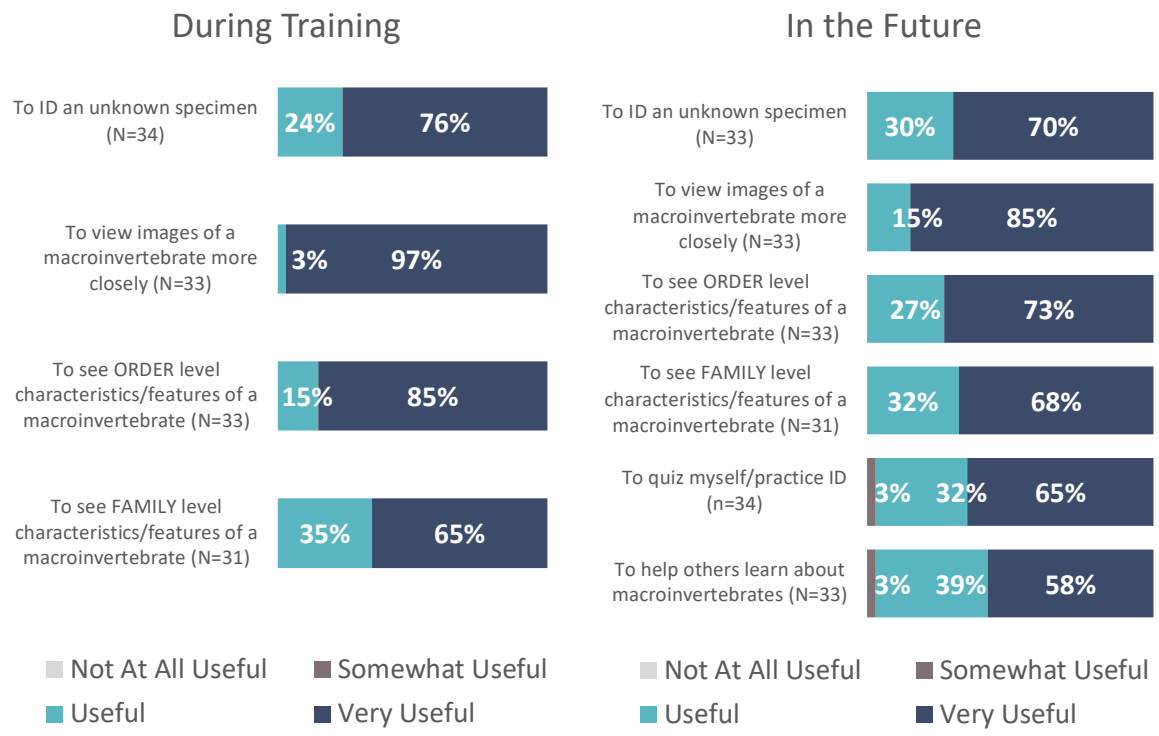
The app was viewed as less impactful on educators' ability to address standards, but this may be due to a lack of clear standards that map onto activities involving aquatic insects.

FIGURE 13: THE POCKET MACRO APP...



Participants thought that the app had been most useful during the training to see the macroinvertebrates up close (see Figure 14). They also thought that the app would be most useful in doing so in the future.

FIGURE 14: USEFULNESS OF THE POCKETMACRO APP DURING TRAINING & IN THE FUTURE



UTILITY OF THE POCKETMACRO APP

Attendees at both trainings shared several specific ways that they might use the PocketMacro app in the future. Some participants planned to use the app for water quality biomonitoring efforts:

> *"Push for stewardship. Use as demo surveying."*

> *"I will use this for my volunteer Streamkeepers. They help our staff ID samples on a yearly basis. This will improve our volunteers' ID ability & confidence."*

Others sought to utilize the app to figure out what was in a local stream to satisfy their own or others' curiosity. One participant used the app with her eight-year-old stepson in a stream behind their house and spent hours doing identifications together. Another participant shared the app with a friend: *"He's an aspiring fly fisherman. So I said, 'Well, here you go. It's a great little app for you to use to figure out what's going to be in the water there...So you know what fly do you want to cast there - What are the fish looking for?"*

Since many participants were educators, they brainstormed at length about how they might use the app in their classrooms. Some planned to collect and identify specimens with students streamside with the potential for extension activities:

> *"I could definitely see us take a laptop out or take my phone out and we can be right next to the stream and going through it that way."*

> *"I would love for us to just spend a couple of days gathering specimens, identifying what we even have in the stream that is running through our property broadly speaking. Then what does that say about the water quality? Are there further things that we want to examine about the water that are there?...What themes are they noticing? Are you finding more specimens of a particular pollution rate in certain areas of the stream? We want to do different areas of the stream. But we're pretty youth-directed in our particular educational institution. So I might put - The introductory activity might just be going to gather specimens, trying to classify them, and say what that says about our stream, and then kind of branching off into, 'What are the other questions that this generates and how do we want to explore those?'...The wonder, the initial shock of those things being in the stream is gone. Now we're getting into the questions about like, 'What's the difference between these things? What does that say about where we are?' The app is going to help them get answers to those like deeper questions."*

Others saw the app as a tool to prepare their students beforehand for what they might encounter outdoors:

> *"Prior to sending students out and trying to identify the specimens that we get, like let's look at some samples of what things look like because they need to be familiar with it before they go out...These images with the features and the Family...familiarizing my students with, 'What are we looking at?'"*

> *"I would say using the app ahead of time, letting them explore it, like understand how the app is set up first...maybe having them explore the Field Guide and share with each other what they found in the Field Guide, what types of organisms, how they are classified. Then possibly doing some ID practice in class. Like, 'How do we go through this?' because if we just go out and use it for the first time, there'll be struggling. 'Okay. I'm getting samples, and then I'm trying to figure out how to use the app.' Like just helping them become familiar with how the app is set up, and then when we go out and get samples and then they can start going through the process."*

Other potential preparation activities included introductory lessons on stream scoring and utilizing the flashcards: *"They also had some physical flashcards that we use to practice identifying some of the features, and some of them were actually a little bit larger for us to look at. So maybe using some of those prior to going to specimens, just looking at some of those larger images so they can see the fine - like the features that are on them."* One teacher planned to pair the app with a printed placemat for younger students.

Teachers who were unable to take their students outside thought about lab-based indoor activities:

> *"I plan to use the app in undergraduate freshwater ecology labs to identify live and preserved stream samples. The app will also be useful to teach students how to use a dichotomous key and observe morphological characters."*

"Maybe having everybody in the class have the same sample, so you can go through step-by-step how to use the app to identify this sample ahead of you. And again, that's pointing out what to look for in your sample and then where to go in your app and then the next step and data, and then going through that with everybody on the same page, knowing what to do."

A few teachers thought about how the app could be useful in subject areas beyond science:

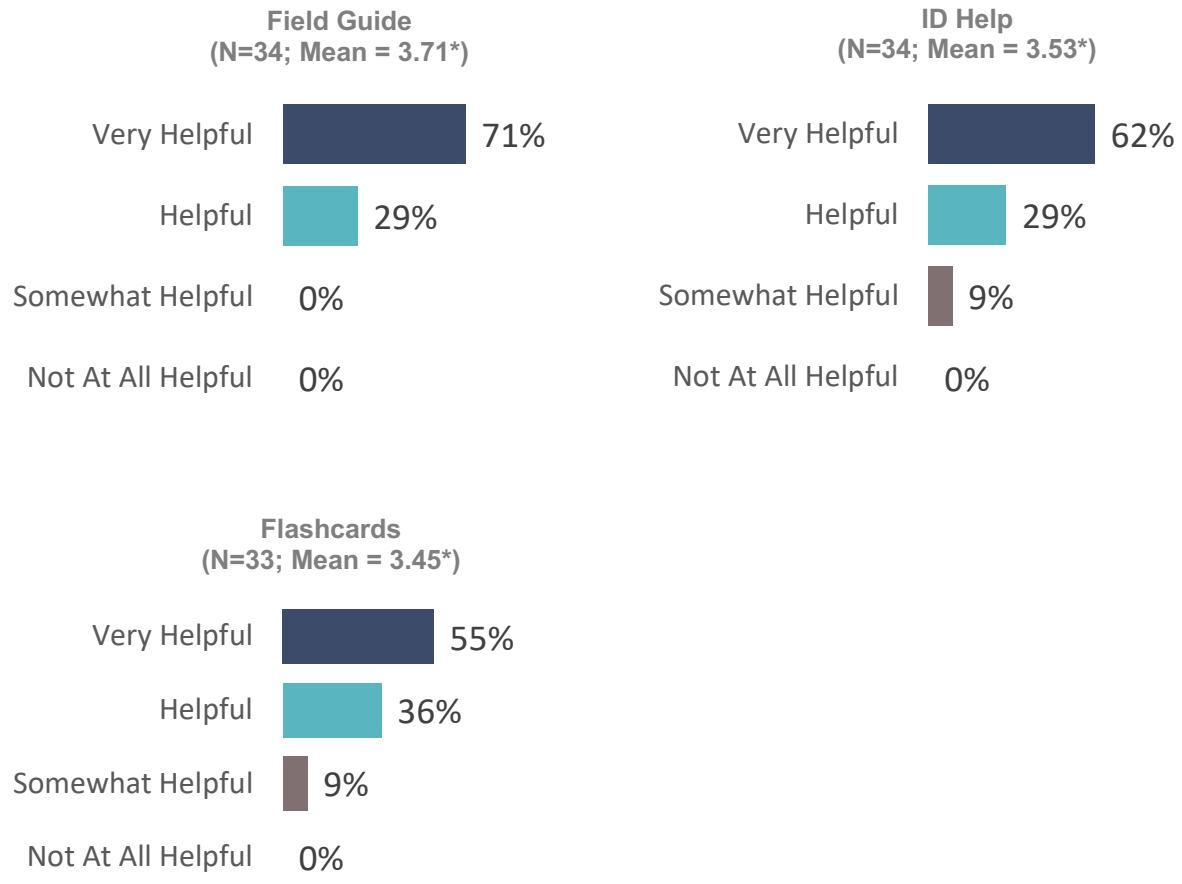
"If you were a math teacher, I feel like you could do this and make statistical analysis, where they would be doing that sort of field - You using the app, and then giving a score to the stream overall with all those different data points...I think with an art class, it would be cool where the kids would draw what they see and compare it to what they're seeing in the app to make those identifications. I mean, I feel like there are very few disciplines that you couldn't tie this into."

"I also think it could be used in like an English class with following the instructions and, you know, looking closely at things and analyzing them, like just some of those literacy skills. Because how to read a flow chart, like some students might not know how, what a flow chart is, and just understanding the terminology. I just see it could be a cross-curricular connection where we can work together on. Just the other thing is like bringing in social studies, and talking about the geography of the area and where they're finding these macros. And because we've been trying to do these interconnected lessons because we work in a team, so math, science, social studies, and English, so like finding a way to bring it all together and connect it."

Opinions About the PocketMacro App's Specific Features

Attendees at both the Educator Training and the Mini-Walkthrough found the three sections of the PocketMacro app to be helpful overall, with the Field Guide rated most highly, followed by the ID Help and Flashcards (see Figure 15).

FIGURE 15: HELPFULNESS OF POCKETMACRO APP SECTIONS - FIELD GUIDE, ID HELP, FLASHCARDS



** On a scale from 1 to 4, with 1 being, "Not At All Helpful," and 4 being, "Very Helpful"*

Thoughts About the Field Guide Section

Attendees were specifically asked to reflect on the usefulness of the Field Guide section's various features. The zoomable images were deemed to be the most useful aspect of the Field Guide (see Figure 16):

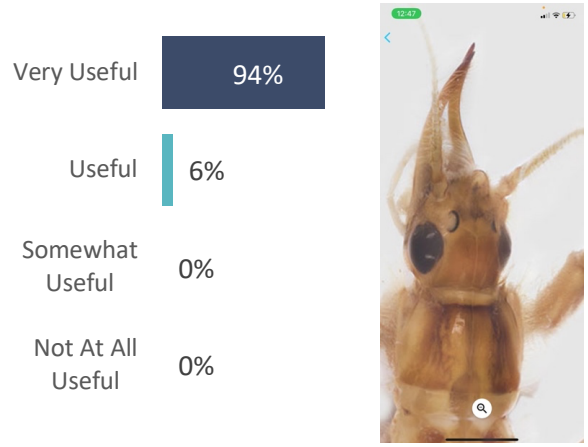
> *"The level of resolution for zooming in on features was incredible!"*

> *"The photographs are pretty amazing and being able to zoom in and out on both sides of the organism, like the ventral and the dorsal are pretty cool. That's something that even I feel like with a magnifying tool, you wouldn't be able to see*

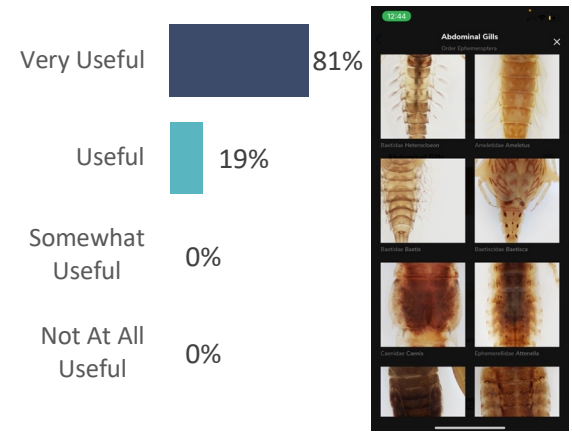
all of the things that are there at that granular kind of level, especially if you wanted to talk about how these things breathe underwater and all of that stuff." "I think that the photography itself, the fact that you could zoom in so much, I guess for me allowed me to look for things that I didn't even really know were there before and could help me delineate between things that are maybe similar that I would've just thought were the same thing before."

FIGURE 16: USEFULNESS OF THE FIELD GUIDE FEATURES

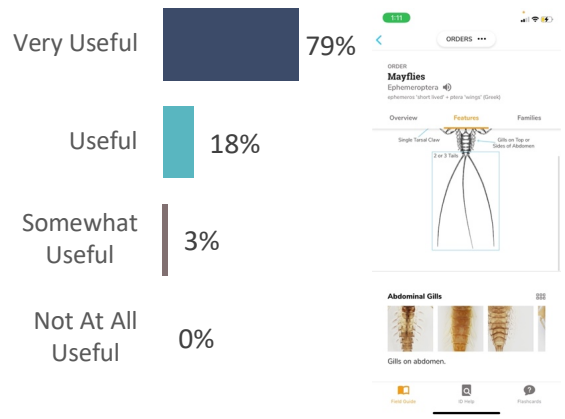
Zoomable Macroinvertebrate Photographs (N=32; Mean=3.94*)



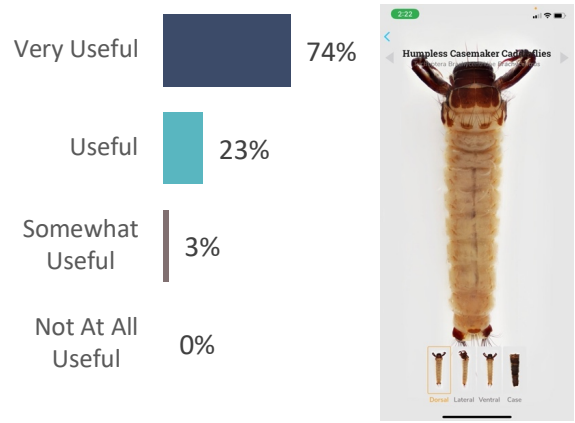
Gallery of Diagnostic Features (Order/Family) (N=31; Mean=3.81*)



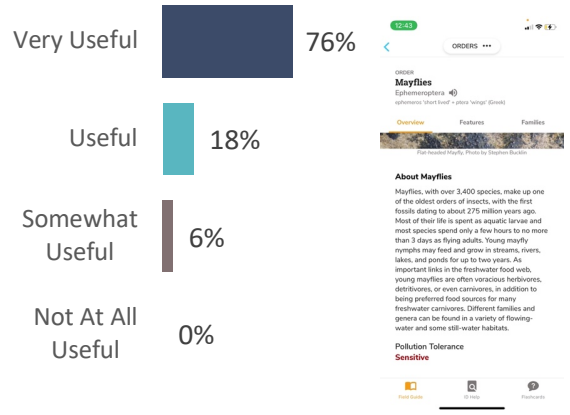
Diagnostic Features (Order/Family) (N=33; Mean=3.76*)



Flip Views (Dorsal/Ventral/Lateral) (N=31; Mean=3.71*)



Pollution Tolerance Information
(N=33; Mean=3.70*)



** On a scale from 1 to 4, with 1 being, "Not At All Useful," and 4 being, "Very Useful"*

One participant noted that although the zoomable images were helpful, some features were still hard to discern:

> *"in helping to verify Order level or more specific levels just using that app, with the photos that are provided and how you can zoom in and really look at the gills or the legs. I found mouthparts kind of difficult to really look at, even with zooming in on the photos and looking at a sample, but yeah. I think zooming in helps."*

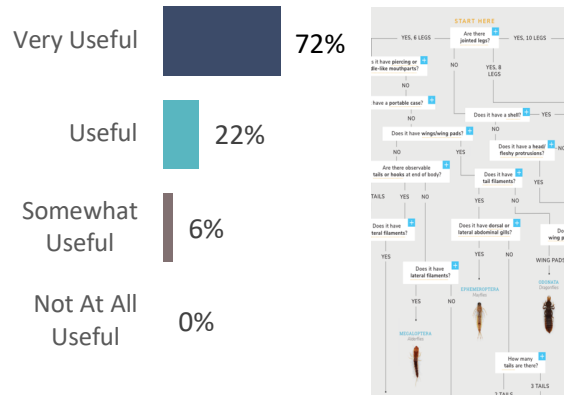
FIGURE 17: IMAGES FROM THE EDUCATOR TRAINING

Thoughts About the ID Help Section

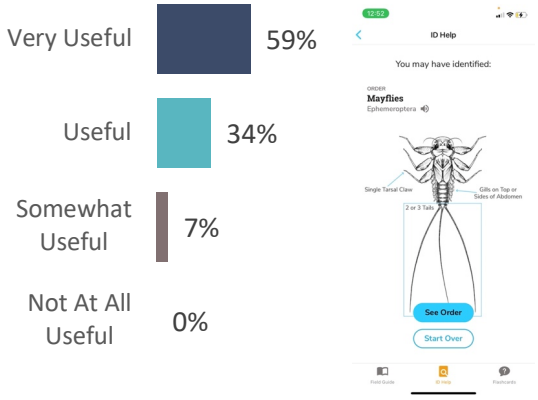
Of the ID section in general, one Educator Training attendee felt that it had impacted their confidence in Family level identifications. Another participant stated that the *"ID aspect [of the app was most valuable because of the] accessibility to information in situ, [and ability] to drill down to details."* Although it was used least often by event attendees, the Zoomable ID Key was thought to be the most useful specific feature of the ID Help section (see Figure 18).

FIGURE 18: USEFULNESS OF THE ID HELP FEATURES

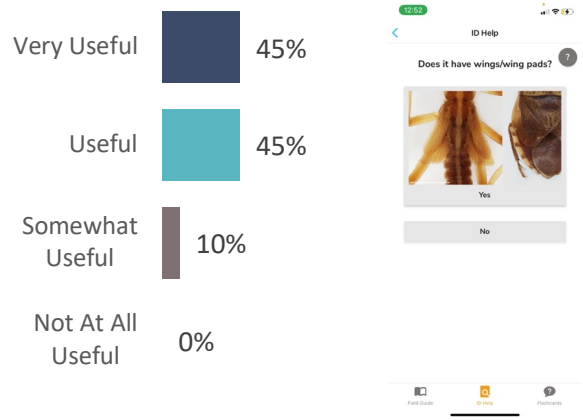
Zoomable ID Key
(N=18; Mean=3.67*)



ID Key Result Page
(N=29; Mean=3.52*)



Guided Dichotomous Key Questions
(N=31; Mean=3.35*)



** On a scale from 1 to 4, with 1 being, "Not At All Useful," and 4 being, "Very Useful"*

Respondents tended to talk most often about the functionality of the guided questions. Some liked that the questions were paired with photographs to scaffold students' understanding: *"If it's asking if it's jointed, some of the students might not know what that looks like. So just seeing those images there, that can help them answer the multiple choice questions."* Others cautioned that users may be led astray if they answer a question incorrectly: *"Your first question is, 'Are there jointed legs and how many?' and somehow - I don't know how - I think in my first practice, I sort of got off on the wrong tangent and wound up way off."* However, a few participants saw deviations in the key as talking points to highlight with students:

> *"The app is at least solid enough in concept that we can get a lot out of it, even if we're going to make mistakes in the classifications...Some of those can be discussion points where we're like, 'Did we make a wrong turn in our tree somewhere along the lines where we thought it was this? But you know, it was really this other element.'"*

> *"Well, they have that little ID Help whereby you simply went through the legs, and then work your way down through steps. And again, this is where you have to remember that every now and then maybe that tail got broken and things like that. So those are some of the little things that I'll be reminding students that these things are living things. 'And, look. Things have accidents, and they might be missing something. So if you made a mistake and call a mayfly a stonefly, it's okay.'"*

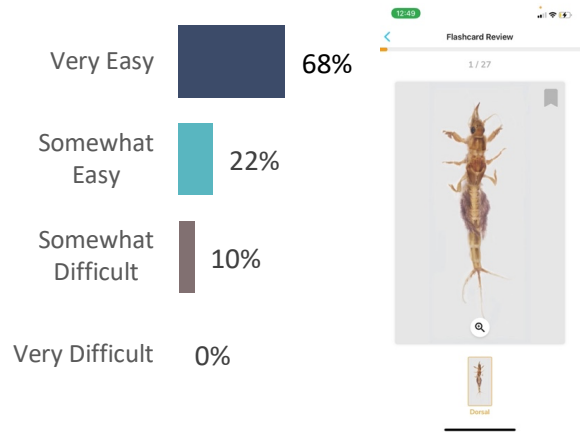
Thoughts About the Flashcard Section

Some attendees thought that the Flashcard section would allow them to practice identification: *"I think that's a useful tool to practice with. I think maybe helping with terminology and vocabulary of specific parts of an insect or other invertebrate...I think seeing some common macros and getting to know them for sure and going through the flashcards is kind of good practice and helps me know them better."* A participant from the Educator Training revealed, *"It sounds really dorky, but I have found myself - Like when I was in a doctor's office waiting room, I was playing with the Flashcard feature."*

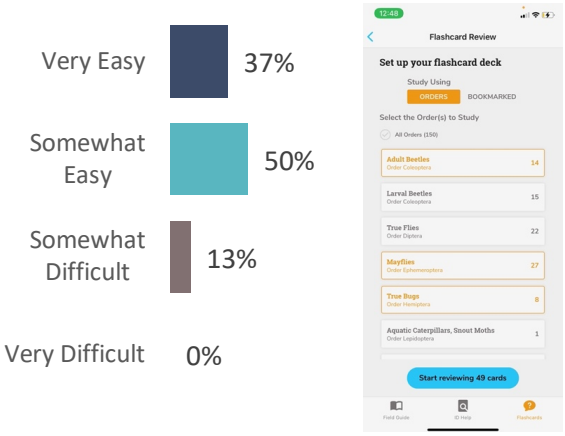
Survey respondents were also asked to rate how easy two of the Flashcard section's features were to use, and whether they would utilize two other features in the future. Attendees found the flipping, swiping, and zooming functionality slightly easier to use than the set-up (see Figure 19). One Educator Training attendee found the flashcards to be *"clunky"* compared to the app's other sections.

FIGURE 19: EASE OF USE OF THE FLASHCARD FEATURES

Flipping, Swiping, Zooming Functionality (N=31; Mean=3.58*)



Flashcard Set-up Functionality (N=30; Mean=3.23*)

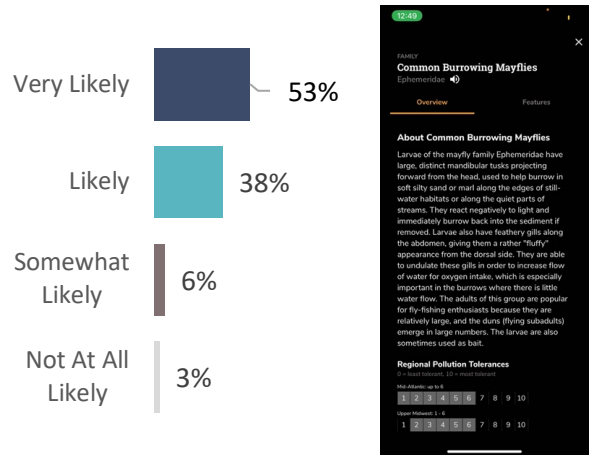


** On a scale from 1 to 4, with 1 being, "Very Difficult," and 4 being, "Very Easy"*

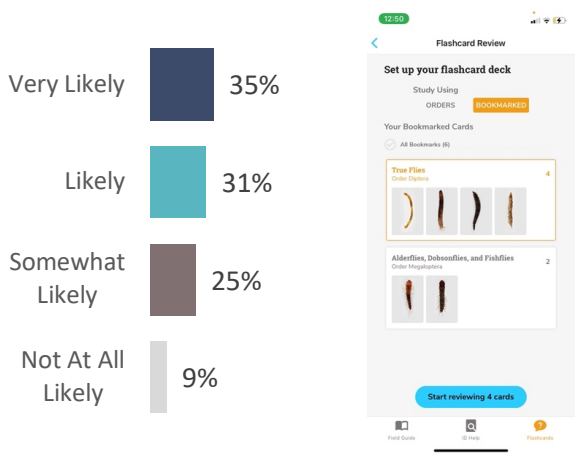
While they were likely to delve into Family Level information in the future, attendees were less likely to state that they would use the Bookmark feature (see Figure 20). However, one Mini-Walkthrough attendee appreciated this functionality: *"I'm at the level of myself where I'm not someone that just walked off the street and is using this app, but I'm still - I'm not great at macros. So I think being able to flag macros that I don't always remember and come back to them is super helpful."*

FIGURE 20: LIKELIHOOD OF FUTURE USE OF THE FLASHCARD FEATURES

Family Level "See More" Feature (N=32; Mean=3.41*)



Flashcard Bookmark Feature (N=32; Mean=2.91*)



** On a scale from 1 to 4, with 1 being, "Not at all Likely," and 4 being, "Very Likely"*

RECOMMENDATIONS FOR IMPROVEMENTS TO THE POCKETMACRO APP

Attendees at both events were asked about other information, features, and functionality they would like the app to incorporate. In terms of improvements to current features, attendees sought the following:

- Additional information
    - Links to other online sources
        - *"I would like to see links to the iNaturalist galleries of different taxa, as on the website. That helps me to get a grasp of the variety of morphology within these taxa."*
        - *"Using these flashcards with a Kahoot type quiz."*
        - *"Web links to adult stage imagery."*
    - More explanation/detail about mouth parts and legs
    - Tips about the macroinvertebrate in the field (i.e., its movement, common places it may be found, etc.)
    - *"A "see the lifecycle" or like short videos about the specimens."*

    - *“I was curious about temporal information. At which season or temperatures is that form identifiable.”*
    - *“If specimens are off color because they are archived, then a note that says, ‘Expect live samples to be dark brown.’”*
- Additional imagery
    - Inclusion of more diagrams and videos
        - *“I'm just thinking of the perspective of a student. If they're looking at the pictures, ‘I don't see any of that.’ It doesn't look like any of those things. But if you see it in the sketch, it's not necessarily a certain color. It's just that the black and white sketch...So just knowing from a student perspective, you're not locked into just only those pictures that are there.“*
        - *“When you have these schematic drawings, maybe it would be also helpful if those are done at a fine enough resolution to zoom in as well on the schematic drawings too.”*
    - Inclusion of more photographs *(“Sometimes insects are different colors or sizes.”)*
- Additional navigation
    - Easier navigation on the first page
    - Search by name (Family name; autofill functionality)
        - *“If I just have this vague memory of a damselfly, can I just type in damselfly and get the Order level of damselflies up, just to quickly bring it up? If something comes to my mind and I want to quickly see what it looks like and to see the body parts and the photos and just background on it, and its sensitivity, pollution tolerance status as well?”*
- Clearer directions
    - Letting users know that they can scroll across to see other images *(“Making sliding images more noticeable feature.”; “Swiping was not always obvious.”)*

    - *“You have to hit the little Zoom icon before you can use your fingers to expand it even more, but that took me awhile. You know, I thought you just kept pressing the Zoom In button, but you hit it once and then you can use your fingers.”*

In terms of potential new features, attendees suggested including:

- Section for Educator resources to connect with other teachers and/or organizations
    - *“If educators come up with resources and activities that they use, if there's a way that someone can just like approve those and then post them somewhere. Just getting other ideas from teachers.”*
    - *“I know Stroud is here, but I'm sure that there are other organizations that are involved in this type of education. It would be great if I could connect to them through the app.”*
- *“A social networking feature to connect with other users would be useful.”*
- An introductory mode for young learners
- A section on invasive species that may be found with native species; Inclusion of planaria
- Location-related features
    - *“Do all these macros live throughout the region? If not, I imagine a map image showing macro region (similar to beginner bird books).”*
    - Geospatial mapping
    - The ability to *“keep track of sites over time”*
    - *“Take the longitude and latitude of where your cell phone is”* and see if others have tagged things in the same stream
- Side-by-side comparisons of photographs of different macroinvertebrates
- The ability to crowdsource IDs
- Photo identification AI
- The ability to save photos taken in the field within the app *(“Similar to eBird.”*)
- Split screen of photograph taken by user and image within the app

    - *“I noticed some of the teachers took photos of the macros they found, so they could blow them up for detail. Some way to interface a personal photo with the app? An easy way to toggle between your photo and ID Help?”*
- The ability to bookmark and save a collection of Families that can be swapped out as needed
    - *“This would be helpful when IDs are uncertain and I want to go back later, or for example, when students are working under the microscope and want to save some for the instructor to review.”*

Specific to the ID Help section of the app, attendees mentioned the following potential improvements:

- Changes to the imagery
    - Ability to flip between the images and the ID Help; Clickable images
    - *“Sometimes it's like these very slight iterations within like the anatomy that you're trying to make decisions about, and you're like, ‘I don't know what that is.’ So I don't know if there was maybe a way to highlight, you know, literally like almost change the picture or put like a circle around what it would be talking about or you know, focus in more?”*
    - *“I would like the question to contain as many images of the characteristic as possible to help with accuracy when using ID Help.”*
- Changing the order in which the questions are asked
    - *“Sometimes we didn't know the answers to the questions right away, but you had to choose something. If there was a way like you could change the order of the questions to the things that you could identify, and then some of the questions that were asked first, like if they could be moved to another part...From the perspective of my middle school students, like if they've never been exposed to it and they really don't know what that looks like, and they're looking at*

the images, but they really can't see it on a specimen then I don't know it. I just think of their frustration level."

- *"Rearrange the order in the 'ID Help' with the selections that are more obvious (like 2 tails or 3) in the beginning and the more difficult 'mouth parts' moved back...Especially in cases where the students may have little to no prior knowledge of macroinvertebrates, it can be a little daunting when the first step in the keys is asking about such a tiny feature as mouthparts."*

- Adding the ability to go back and see how the different options play out
  - *"ID decision tracking and toggle to correct mistakes."*
  - *"I would've loved to have had some kind of a - and we talked about this in the workshop - was just like some kind of a log of like, as you made taxonomy choices, like what your choices were...Like could you have a screen where...it could give you the 'Here's all the choices you made, which ended up at blank organism.' And could you like, just without having to go back, back, back, back screens or start over, could you just flip a switch and could it change what the outcome would be?"*
  - *"If they get to the end and they realize that they've made a mistake, I wish that there was like essentially a button that said, 'Show me my choices.' So, okay. 'Here are the things that you selected.'"*

THOUGHTS ABOUT THE OTHER TRAINING RESOURCES

OPINIONS ABOUT THE MACROINVERTEBRATES.ORG WEBSITE

Attendees at the Educational Training were asked to share what aspects of Macroinvertebrates.org were most valuable to them, and what features or functionality could be improved. The main thing that attendees mentioned appreciating about the website was the quality of the images and the ability to zoom into the photographs: *"It's an incredible resource. There's so much that it makes it so easy for the students to master a visual of what something looks like in the real world."* Attendees also felt that

the website was easy to use and accessible, and that it contained a lot of useful information, printable resources, and quizzes to learn more about aquatic macroinvertebrates. In terms of presentation, users liked that they could view all of the Orders at the same time on the home page of the website. One attendee appreciated the *"wide variety of options for all types of users."* Another felt that the main strength of the website was the number of example specimens as opposed to the app. An attendee even shared a potential activity she would do with her students using the website:

> *"I would maybe consider a poster project where I would say to them - I would give them a fake stream and give them very specific criteria about what's going on around the stream and then tell them to go [on the website], tell them to look up the organisms, tell them to give me a generalized sketch of X number of organisms or you have to have 22 animals on the poster. You can double them up because if you have a really polluted stream, you can have 12 red worms. I don't care, but you know, go through and look it up and look at their sensitivity level and draw me the organisms that are going to live in your little stream."*

FIGURE 21: SCREENSHOT OF THE MACROINVERTEBRATES.ORG WEBSITE

Similarly to the app, improvements to the website that were suggested by attendees included:

- Additional information
    - Links to other online sources (i.e., iNaturalist photographs)
    - Inclusion of invasive species
    - "*A location guide [indicating whether the macroinvertebrate] prefers small streams, or large streams, or ponds."*
- Additional imagery
    - Display of macroinvertebrates at larva/adult stages for comparative purposes
        - *"I would love to see adults for all the larvae! I understand that beetle adults are shown because they are living underwater. But it would be fun to see the airborne adults as well. It might help engage people if they can relate the stream macros to the more familiar adult insect."*
- Networking features
    - *"A community portal for discussion/questions and/or to upload images...not necessarily to be managed by anyone associated with the site, but more of a page for users to communicate amongst each other."*
- Storage of photos taken by users: *"A place to keep track of macros you have found!"*
- Crowdsourced educator resources
    - *"That would be nice to have just that bank because I know a lot of people have ideas out there...I don't have a lot of exposure to elementary teachers because I teach at the secondary level...Sitting at the table at that training, I was with some elementary teachers and they were sharing from their perspective of, 'Oh, I can do this activity and this way.' And I'm like, 'Wow! I never thought of it that way.'"*
- More support in ID Help: *"More comprehensive/clearer guided taxonomy questions."*

Opinions About the Texture Rubbings

Attendees noted that the 3D-printed models of macroinvertebrates provided more tactile engagement with the aquatic insects:

> *"I thought it was a very cute activity to do with students. It's something easy that you can just go do...I can feel those features like when I'm rubbing off the top of it...The hands-on aspect with students is just better than just like a flat piece of paper, just looking at it."*

> *"That's something that like my age group that I teach would be all over and it's sensory."*

> *"The 3D was just a very easy way because it's manipulatable. They can pick it up and turn it."*

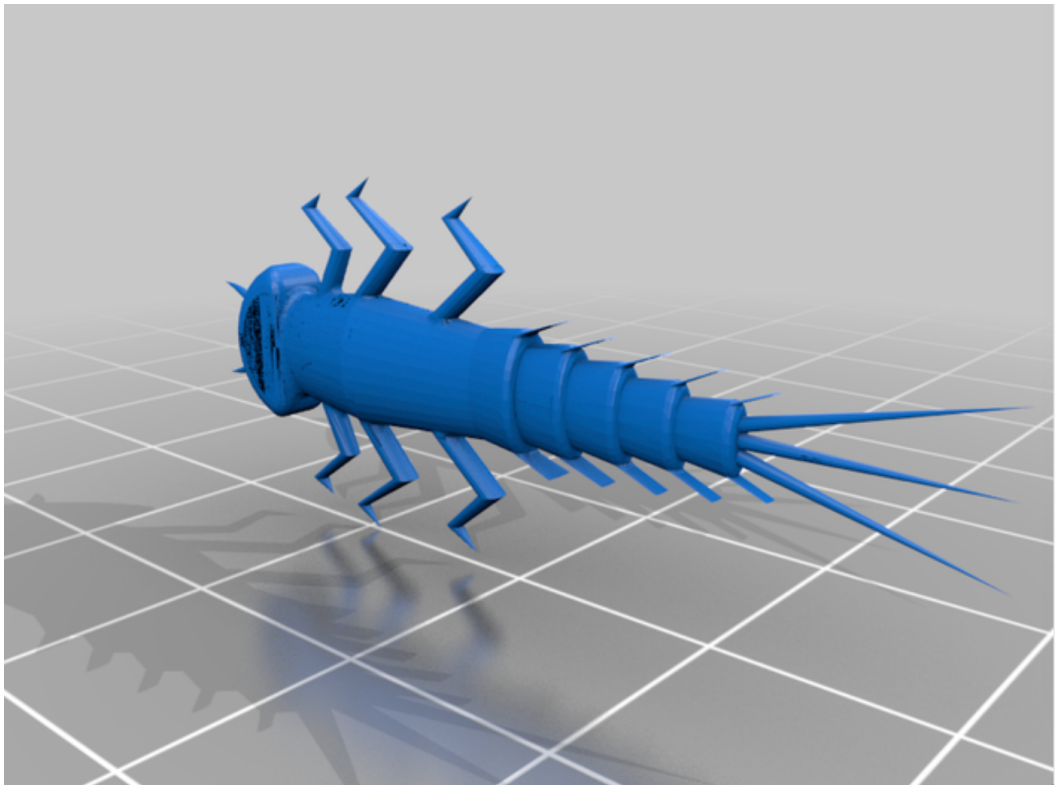
Educators acknowledged that the activity was most appropriate for younger students, and would likely not hold the attention of older learners.

One attendee was very excited about the possibility of using the large 3D models in her classroom as an introduction to macroinvertebrate identification:

> *"There's the discovery piece of it, which is really fun. Like, 'Oh, what did I get?' I thought that would be really great for younger kids especially...probably more of an introductory thing...These are some things that we could find, so maybe just as like a hook activity for planting that seed of like discovery, I guess, or inquiry...I just thought it was a really interesting jumping off point."*

This teacher planned to first print out macroinvertebrates that show up in her local stream. Then she wanted to showcase aquatic insects that live in different environments: "I would like an entire series on them. I would like maybe 12 or 15 or 18, and I'd love them to go the gamut from 'I will live in a dirt puddle with no oxygen,' all the way up to 'If it's not a pristine Appalachian spring, I'm going to die.'" She considered printing out the individual body parts in addition to the whole macroinvertebrate as a way to point out hard-to-see anatomical features.

FIGURE 22: SCREENSHOT OF A 3D PRINTED MODEL OF A MAYFLY



Source: Stroud Water Research Center

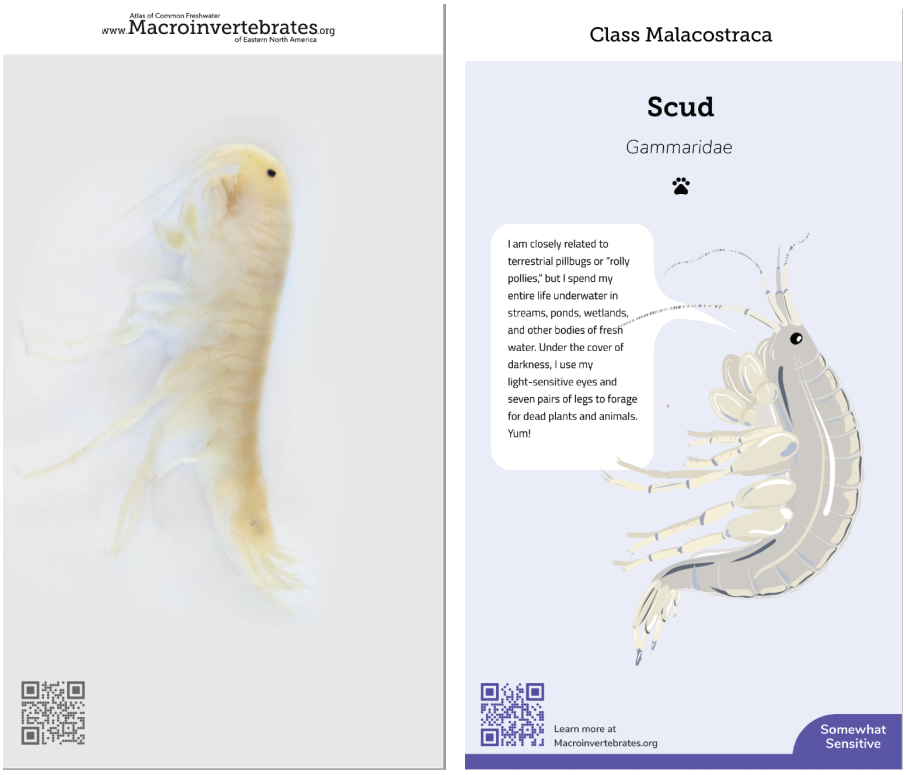
OPINIONS ABOUT THE PHYSICAL FLASHCARDS

Educators had minimal things to say about the physical flashcards. One educator indicated that the color-coding on the cards had initially been confusing, but that her table had eventually figured it out. This educator also liked that the cards included information about *"the durability of the organism, the stream quality that they could exist in."*

Like the other resources, educators brainstormed ways that they could incorporate the flashcards into their instruction. One educator planned to use the flashcards with students *"as a tool to prepare them before they actually go out in the field...'Let's look at some of these flashcards, like what do they look like? How can you group them together?'"* Others liked designing games using the cards during the training and pondered doing the same creative activity with their older students in groups. One

educator thought that it might be fun for students to build their own streams using hundreds of cards: *"So put them out on lab tables and say, 'Here are your organisms...Tell me what the health of the stream is.' But then I could say things like, 'A stream goes from Table 1 to Table 2. Explain to me what could have happened, and that would either be a cleanup effort or a catastrophe."*

FIGURE 23: SCREENSHOT OF A FLASHCARD OF A SCUD



Photography by: Andrea Kautz, Carnegie Museum of Natural History
Aquatic Macroinvertebrate Card Illustrations by: Ricky Chen and Karis Wang

CONCLUSION

The Educator Training and Mini-Walkthrough were both positive training experiences for attendees. Participants appreciated the information presented, the guided activities allowing them to explore the PocketMacro app, and the opportunities throughout to interact with other individuals interested in learning more (and in many cases teach others) about aquatic macroinvertebrate identification.

APPENDIX A: SURVEY INSTRUMENT

Thank you for your interest in our study! The purpose of this survey is to gather your opinions on the Macroinvertebrates.org Educator Training/Mini-Walkthrough resources and what you took away from the experience.

The survey should take about 15 minutes to complete. **If you provide your email address at the end of the survey, we will send you a $25 online gift card.**

Rockman et al (REA) is the independent research group that is leading the evaluation. REA team members may use your responses in reports, publications, or presentations, but we won't share any of your personal information. If you choose to share your contact information, we will only contact you in regards to the gift card or future studies (optional). Completing the survey is voluntary, but we will not send a gift card to those who do not provide their email address at the end of the survey. There are minimal anticipated risks for participating.

Please contact *[redacted contact information],* if you have any questions.

This project has been reviewed and approved by the Heartland Institutional Review Board. Questions concerning your rights as a participant in this research may be addressed to the Executive Director at Heartland IRB. [redacted contact information].

After reviewing the information above, please click on one of the options below. If you wish to participate, please click the "I AGREE" button and you will be taken to the survey. If you do not wish to participate in this study, please select "I DO NOT AGREE" or close this browser window.

____I AGREE to participate in this study. Please take me to the survey.
____ I DO NOT AGREE to participate in this study.

PART 1: ABOUT THE TRAINING/MINI-WALKTHROUGH

Please check the box below that best describes your opinion.

1a.) How useful was the Educator Training/Mini-Walkthrough overall?

Not at all helpful (1)	Somewhat helpful (2)	Helpful (3)	Very helpful (4)

1b.) How useful were the following aspects of the Educator Training/Mini-Walkthrough to you?

	Not at all helpful (1)	Somewhat helpful (2)	Helpful (3)	Very helpful (4)
Learning about the Macroinvertebrates.org website				
Learning about the PocketMacro app				
Collecting live macroinvertebrates in the stream [ED TRAINING ONLY]				
Texture rubbings of macroinvertebrates [ED TRAINING ONLY]				
Macroinvertebrate Flashcards				

2.) What aspects of the Educator Training/Mini-Walkthrough did you find most valuable?

3.) On a scale from 1 to 10, with 1 being, *"I have no familiarity at all with aquatic macroinvertebrates"* and 10 being, *"I am an aquatic macroinvertebrate expert,"* how knowledgeable would you say that you were/are about aquatic macroinvertebrate identification…

	1	2	3	4	5	6	7	8	9	10
BEFORE the training/ Mini-Walkthrough										
AFTER the training/ Mini-Walkthrough										

4.) Please indicate how much you DISAGREE or AGREE with each of the following statements:

The Macroinvertebrates.org Educator training/Mini-Walkthrough increased my confidence in my ability to...	Strongly Disagree (1)	Disagree (2)	Neither Agree, Nor Disagree (3)	Agree (4)	Strongly Agree (5)
Collect aquatic macroinvertebrates samples [ED TRAINING ONLY]					
Determine water quality based on aquatic macroinvertebrate identification					

[ED TRAINING ONLY]					
Use the **Macroinvertebrates.org website** to identify aquatic macroinvertebrates [ED TRAINING ONLY]					
Use the **PocketMacro app** to identify aquatic macroinvertebrates					

5.) Please indicate how much you DISAGREE or AGREE with each of the following statements:

The Macroinvertebrates.org Educator training/Mini-Walkthrough increased my confidence in my ability to...	Strongly Disagree (1)	Disagree (2)	Neither Agree, Nor Disagree (Neutral) (3)	Agree (4)	Strongly Agree (5)
Teach others how to identify aquatic macroinvertebrates					
Engage students or volunteers in learning about macroinvertebrates and freshwater environments					
To access tools and resources I need to improve my teaching of this subject					

6.) To what extent do you feel like the Educator Training/Mini-Walkthrough provided you with tools to prepare your students or volunteers to identify aquatic macroinvertebrates?

Not applicable	Not at all (1)	(2)	(3)	(4)	To a large extent (5)

7.) In what ways (if any) might you use the tools from this Educator Training/ the Mini-Walkthrough?

PART 2: ABOUT THE POCKETMACRO APP

8.) Please indicate how much you DISAGREE or AGREE with each of the following statements:

The PocketMacro App...	Strongly Disagree (1)	Disagree (2)	Neither Agree, Nor Disagree (3)	Agree (4)	Strongly Agree (5)	Not Applicable / Did Not Use App
Made it easier for me to **see relevant features** for identifying aquatic macroinvertebrates						
Increased my **confidence** in identifying aquatic macroinvertebrates						
Increased my **accuracy** in correctly identifying aquatic macroinvertebrates						
Increased the **quality** of the data I feel I can report						
Helped me **see differences** between insect groups						
Provides me with an **effective way to continue practicing** how to identify aquatic macroinvertebrates outside of trainings						
Is better than other tools/materials I've come across **to help me learn** about aquatic macroinvertebrates						

9.) Please indicate how much you DISAGREE or AGREE with each of the following statements:

The PocketMacro App...	Strongly Disagree (1)	Disagree (2)	Neither Agree, Nor Disagree (3)	Agree (4)	Strongly Agree (5)	Not Applicable / Did Not Use App
Will be **easy to integrate** into my current program offerings or lessons						
Will **enhance** my current program offerings or lessons						
Enables me to **better meet and address educational standards**						
Is better than other tools/materials I've come across to make aquatic macroinvertebrates **more accessible to others**						
Is better than other tools/materials I've come across **to engage students or volunteers with aquatic macroinvertebrates**						

10a.) How useful was the <u>PocketMacro app during the training</u> for doing the following?

	Not at all Useful (1)	Somewhat Useful (2)	Useful (3)	Very Useful (4)	I did not use the app for this purpose
To ID an unknown specimen					
To view images of a macroinvertebrate more closely					
To see **ORDER** level characteristics/features of a macroinvertebrate					
To see **FAMILY** level characteristics/features of a macroinvertebrate					

10b.) How useful was the PocketMacro app to you in the future for doing the following?

	Not at all Useful (1)	Somewhat Useful (2)	Useful (3)	Very Useful (4)	I did not use the app for this purpose
To ID an unknown specimen					
To view images of a macroinvertebrate more closely					
To see **ORDER** level characteristics/features of a macroinvertebrate					
To see **FAMILY** level characteristics/features of a macroinvertebrate					
To quiz myself/ practice ID					
To help others learn about macroinvertebrates					

11.) Overall, how helpful were the following sections of the Pocket Macro app?

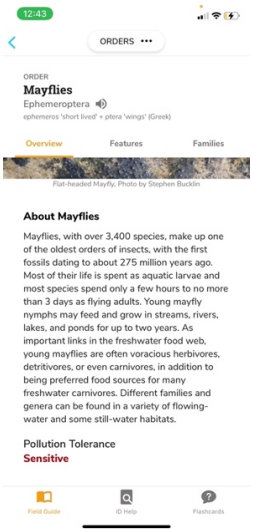
	Not at all Helpful (1)	Somewhat Helpful (2)	Helpful (3)	Very Helpful (4)	I did not use this section (N/A)
Field Guide 					
ID Help 					
Flashcards 					

12.) How useful were the following features of the Field Guide section?

Not at all useful (1), Somewhat useful (2), Useful (3), Very Useful (4), I did not use this feature (N/A)

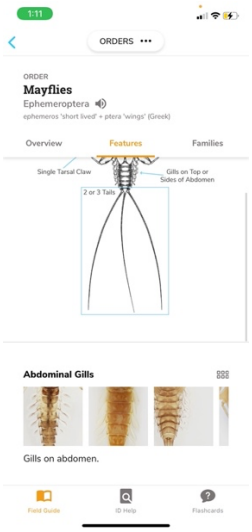
Please circle your answer below each image.

Pollution Tolerance Information



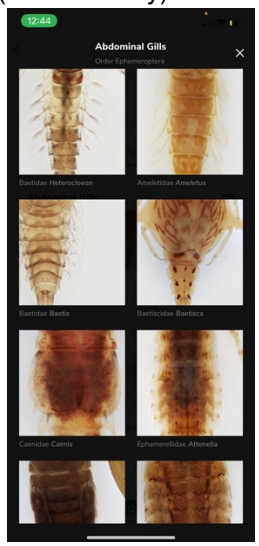
N/A 1 2 3 4

Diagnostic Features **(**Order/Family)



N/A 1 2 3 4

Gallery of Diagnostic Features (Order/Family)



N/A 1 2 3 4

Flip Views Functionality (Dorsal/Ventral/Lateral)

N/A 1 2 3 4

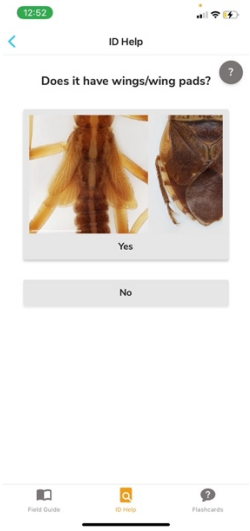
Zoomable Macroinvertebrate Photographs

N/A 1 2 3 4

13.) How useful were the following features of the ID Help section?

Not at all useful (1), Somewhat useful (2), Useful (3), Very Useful (4), I did not use this feature (N/A)
Please circle your answer below each image.

Guided Dichotomous Key Questions

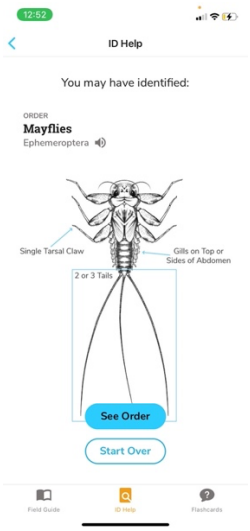


N/A 1 2 3 4

Zoomable ID Key (*if available*)

N/A 1 2 3 4

ID Key Result Page



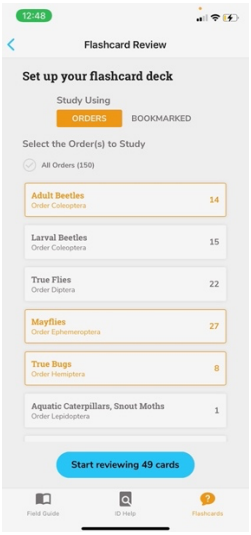
N/A 1 2 3 4

14.) How easy was it to use the following features in the Flashcard section?

Very difficult (1), Somewhat difficult (2), Somewhat easy (3), Very easy (4), I did not use this feature (N/A)

Please circle your answer below each image.

Flashcard Set-up Functionality



N/A 1 2 3 4

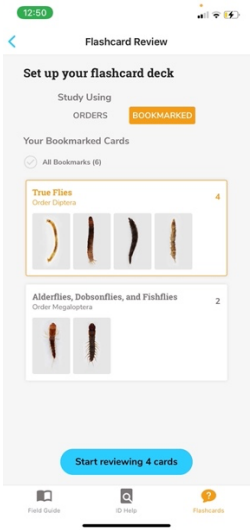
Flipping, Swiping, Zooming Functionality

N/A 1 2 3 4

15.) How likely are you to use the following features in the Flashcard section?
Not at all likely (1), Somewhat likely (2), Likely (3), Very Likely (4), I did not use this feature (N/A)

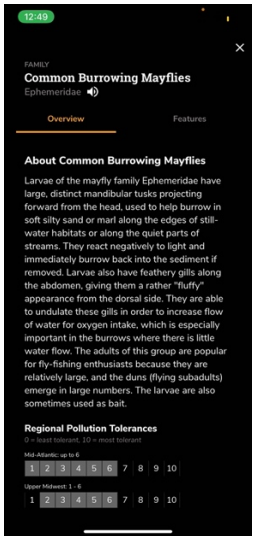
Please circle your answer below each image.

Flashcard Bookmark Feature



N/A 1 2 3 4

Family Level "See More" Feature



N/A 1 2 3 4

16.) Now, reflecting back on the PocketMacro app, what aspects did you find the most valuable?

17.) In what ways (if any) are you likely to use the PocketMacro app with your students or volunteers? For any particular activities or contexts?

18.) In what ways does the PocketMacro app need to be improved to be useful to you in your setting?

19.) What other information, features, or functionality would you like to see added to the Pocket Macro app?

PART 3: ABOUT THE WEBSITE [ED TRAINING ONLY]

20.) What aspects of the Macroinvertebrates.org website did you find the most valuable?

21.) What other information, features or functionality would you like to see added to the Macroinvertebrates.org website?

PART 4: ABOUT YOU

1a.) Your Name (First & Last): _____

1b.) Your Email Address: _____

2a.) Have you ever received training in how to do aquatic macroinvertebrate identification BEFORE the Macroinvertebrates.org Educator Training?

___Yes ___No

2b.) If yes: Please describe when, where, and with what organization:

3a.) Which of the following best describes you? Check all that apply.

____ I have collected macroinvertebrate biomonitoring data **in the past**.
____ I am **currently** involved in an organization where I collect macroinvertebrate biomonitoring data.
____ I am **planning** to become involved in collecting macroinvertebrate biomonitoring data in the future, but do not currently do so.
____ I have **never** collected macroinvertebrate biomonitoring data, and do not plan to do so in the future.

____ I have engaged students or volunteers in lessons or programming about aquatic macroinvertebrates **in the past**.
____ I **currently** engage students or volunteers in lessons or programming about aquatic macroinvertebrates.
____ I am **planning** to engage students or volunteers in lessons or programming about aquatic macroinvertebrates, but do not currently do so.
____ I have **never** engaged students or volunteers in lessons or programming about aquatic macroinvertebrates, and do not plan to do so in the future.

3b.) If you plan to or already collect macroinvertebrate biomonitoring data, please name any organizations you volunteer for/or to whom or what entities you contribute your data:

4.) Your Gender

____ Male
____ Female
____ Non-binary
____ Prefer to Self-Describe:_____
____ Prefer not to say

5.) Your Age (in years): _____

6.) Race (Check all that apply)

____ White/Caucasian
_____ African American Hispanic or Latinx
_____ Asian
_____ Native American or Pacific Islander
_____ Middle Eastern
_____ Other (Please Specify): _____

7a.) Which best describes you? Check all that apply.

_____ I am a classroom teacher
If checked: What grades do you teach? _____
_____ I am an informal educator (i.e., I work at a museum, library, afterschool program, or summer camp)
_____ I am a student.
_____ I am a trainer who leads workshops on how to identify benthic macroinvertebrates.
_____ I am a science professional who works with benthic macroinvertebrates in my job.
_____ I am a science professional who does not work directly with benthic macroinvertebrates in my job.
_____ I work with benthic macroinvertebrates in some other capacity (e.g., volunteer water monitoring).
_____ Other (Please Specify): _____

7b.) Please explain your role:

8.) Are you interested in participating in a phone interview about your experiences at this training for an additional $25 gift card?

___Yes ___No

APPENDIX B: INTERVIEW INSTRUMENT

Thank you for agreeing to participate in this interview today. I'd like to ask you some questions about the training that you participated in and your thoughts about the PocketMacro app in particular. Please answer honestly – I really want to know what you think. Your responses will help the project team understand what people get out of these trainings, and what's working and what could be improved about the app. When I report back to the project team, your responses will be anonymous and won't be linked back to your name. I am going to be audio recording the interview to help with my notes. Do you have any questions before we get started? Great. Let's begin.

1.) For my records, can you please state your name and your occupation?

PART 1: EDUCATOR TRAINING

2.) **So, why did you decide to participate in the Macroinvertebrates.org Educator Training?** *[Prompt: What were you hoping to get out of it?]*
a. Did the training meet those expectations? *[Prompt: How so? / What was missing?]*

3.) **If you had to tell someone about <u>this training</u> who hadn't done it before, what would you tell him or her about it?** *[Prompt: Any big lessons learned or takeaways about doing aquatic macroinvertebrate identification?]*

4.) **What did you like best about the training?**
a. Were there any specific resources or activities that you found particularly helpful? *[Prompt for explanation]*

5.) **Was there anything that you didn't like as much about the training or found confusing?** *[Prompt for explanation]*

a. Do you have any suggestions for ways that the training could be improved?

6.) **What did you get out of the training?** *[Prompt: Did you learn any new information or skills]?*
a.) Do you feel ready to identify macroinvertebrates that you collect out in the field after the training? *[Prompt: Before you came to the training, did you feel ready to ID to Order? To Family? Do you feel more prepared now that you've done the training or about the same as you did before the training?]*
b.) Do you feel ready to teach others about macroinvertebrates after the training? *[Prompt: Do you feel more prepared now that you've done the training or about the same as you did before the training?]*

PART 2: POCKETMACRO APP
7.) Now, I'd like to ask you a bit more about using the PocketMacro app.
a.) What were your first impressions of the app?
b.) What did you like best about the app? *[Prompt: Any particular features?]*
c.) Is there anything about the app that you didn't like as much or found confusing?
d.) Were the content & format approachable? What makes you say that?
e.) Have you explored the app at all after the training? *[Prompt: If yes: how?]*

8.) What (if anything) did you get out of using the app? *[Prompt: How did it help you?]*
a.) Are there particular features that you feel like will be most helpful to you? *[Prompt: Which ones and in what ways will they be useful?]*

9.) Tell me a bit about the process you went through to identify aquatic macroinvertebrates during the training.
a.) Overall, what tools/resources did you use or find most helpful?

i.) In particular, how did you use the app to identify an insect?
b.) Did the app change how you ID macroinvertebrates or what you look for?
c.) How does the app compare to other ID resources available?

10.) What's challenging about teaching about aquatic macroinvertebrates?
a.) In what ways (if any) does the app address these challenges?
b.) Have you ever used online tools with students or volunteers in this way before?
c.) In what ways (if any) might the app impact you or your students or volunteers' engagement with aquatic macroinvertebrates? *[Prompt: The ways they think about or talk about macros; Observation skills, confidence, accuracy. etc.]*

11.) Where are some of the places where you teach or learn about aquatic macroinvertebrates?
a.) Could the app be utilized in those settings? Why or why not?
b.) [If not already mentioned]: Do you think you would use the app with students or volunteers by a stream? *If yes: In what ways? If no: Why not?*
c.) When using an app like this outdoors, do you think of it more as enhancing the experience or detracting from the experience? *[Prompt: in what ways does it enhance the experience? In what ways does it detract from the experience?]*
d.) Are there other teaching or learning contexts that the app would be useful in?

12.) Would you recommend the app to someone who wanted to learn about or identify stream insects? Why or why not?

13.) Do you plan to use the app in the future? [Prompt: If yes: how? If no: Why not?

14.) Do you have any ideas for ways that the designers could improve the app? *[Prompt: Was there something missing that you wanted to see or do in the app?]*

PART 3: POCKETMACRO RESOURCES

15.) Now, I'd like you to tell me a bit about what you thought about the other resources provided at the training.

ai.) What did you think about the MacroCards? [Prompt: Likes/dislikes]

aii.) How might you use those in the future [Prompt: Yourself/with students or volunteers]?

bi.) What did you think about the rubbings activity? [Prompt: Likes/dislikes]

bii.) How might you use that in the future [Prompt: Yourself/with students or volunteers]?

16.) Is there anything else you'd like to share about the PocketMacro app or associated educational materials shared (Macrocards, stickers, poster, 3D rubbing activities)?

17.) Is there anything else you'd like to share about the training you attended?

Thanks for sharing your thoughts with me today!