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Cover Page Footnote

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Using a Connected Learning Framework to Promote Democratic Education During a Transition to Online Learning

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Abstract

In this essay, we discuss how a Connected Learning (CL) approach to education can offer students and teachers a democratic framework to follow when designing instruction, especially with the recent shift to online and hybrid instruction due to the global pandemic. We present literature on the opportunities and challenges of transitioning to online instruction in the midst of the pandemic. We then discuss how the CL framework promotes a democratic approach to teaching and learning. Finally, we offer guidance on how to design a unit or lesson plan using a CL framework to provide both a connected and democratic learning experience for students. We also offer suggestions on how to foster an innovative, authentic learning experience that includes elements of an online or hybrid context to support connected learning. Drawing on a classroom example from the field, we conclude with recommendations for utilizing non-traditional, formative assessments to fairly assess a range of learning outcomes as demonstrated by students.

Introduction

Leveraging a Connected Learning Framework for Online Instruction

We believe a democratic culture can be created in classrooms by using a Connected Learning (CL) framework to shape approaches to teaching and learning. In response to the threat of COVID-19, an abrupt disruption to teaching modalities and environments in schools across the US caused a paradigm shift in how teachers deliver instruction and ultimately how students are learning. This shift forced many U.S. teachers into learning landscapes that are unfamiliar to them and their students. While online instructional practices are not novel, they are new to many K-12 teachers who were previously well-prepared for *in-person* teaching (Kaden, 2020; Mäkelä et al., 2020). Consequently, teachers need to adapt previous teaching strategies and find ways to connect with students quickly (Kaden).

We are proposing a method to lessen the effects research suggests will occur as a result of the COVID-19 crisis. These effects include learning loss and increased high-school dropout rates which pose a particular threat to under-resourced populations (those from low SES and non-dominant races) (Dorn et al., 2020). Dorn and colleagues claim this learning loss is directly dependent upon: (1) student access to remote learning; (2) the quality of remote instruction; (3) home support; and (4) their level of engagement with learning.

One way forward for teachers struggling to navigate online learning includes incorporating a CL framework when planning engaging, online instruction (Teräs et al., 2020). Developed by Ito and colleagues (2013), the CL framework (see Figure 1) for teaching and learning is based on findings that the "most resilient, adaptive, and effective" learning occurs when "a young person can pursue a personal interest or passion with the support of friends or caring adults and is, in turn, able to link this learning and interest to academic achievement, career success or civic engagement" (p. 4). Another reason this framework is particularly appropriate to enhance online instruction is based upon these scholars' claim regarding the potential for a CL framework to address the gap between in-school and out-of-school learning.

Figure 1

Connected Learning Framework (Ito et al., 2013)

There is a notable overlap between CL and democratic education (DE) principles. For the purposes of this paper, our definition of democratic education draws on Beane's (2019) work which states that DE occurs when students have the right to think for themselves; be fully informed about current issues; hold their own beliefs; contribute to how things are done in their classrooms; are free to explore personal interests; and feel their learning space is equitable. According to Ryan and Patrick (2001), a focus on student interaction in middle grades classrooms is encouraged, in particular, because peer relationships are highly valued by young adolescents. The creation of this social and inclusive classroom environment supports positive changes in adolescents' motivation and engagement in learning (Ryan & Patrick). Thus, by using a CL approach to online learning, we argue that teachers can foster a more democratic learning experience for their classrooms that uniquely meets the developmental needs of adolescents.

Literature Review

Opportunities and Challenges when Navigating Online Learning in K-12

Researchers agree that the students who are most vulnerable for experiencing a decrease in academic achievement during the transition to online learning are those who are already at risk, such as students from low socio-economic backgrounds (Dorn et al., 2020; Mäkelä et al., 2020). More than ever, teachers face an amplified need to engage students in their learning due to the lack of social and physical interaction typically found in the face-to-face classroom environment. In a literature review by Mäkelä and colleagues, the authors identified challenges and respective opportunities teachers and students now face in relation to online education during the COVID-19 pandemic (see Appendix A, Table 1).

In some respects, teaching online affords instructors opportunities to extend the students' learning to outside-of-school contexts by encouraging students to collaborate with peers, family members, or caring adults as a part of their learning process. Another notable advantage to online learning is the ability to connect with students in extreme circumstances such as COVID-19 (Mäkelä et al., 2020). However, teacher attitudes, willingness to change, access to technology, social isolation, and increased workloads all present barriers to effective, engaged teaching and learning (Mäkelä et al.). Despite these challenges, Mäkelä and colleagues claim that even minor changes at an individual level (e.g., teacher attitudes) can positively impact the overall morale and culture of virtual classrooms. Since research demonstrates many teachers have negative attitudes toward technology use, these authors argue that if teachers resolve to maintain a positive attitude about technology use, it may be enough to positively shift online instruction.

Learning Outcomes of Connected Learning

Ito and colleagues (2013) describe how a CL approach to education can elevate both individual and collective capacities in an integrated way. CL provides a framework that is value-additive in that the sum of the interests, contributions, skills, talents, and ideas of the individuals combine to create a collective capacity for that community and beyond (Ito et al.). This stands in stark contrast to that of a traditional classroom where standardized metrics are often used to gauge individual achievement. Proponents of the CL framework state high-functioning CL environments include many opportunities for individual contribution and growth in the service of collective goals of the whole group. These environments also demand a virtuous feedback loop between the individual's contributions and the quality of the collective culture and knowledge of the group. Finally, low barriers to entry and participation, along with a multiplicity of roles, are key attributes of these CL environments (Ito et al.).

Connected Learning in the Virtual Classroom

So, how might this CL framework be realized in the virtual classroom? Because it requires a culture shift, it will take patience to cultivate. CL scholars suggest that, due to the complexity of learning environments, achieving CL requires a bottom-up approach of designed, emergent elements in a series of "experimentation and flux" (Ito et al., 2020, p. 62). The key to the experimentation is for teachers to consider how they might weave in elements of interest-based, peer-supported, and academically-oriented contexts to their learning landscapes (see Appendix A for an example of guided reflections for educators). One way we suggest achieving this is by investigating student interests (i.e., via

surveys, discussions or informal conversations), incorporating these interests into the curriculum, and leveraging the at-home learning environment for deeper learning.

Examples of CL in the Classroom

Drawing on students' specific interests and cultural practices out-of-school, while incorporating caring adults, family members, and community members into the child's learning experience can connect informal and formal learning. For students, this achieves an intentional *connection* between these two contexts. For example, 7th-graders who are discussing world cultures could conduct, incorporate and showcase interviews from family or community members representative of other world cultures using preferred digital tools, music, and images. The students could use smartphones to record their interviews and could present their ideas taking on roles of local journalists, historians, or videographers. A class of 8th graders studying properties of force and motion might use a local playground or park, consider the types of equipment they enjoy, and apply the concepts to create a model out of recycled materials to demonstrate their learning.

Democratic Education in the Classroom

We have positioned our conceptualization of Democratic Education (DE) after the Beane (2019) article, wherein Beane describes DE as an approach that allows students to explore issues found in the real-world while considering personal and community concerns. As a result, Beane argues this approach engenders opportunities for students to broaden and deepen their understanding of both themselves and their world around them. Choosing a real-world issue to study should include—as much as possible—active participation by the students and the teachers. Beane underscores the importance of this choice as one of the hallmarks of democracy.

Other characteristics of DE in the middle grades, according to Beane (2019), include: (a) projects that allow for learning through doing; (b) disciplines that are integrated naturally; (c) issues that are explored via sources beyond disciplines (i.e., cultural histories, popular culture, and students' personal knowledge); (d) emphasis is placed on collaboration for collective and individual action; (e) all students are given the same "problem" or theme and then given latitude for differentiation as they work on various projects or tasks; (f) assessment is based on students' individual and group reflections about their work and growth as evidenced by portfolios, project exhibitions, and community action; and (g) teachers are active participants in listening carefully to their students, suggesting directions for their ideas, bringing broader perspectives to issues, and offering feedback about individual and group work (Beane, pp. 2-3).

Finally, Beane (2019) offers these key factors teachers should consider for middle grades when aiming to provide a democratic approach to learning: (a) many middle schools are still organized around schedules that allow for activities in a larger block of time to plan and collaborate with other like-minded teachers; and (b) young adolescents are ready, willing, and able to take on questions of values, from those in everyday events to matters of social and economic justice. Together, curricula that draw on student interests and cultural practices while creating learning contexts that explore real-world issues where students actively participate with choices and differentiation, encourages democratic and connected learning.

Suggestions for Implementation

Unit Overview

The application of CL principles to support a DE-centered curriculum is detailed in the introductory activities for a unit (see Appendix B – Table 2) where middle school students work together to address the question: "How can we improve our local community?" Guidelines for activities/tasks supporting the general unit design are flexible, allowing teachers to fully incorporate student participation and their ideas to determine how to improve the community. Throughout the unit, opportunities for family and community involvement are present in brainstorming activities, research phases, and project development suggestions along the way. Student assessment in a CL environment is not easily measured by traditional standardized assessment methods. Often, students are not working on the same products or problems at the same time. Therefore, offering diverse forms of recognition for problem solving and non-traditional assessments can be very empowering to connected learners (Ito et.al., 2013).

Below, we discuss a unit and problem-solving scenario that *connects* the home or out-of-school learning environment with in-school lessons designed by their teacher. The unit was taught by a public middle school teacher in the Northeastern United States. Specifically, the tasks within the unit rely on the participation of the students' family, community connections, and/or peers as a method for extending their learning across contexts, as is suggested by the CL framework. In the next section, the *steps to implementation* are outlined by the teacher from her firsthand experience.

Steps to Unit Implementation

Start with a Broad Driving Question

The unit began with a broad framing question, "How can we improve the local community?" Due to the purposely broad nature of the question, it can be introduced in any classroom. In this example, the science teacher incorporated the question to engage her students in a community-based science unit. Throughout the unit, the teacher designed other discipline-related (math, science, reading, language arts, and social studies) activities to incorporate skills from other classes. For example, calculations were used to measure run-off calculated for rain events when looking at problems with localized flooding (math). Interviewing community members or writing letters or emails to community recreation board members about concerns with speeding through local neighborhoods or issues with the local playground provided an opportunity for students to practice ELA writing and research skills. The community-based nature of the question supports tenets of CL learning and DE as the unit is situated in a collaborative context that supports finding an equitable solution through a collective problem-solving effort to investigate an area of interest personal to the students.

Brainstorming

Following the introduction of the driving question, an initial brainstorming activity encouraged students to reach out to parents, siblings, or other caring adults to develop a list of problems in the local community. Before students can decide how to improve their community, they must discuss issues they see through their own eyes. The range of community problems resulting from the brainstorming activity was broad. It was important for the teacher to prompt students to speak directly with those in their home and out-of-school learning environments as part of the activity. In this case, clear and specific directions stated that it was expected that students ask others for input and this aspect was noted on the teacher-designed rubric. Students shared ideas digitally through discussion boards in an LMS, a shared document in Google, or verbally in a live Google Meet. When attempting to create a DE experience in the classroom for the first time, the use of online tools can fully support the integration of a CL framework (Ito et al., 2013).

Facilitating Discussions

After the initial collection of ideas, small groups of three to four students further discussed their ideas. Acting as a facilitator, the teacher prompted groups to ask questions of each other if they did not understand a problem the student shared. Groups typically completed these discussions in 10 minutes within one class period. Facilitating discussion of those personally identified issues modeled important listening and critical thinking skills that students can later employ when working through creating an equitable solution with others, characteristics that are indicative of democratic education. Online discussions lend themselves well to both synchronous and asynchronous learning environments and can facilitate participation and collaboration. Middle grades learners can participate synchronously through web-conferencing tools or asynchronously by using webcams or smartphones to record themselves. There are also opportunities for teachers to utilize newer tools such as Google's *Jamboard* (an interactive digital whiteboard) or Padlet as an interactive whiteboard in both synchronous and asynchronous learning situations. A traditional discussion board involves posting a topic and allowing students to reply to both the topic and/or each other. Although it could be used to house initial student brainstorming responses, the asynchronous nature of the discussion board may not be easily converted to a list allowing the class to select one issue, narrow the focus of an issue, or define it further. As part of the second task in this unit, *Issue Exploration*, it was important for the teacher, as a facilitator, to guide students to consider all issues in the initial brainstorming list and prompt discussion among the students using a live meeting, small breakout rooms, or even an asynchronous discussion board. Even if one

specific problem is not chosen for development in this unit instance, the task of narrowing a list of problems to investigate itself supports elements of DE by allowing students to broaden and deepen their understanding of the world around them.

Collaborating with Digital Tools

A variety of digital tools were used to collaborate. It is important for the selected tool to be developmentally appropriate and easy to use. Students focused on brainstorming ideas for the prompt and not mastering the use of a complex technological tool. It was also important for the teacher to understand learners' needs and allow for flexibility in how a student chose to participate or relay information. The teacher promoted the use of students' existing skills to build the new skills needed to communicate and collaborate in the online or hybrid environment. For example, the simplicity of *Jamboard* encourages students to focus on the brainstorming task instead of experimenting with font and color combinations as they are often distracted with those features in presentation building programs.

The teacher introduced new collaborative tools with the premise, "We are all learning new tools. If you figure out something interesting about the tool, let me (the teacher) and your classmates know. We can all learn from each other." Modeling the use of digital tools may also yield increased social interaction and peer-support indicative of a CL environment. As the teacher continued to facilitate the unit, the remaining tasks involved general learning concepts mirroring the engineering design process such as (a) conducting background research of the selected community issue; (b) brainstorming possible solutions; (c) designing and testing prototypes and, ultimately; (d) redesigning and sharing their ideas with the community.

Solutions and Final Products

Throughout the unit, students drove the direction of the project. Initially, they brainstormed community issues that included: local flooding of low-lying areas, availability or lack of crosswalks at highly traveled locations, bus safety, litter, and air pollution testing. Next, they voted to focus on one specific issue and designed solutions for improving school bus safety. Students were encouraged to keep a record of their learning along the way (portfolio) and were allowed to present their final submissions digitally. In this way, the process and products when showcasing solutions are valued. Digital project submissions also afford a broader reach for students' work; wherein family, peers, and community members can review and provide feedback. Digital tools such as video recordings, infographics, storyboards, or shareable presentations (Google Slides, Canva, Loom, Screencastify, Adobe Spark presentations) offer ease of recording the students' presentation that can then be viewed asynchronously by their peers, teachers, family, and community members. The aforementioned digital tools were available free to students and teachers to use in the classroom. Student investment in the authentic, real-world application resulted in a highly engaging DE learning experience for all.

Assessment Considerations

Working on personalized projects often results in a range of products created by the students. The lack of uniformity among projects can result in unfairly assessing student learning. In general, the developers of the CL framework suggest students receive feedback on their progress immediately, are provided tools for *reflection* and are given opportunities for mastery of practices (Ito et al., 2013). This might be accomplished by creating criteria sheets and checklists for students, aligned to non-traditional assessments, that highlight skills necessary to solve the problem—focused on the design, process, and presentation of solutions. These assessment practices are most often found in formative assessment as opposed to traditional summative approaches. Further, we suggest teachers incorporate diverse forms of assessments that are visible across communities. Virtual environments allow for this sort of visibility.

Formative assessment practices that a teacher might consider include: engaging students in social interaction, using peer review, creating artifacts such as design sketches, and developing explanations for their designs that are shared collaboratively with their peers. Incorporating an element of personal reflection to accompany the project assists teachers in evaluating student progress in a fair and just manner. Existing engineering design process rubrics can be modified to fit specific projects and gauge student growth in relation to CL principles and DE.

Discussion

Virtual Teaching and Democratic Learning Opportunities

American teachers were challenged in 2020 to deliver their middle grades curriculum in virtual environments that have proven to be novel landscapes for instructors and learners alike. Research demonstrates there are long-term risks of learning loss as a result of the move to virtual learning. This paper demonstrates how to draw on a CL framework (Ito et al., 2013) to assist middle grades teachers in the creation of a democratic approach to teaching and learning in physical or online instruction. We have outlined steps educators can take to develop units that aim—through student agency—to incorporate principles of a CL framework (i.e., interest-based, academically-oriented, peer-supported, openly-networked, production-centered, and shared-purpose). Specifically, we encourage teachers to identify a real-world problem in their community by brainstorming with their students to identify and explore problems they care about. We suggest exploring problems in which disciplines might naturally emerge during the process of designing a solution to the problem. With the use of accessible online collaboration tools, students draw stronger connections between the learning contexts of CL. As instructional modalities have been forcibly changed, we encourage readers to consider how they might also adapt their assessment practices to meet the needs of the virtual spaces. This may include alternative modes of submission of student work (e.g., students displaying their knowledge by creating an infographic or edited video rather than a static presentation). This shift in assessment would also require scoring rubrics to align with the steps of the engineering design process (see Appendix C – Table 3) rather than focusing only on a completed product (e.g., slides, poster, speech). Our suggestions include the use of smartphones and other inexpensive or free digital tools that all students can access online and offline. By ensuring that access to technology is not a barrier to participation, our suggestions for implementation are inclusive for *all* students. Finally, we feel the recent transition to online learning should be embraced by middle school teachers and students with positive perspectives because experiences created by an online environment can bolster opportunities for more democratic learning across contexts, time, and space.

We feel with the challenges presented by virtual and at-home-learning, there are also opportunities to facilitate a CL experience for students by incorporating their families, peers, or caring adults into their thinking and learning as a method for *extending* their learning across contexts. One of the hallmarks of CL posited by the founders of the framework states that CL addresses the gap between in-school and out-of-school and new equity gaps in learning (Ito et al., 2013). The authors suggest that CL taps into the unique learning opportunities offered by digital tools such as more easily connecting home, school, community, and peer contexts; and support of peer connections based on shared interests; and create stronger connections with non-dominant youth by drawing from the capacities of diverse communities (Ito et al.). Ultimately, the incorporation of a CL framework leverages the potential of *connection* via digital tools to celebrate both similarities and differences between students, students' families and cultures, and students' communities. When diverse pathways to participation are recognized and folded into online curriculum, all students' learning potential is expanded.

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Appendix A

Table 1

Opportunities and Challenges for Online Education Related to the COVID-19 Crisis (adapted from Mäkelä et al., 2020

Opportunities	Challenges
1. increased flexibility in schedules 2. individualization/personalization of learning 3. high-quality instruction (in some cases) 4. improved learning outcomes and skills 5. increased access to resources via use of Information and Communication Technologies (ICT) 6. online collaboration and social networking with peers 7. provide support for learners' mental and physical health 8. higher administrative efficiency 9. ensuring education in exceptional circumstances	1. requires a change in teaching methods 2. roles of teachers and parents need to change 3. new barriers/difficulties to learning (e.g., time management and self-discipline) 4. teachers' negative attitudes toward technology 5. lack of ICT competency and support 6. lack of up-to-date ICT infrastructure 7. lack of social contact (between teachers and students, and between students and their peers) 8. negative effects on learners' physical and mental health 9. increased workload and need for additional resources

Appendix B

Table 2

Guided Reflections for Educators: Designing with a Connected Learning Framework

Learning Principles - Connected Learning joins the following Contexts for Learning:	
Learning Contexts	**Guiding Reflections** Are young people given opportunities to:
Peer- Supported In their everyday exchanges with peers and friends, young people are contributing, sharing, and giving feedback in inclusive social experiences that are fluid and highly engaging.	• Contribute expertise, ideas, and questions? • Share work? • Give feedback to their peers? • Socialize and hang out? • Mess around/play in a social context?
Interest-Powered When a subject is personally interesting and relevant, learners achieve higher-order learning outcomes.	• Is the experience centered on participant interest (adult and teen)? • Can young people form groups to explore a facet of this interest? • Are there ways for young people to "lurk" as they discover new interests? • Are there supports for young people to develop expertise around their interests? • Is interest being publicized and celebrated? • Are pathways for mastery in an area of interest made visible for others to see, either within the platform or within connected experiences?
Academically-Oriented Learners flourish and realize their potential when they can connect their interests and social engagement to academic studies, civic engagement, and career opportunities	• Are mentors present who can help young people to connect their interest/activity to academic/institutional domains? • Are outputs made visible within academic/institutional contexts that have relevance to the adult world? • Do adults celebrate youth participation as academically meaningful and relevant? • Do formal/academic settings provide space/opportunity for engagement with interest?

Core Properties of Connected Learning Experiences Include:	
Production-Centered	Digital tools provide opportunities for producing and creating a wide variety of media, knowledge, and cultural content and experimental and active ways.
Shared Purpose	Social media and web–based communities provide unprecedented opportunities for cross-generational and cross-cultural learning and connection to unfold and thrive around common goals and interests.
Openly Networked	Online platforms and digital tools can make learning resources abundant, accessible, and visible across all learner settings.

Design Principles to Inform the Intentional Connection of Learning Environments:	
Everyone Can Participate	Experiences invite participation and provide many different ways for individuals and groups to contribute.
Learning Happens by Doing	Learning is experiential and part of the pursuit of meaningful activities and projects.
Challenge is Constant	Interest or cultivation of interest creates both a “need to know” and a “need to share.”
Everything is Interconnected	Young people are provided with multiple learning contexts for engaging in connected learning—the context in which they receive immediate feedback on progress, have access to tools for planning and reflection and are given opportunities for mastery of specialist language and practices.

Digital Tools Amplify Opportunities for Connected Learning by:	
Fostering engagement and self-expression	Interactive, immersive, and personalized technologies provide responsive feedback, support a diversity of learning styles and literacy, and pace learning according to individual needs.

Increasing accessibility to knowledge and learning experiences	Through an online search, educational resources, and communities of expertise and interest, young people can easily access information and find relationships that support self-directed and interest-driven learning.
Expanding social supports for interests	Through social media, young people can form relationships with peers and caring adults that are centered on interests, expertise, and future opportunity in areas of Interest.
Expanding diversity and building capacity	Digital networks empower marginalized and non-institutionalized groups and cultures to have a voice, mobilize, organize, and build economic capacity.

Note. Adapted from: Ito et al., 2013, p. 12 & 62

Appendix C

Table 3

Detailed Unit Example

Objective:	The middle school class works together to address the prompt: "How can we improve our local community?"
Selecting a Possible Topic(s):	A teacher initiates a brainstorming activity in which students are asked to list problems in the community. The structure of the brainstorming activity lends itself to supporting shared tenets of DE and CL. The topic is decided upon through a series of brainstorming sessions either in school, online, or a mix of both environments. In all settings, group norms should be established prior to beginning ensuring all student ideas are valued and individuals feel safe to participate. For example: Individual brainstorm session: Each student is tasked to develop a list of problems in the community. [IP] They are encouraged to discuss ideas with their families, other out-of-school learning mentors, peers, or caring adults. Each student's list serves as a personal connection of how students and their families see their own community. [IP] Group brainstorm sessions: In small groups of 3-4, The teacher/ facilitator prompts students to compile a digital list of issues [SP; PS] that can be shared using digital tools such as *Google Jamboard or Slides*, or another shared document. [ON] Students meet synchronously in whole-class meetings online or in-person with a teacher present to discuss further and narrow the focus of how students can improve their community by addressing one of the ideas presented in class. [AC]
Summary of Unit:	A middle school unit explored the prompt: "How can we improve our local community?" Students brainstormed ideas related to quality of school lunches, lack of crosswalks in high-traffic areas near their homes, localized flooding, safety on school buses, and playground safety to name a few. Once the list was narrowed down, the students voted [DE] to select the topic to work on as a class. Each class voted for their own topic, thus different class periods investigated different community issues. [IP] One class selected the problem of student safety on school buses. Students expressed concerns over overcrowding and the lack of a clear aisle to enter and exit the bus. Students reported difficulty with bookbags and personal items clogging the aisleway. The district's buses are like many other schools, they lack adequate storage space for student belongings and seat belts. Ultimately, students decided the project would investigate the development of a storage unit that could retrofit onto existing bus seats for the safe storage of student belongings.
Unit Tasks	Additional student activities: 1. Intro to the Design Process: Introduced students to the Engineering Design Process (EDP) with the help of the Technology Education teacher. Students used a digital collaborative environment

dedicated to the project to share progress, learning, resources, etc. [ON; AO; SP]

2. Define the Problem Further: The students helped define the problem during their brainstorming sessions. They used this problem to research and collect background information pertinent to the problem. Students self-organized into groups to decide if the bus trips were, in fact, overcrowded. [AO] One way they collected evidence of the problem included using their cell phones to take pictures of what the inside of the bus looked like in the morning and afternoon trips on multiple days. [ON] Personal interviews of students supported visual evidence of overcrowdedness. Asking students if they have ever experienced a fall, trip, or unsafe time on the bus required interview skills. A written transcript of these interviews along with the pictures served as artifacts of student learning. [AO]
3. Conduct Background Research: Students measured backpacks (L x W x Depth) and recorded data in a shared digital document. Students considered both elementary and high school students' backpack measurement data. These measurements were averaged to determine the storage unit size needed to accommodate the various age levels of student backpacks. Math skills were highly involved in this phase through the computation and use of spreadsheets to collect, share, and analyze data. [AO; SP; PS; PC]
4. Specify Requirements Needed for Solution: Students photographed and measured the area under the bus seat on multiple buses to determine how the prototype could be attached and what size would fit. Drawings and comparison activities encouraged discourse among team members and allowed for team building. [PC; AO; PS; SP]
5. Brainstorm Solutions: Students sketched possible prototypes on paper or digitally. Students presented their prototypes to their group or class and invited group discussion to determine which design to "manufacture." This further exemplifies the principles of DE.[PC; AO; PS; SP]
6. Build a Prototype: Students used a variety of materials to develop and build a prototype. [PC] Possible materials used included wood, metal, or plastic. Reaching out to caring adults, high school shop classes, and local Vo-Tech center teachers for help building a metal prototype could broaden the community scope of the project. [ON; AO] Once students had 2-D drawings, a smaller 3-D prototype would be easier for students to envision and build.
7. Testing and Redesign: It is important for students to test their prototypes. Teachers might arrange for a school bus to park at the school during the day so students can install at least one prototype. Following the prototype test, they redesign as needed to best accommodate the constraints of the project. Because of time limitations in the classroom, this unit concluded with one iterative cycle of design prototype-test-redesign before students offered their reflections.

*Assessment:

Assessment Criteria	Not Attempted	Developing	Achieved
1. Brainstorms Community			

	Issues (student provides evidence)
	2. Statement of the Problem (student re-states in final process/ product)
	3. Findings from Background Research (student includes notes, drawings, list of sources to support the design solution)
	4. Design Solution (student provides evidence of an original or group prototype)
	5. Participation in Group Discourse (student explains in what ways they added to the conversation through questions asked or explanations offered)
	6. Personal and/ or Group Reflection (student explains how their design/ ideas affected the solution to a community issue)

*By providing students with an assessment rubric at the beginning of the project, teachers can remind students to keep evidence and artifacts relevant to each criteria such as in a digital portfolio as suggested by Beane, 2019.

Connections to Democratic Learning:	● Personalized ● Content Accuracy/ Knowledge Construction ● Collaborative, Peer-supported activities ● Community-Based ● Equitable solution to meet the needs of all soci-economic levels
Connections to Connected Learning:	● Selected topic through personal student-interest [IP] ● Academically-oriented including multiple content areas [AO] ● Requires teamwork and peer-support [PS] ● Encourages the use of community members and ties to local resources [SP] ● Produces a tangible product to solve a problem [PC] ● Research and collaboration occurred both asynchronous and syncronously via digital tools, which lowered barriers to participation [ON]
Overall Project Summary	Developing a cost-effective, retro-fit storage system underneath school bus seats provides all students with a safer route to and from school. Leading the students through a real-world problem they experience first-hand provides a meaningful learning event and impresses upon the importance of using the Engineering Design Process (EDP) to solve problems. Ideas to expand the project to service public transportation could address larger

	societal issues for all consumers including students that rely on public transportation for daily life.
Shift to Online Learning	The ability of a teacher to facilitate this complex lesson when not in a face-to-face (F2F) environment is still possible given the availability of certain digital tools. Modifications such as using small group activities and breakout rooms with free versions of conference software will allow the facilitation of the brainstorming activities noted above. Using a secure digital classroom platform (or LMS) to post announcements, share documents and communicate both synchronously and asynchronously will allow the project to adhere to following the Engineering Design Process (EDP) as explained in the table above.

Note. Elements of Connected Learning are denoted using the following tags:
IP = Interest-Powered; PS = Peer-Supported; AO = Academically-oriented;
ON = Openly-Networked; PC = Production-Centered; & SP = Shared Purpose.
The ambiguity of the driving question allows students to think broadly about their own experiences. The teacher uses this opportunity to encourage students to think for themselves and not rely on the teacher for direction. A driving question should be broad enough so that all of the activities fall under the category. The purpose of a DQ is so that all discipline-specific activities are. For example, students solved math problems related to volume to determine if there is enough room under the seat.