

# Teacher Perspectives on Personalized Guidance for Science Homework.

## Objective

During in-class instruction, teachers actively support students through *personalized guidance*, including discussions and responsive teaching methods that relate and refer to individual student's classroom, social and cultural experiences (NAS, 2018). In contrast, while homework provides students with an opportunity to review and deepen classroom learning, homework for middle and high school students is often done in isolation where the teacher is unable to provide the personalized guidance they would give in class (Cooper, 2015). As part of a larger project, our goal is to develop an online teacher tool to augment homework with personalized guidance that goes beyond the types of automated hints and feedback provided by current Intelligent Tutoring or Educational AI systems (Holstein, et al., 2020). To inform that work, in this study, we examine 1) science teachers' current practices to guide students during classwork, 2) how and why they currently provide homework, and 3) how they would want to support their students during homework.

## Theoretical Framework

To understand how science teachers would want to provide personalized guidance for homework, our work takes a sociocultural perspective on learning (Vygotsky, 1978; Miyake & Kirschner, 2014). This perspective recognizes how a student's acquisition and integration of domain knowledge is built upon their sociocultural experiences and socially situated interactions. This approach is in alignment with modern K-12 Next Generation Science Standards (NGSS, 2011) that emphasize integrated science learning and cross-cutting concepts that represent deeper science learning. In this way, teacher practices often utilize personalized guidance to draw on shared experiences and social interactions to co-construct knowledge during classroom activity. For example, a teacher might refer to student experiences or a previous classroom discussion about a concept (e.g., the ways we feel heat) to contextualize more formalized instruction and connect a student's ideas to the concept (e.g., the scientific definition of heat; Scott et al., 2006; Louca et al., 2012).

Homework is designed to build understanding and practice outside of the classroom, but as an activity that is usually done in isolation, homework lacks the responsiveness and personalized guidance a teacher would provide in a classroom, and parents often struggle to effectively engage with science content (Cooper, 2015). Some learning systems support student homework through feedback on answers, providing step-by-step problem-solving help and mastery tracking (Wilson & Kennedy, 2017) and adjust student activities according to student performance (Aleven et al., 2016). However, these approaches are generalized and focus primarily on direct responses to student problem-solving and input. This leaves a need for systems capable of providing guidance that reflects the socially situated shared experiences students have in and out of the classroom, in the way teachers do.

To address this need, in this study we ask the research question: *What personal guidance do teachers employ to support student learning in classrooms and how would teachers want to provide personalized guidance for science work at home?*

### **Method and Data Sources**

We recruited 7th and 8th grade science teachers through the National Science Teaching Association (NSTA) email listserv and conducted 1-hour interviews with teachers (N = 9), recorded during Zoom online sessions. The semi-structured interviews focused on current practices for classroom and homework guidance and additional desires for supporting homework, but also allowed for exploration of additional lines of discussion (Blandford, 2013). After opening the interviews with questions related to their teaching experience, we asked the teachers about how and when they provide guidance and supports to individuals and groups within the classroom, how they anticipate and address misunderstandings, and their approach towards giving homework, including the types of activities they use, what issues they experience, and what purposes they see homework fulfilling. Figure 1 illustrates our research process.

The recordings of the interviews were transcribed verbatim and analyzed using a Thematic Analysis approach to qualitatively identify patterns in the data (Braun et al., 2018). After familiarizing themselves with the data, the researchers engaged in several rounds of inductive generation of semantic and latent codes (see Table 1) which were used to organize and build themes through iterative discussion in relation to the research questions.

## Results

In this section, we describe the four major themes generated from our analysis and support them with direct quotations from participants. All quotations are attributed to participants by their (non-consecutive) study ID numbers.

**Theme 1: Teachers use homework as an extension of the classroom.** Teachers preferred to avoid having students grapple with completely new concepts for homework, seeing the role of homework “to extend what we're doing in the classroom.” (T10) and as “an extension of what we were learning in class to tie into their interest and to get them to think deeper about it” (T4). A common reason for not introducing new concepts during homework was, “because I’m not there to support it” (T11) or provide guidance, and that “when the kids are at home there's a different dynamic...there's nobody there encouraging and motivating them.” (T3). To address their concerns about their inability to support new content at home, teachers created in-class activities specifically to prepare students for the upcoming homework, such as doing “one article in class and then a follow up article for homework” (T11), or to help address anticipated misunderstandings, “I would model that through a ‘I do we do you do’...within in the classroom, before I ever asked them to do it on their own outside.”(T2) In sum, teachers voiced a desire to extend and deepen their classroom learning but appear to be reluctant to introduce new content without the ability to provide guidance. Therefore, teachers appeared to rely on personalized in-class activities to prepare students for homework.

**Theme 2: Teachers use their experiences with students to provide personal guidance.** Teachers emphasized that they include qualitative understanding of their students to inform the guidance they provide, and consider, “how did the student learn?... Did certain factors help the student more? Did the student need extra motivation? Did the student need extra time, less time?” (T16). Teachers also try to ground their guidance by referencing previous activities from class to help explain new content, “I often will loop back to that concept again... and I say, ‘remember last year when we learned about this one part?’” (T3). Teachers often look to incorporate “activities that that I feel are of high interest to them” (T3) and “try to keep them as involved as I can,” (T16). While most teachers personalize tasks based on metrics like pre-assessments, they also seemed to emphasize the importance of paying attention to and tracking other aspects such as individual student’s interests, needs and experiences, to personalize guidance.

### **Theme 3: Teachers use a wide range of multimedia rather than a singular textbook.**

Given the “amazing amount of science material out there” (T9), teachers “have branched away from the textbook” (T5) to use a variety of materials for homework such as videos, articles, and interactive online content. They seem to see multimedia promoting engagement and learning, as T1 told us, “kids love videos you know... there's something about hearing it from somebody else's mouth besides mine that makes them understand it or own it a little more.” This variety also helps them tailor assignments, as T16 explained, “you might have one group of students who need the vocabulary help....and you might have some students working on a simulation so they can better understand the experiment or the process”. This theme highlights how teachers integrate a variety of media to meet their student’s needs and amplify student engagement and motivation.

### **Theme 4: Teachers value homework but are hindered by many practical and equity barriers.**

Teachers recognized the value of homework to augment classroom learning and “build on their understanding” (T16) at home where students can “reflect or really analyze that problem on their own, they just don't get that in the classroom.” (T2). However, teachers are concerned that some students do not always have adequate time for homework because, “they have to watch their sister, little brother, while the mom or dad is away at work” (T11), or “are the one making dinner for the family” (T10). Inequities in students’ opportunities for homework seem to lead teachers “to keep [homework] minimal for students, because there's a definite equity issue nowadays.” (T11). These statements suggest that while teachers recognize the additional value homework can add to classroom learning, there remain issues outside of the teacher’s control that hinder students’ ability to effectively engage with learning at home.

## **Discussion and Implications**

The findings provide us with theoretical and practical implications for researchers and instructional designers to develop methods for teachers to provide personalized guidance during homework. First, we contribute to theory on how teachers build classroom discussions and experiences around science concepts that use homework for further exploration and extension. Teachers provide opportunities to co-construct knowledge in ways that relate personally to students’ experiences they feel are needed at home (Vygotsky, 1978; Miyake & Kirschner, 2014). Teachers also apply their own understanding of their student’s interests, perspectives, strengths and needs when giving personalized guidance, which is of particular importance where time and equity

constraints threaten the effectiveness of homework. These findings build our theoretical understanding of how teachers perceive the role of homework, how they personalize guidance for students, and how they structure classroom and homework as complimentary forms of learning.

These findings also suggest several practical implications for developing tools for teachers to support or augment homework that should:

- 1) Emphasize a link between in-class and in-home work by creating connected sets of content in a variety of formats for use across in-class and at-home learning.
- 2) Empower teachers to augment multimedia materials with personalized guidance to relate homework to in-class discussions, local contexts, student interests and prior experiences.
- 3) Address homework inequities by providing students with flexibility in due dates or formats for completing work, and providing personalized guidance, such as teacher-annotated materials or worked examples.

## **Conclusion**

In this work, our goal was to understand how teachers provide personalized guidance for science classwork and how they would want to further support students at home. In line with prior research, we found that while teachers value homework as an extension of classroom activities using a variety of multimedia to deepen student learning, they have minimized the use of homework as they know students receive uneven levels of guidance and opportunities to complete homework (Cooper, 2015). We believe our findings suggest that teachers may welcome additional tools and technologies to provide better and more equitable guidance for students during homework, but these tools will need to reflect how they currently provide classroom guidance.

The significance of these findings is that they reveal how teachers prepare students for homework activities by reviewing, practicing, or mirroring the activity first in class, thereby providing guidance the students take home with them. Of particular importance is that this homework preparation is personalized based upon the teacher's qualitative knowledge of individual students and relies upon previous socially situated classroom experiences and activities.

One major limitation of this study is the small sample size, and that the majority of our sample includes teachers with significant experience in the classroom. As such, the findings have limited capacity for generalization and may not apply well to the perspectives and needs for new or inexperienced teachers. We also recognize that our design implications are limited as they are not derived from work examining teachers' use of tools or technology to support homework, but rather focus on current and desired practices around classroom and homework guidance. We plan future research to clarify the affordances needed by such a teacher tool, and through the use of co-design or participatory design aim to empower teachers to build systems that meet theirs and their students' needs. (See Figure 1).

In conclusion, we believe this work contributes a needed understanding of modern science teacher views around supporting students during homework that extends existing theory and informs instructional design and practice. By continuing to involve teacher perspectives, we examine the role and utility of homework in science and ground our theory-building in real classroom practice.

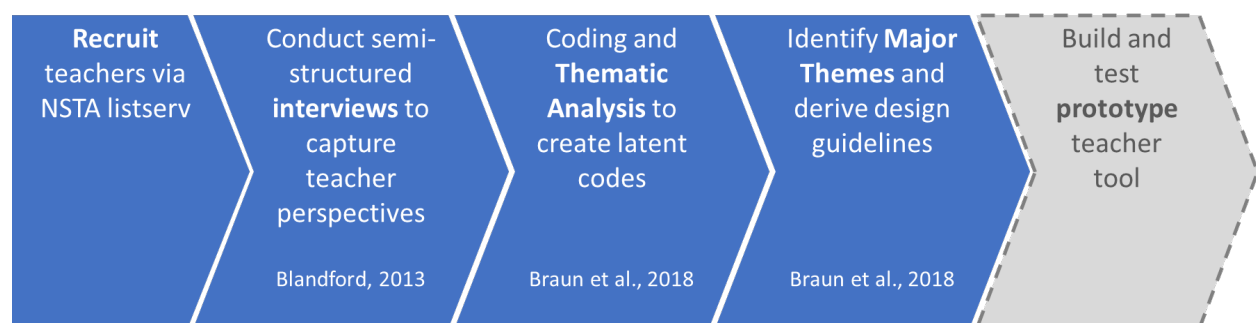


Figure 1. Co-designing a teacher tool based on teacher perspectives.

Table 1. Codebook showing latent codes and example quotes from the interviews.

Name	Formal Definition	Example Quotes
Extension of classroom	Teachers use homework as an extension of classroom activities, whereby the teacher provides pre-support of the homework tasks.	We do one article in class and then a follow-up article for homework, because I want to make sure they have the vocabulary in class before, and they understand the vocabulary that they're going to need.
Personal interests, home connection	Teachers use homework to relate to students' personal interests, their home and local environment to add personal connection to deepen the learning.	Usually it involves them going home and looking at their basketball or football and applying what we were learning in physics to those things they were already naturally curious about. So their homework was to tie into their interest and to get them to think deeper about it.
Many formats and resources	Teachers choose multiple ways of engaging with content, including audio and visual materials, written and oral responses.	I try to give them multiple ways, you know I'm a firm believer in the different modalities that kids learn, and you switch it all up.
Anticipating misunderstandings	Teachers look for and anticipate student misunderstandings to respond to them immediately	If I'm starting to notice the same errors, the same misconception, I will do something like "Hey guys, let's stop what we're doing, let's think about this for a moment" and a reteach that concept
Scaffolding, personalized supports, differentiation	Teachers provide a range of ways to provide personalized scaffolding or supports based on the needs of the class, group or individual.	As we do these activities, you want to make sure that you're personalizing the learning for students. You want them to be successful so you have to look back at your notes to know what factors are needed to help this student be successful.
Giving student choice	Teachers provide students with choices between different modes and different levels of difficulty in their classroom and homework activities	What I will do is maybe give them a few different articles to choose from to read. One of which might be more simplistic in nature, one might be more complex, and one would kind of be a mid-level that approach a similar topic maybe just from different viewpoints.
Tracking student interests	Teachers survey, collate and update information on their students' learning preferences, personal interests and academic progress	I do an interest survey to get to know the kids and their learning aspect. It helps me throughout the school year and then as I'm meeting the kids and working with them, I get to learn some of their habits, so I adjust the learning as needed as I get to learn them better.
Personal connection to science	Teachers want students to understand and develop a personal connection to scientific methods, thinking and approach.	So my objective would just be for them to be able to ask really good questions. The ability to ask questions, especially in the sciences is so important. Just improving that, asking better questions each time.
Engagement and motivation	Teachers apply multiple ways to enhance engagement and motivation, including applying fun and gamification strategies, and providing variety.	We're able to find things that are new and things that we really want to pique their curiosity. Once you bring that hook in for learning, you know you've got their attention and you know they're ready to soak up all that new information and material.
Inequity, fairness issues	Teachers see student's face issues with homework tasks due to inequity of technological availability and constraints of time and support at home.	They still might not do the assignment because they are the one making dinner for the family, or they're the ones sitting at home, helping their younger siblings get their work, getting them fed because their parents work.
Different performance at home	Teachers experience contrasting student performance between classroom and home, including vast shortfalls and vast improvements.	When the kids are at home that's a different dynamic. There's nobody there encouraging and motivating them and it ends up becoming work that is really impacting their grades.
Value of homework, as practice, deepen learning	Teachers view homework playing an important role in deepening learning, practicing, and providing a different environment and timing.	You want them to come away with the understanding of the concept or the topic. You want them to be able to practice on the project that we're working on and don't have time in class to practice.

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